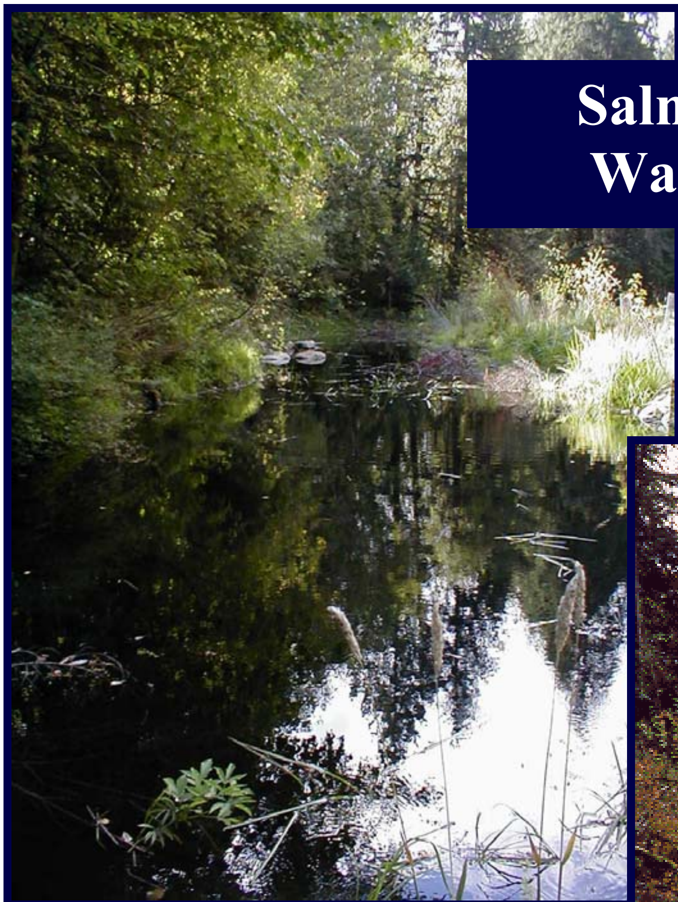
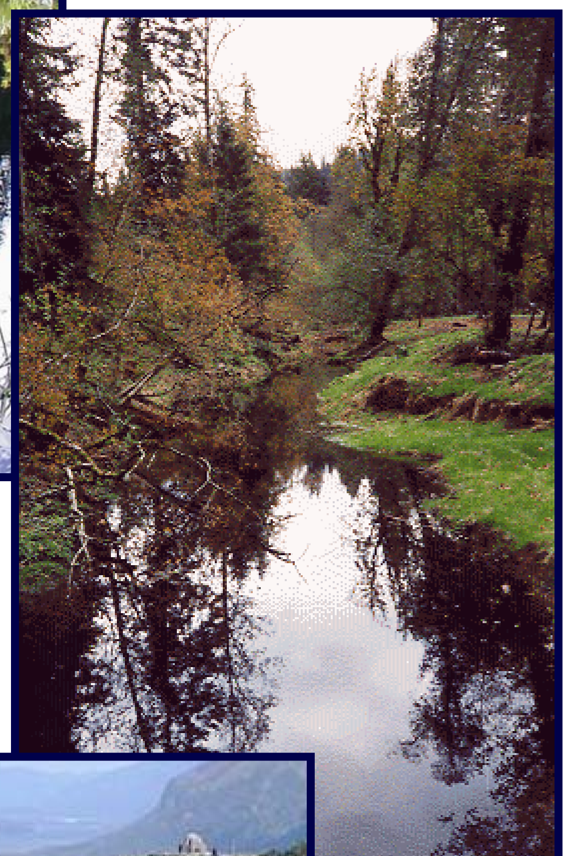
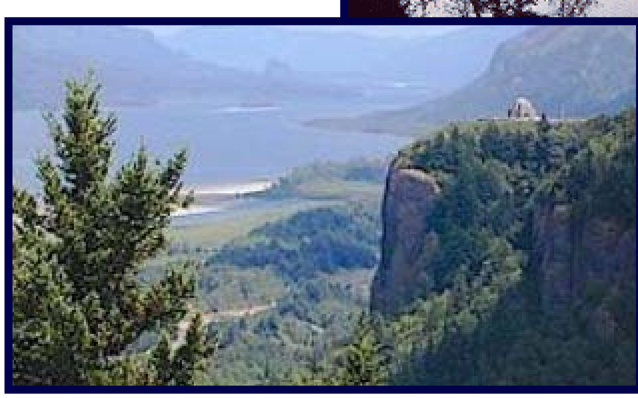
Salmon-Washougal and Lewis Watershed Management Plan



"Our mission is to develop and implement a watershed management plan for the responsible use of water to balance the needs of people and natural resources."





Lower Columbia Fish Recovery Board, Lead Agency
Counties of Clark, Cowlitz and Skamania

[Org. 7/21/06]

Salmon-Washougal & Lewis Watershed Management Plan

WRIAS 27-28

Adopted
In Joint Session by the Commissioners
By
Clark, Cowlitz and Skamania Counties
July 21, 2006

Lead Agency:
Lower Columbia Fish Recovery Board

For Submission to the Planning Area Counties
WA Ecology Grant #9900294

Prepared by:

HDR | ees

Initiating Governments

Clark County

Cowlitz County

Skamania County

Yakima County[1]

Cowlitz PUD

Clark Public Utilities

City of Vancouver

City of Woodland

Chinook Tribe

Cowlitz Tribe

Yakama Nation

Planning Unit

Camas Washougal Wildlife League

CDID#2

Chinook Tribe

Citizen-At-Large

City of Battleground

City of Camas

City of Kalama

City of La Center

City of North Bonneville

City of Ridgefield

City of Vancouver

City of Washougal

City of Woodland

Clark County

Clark County Responsible Growth Forum

Clark Public Utilities

Clark Skamania Fly Fishers

Columbia River EDC

Cowlitz County

Cowlitz Indian Tribe

Cowlitz PUD

Friends of the East Fork

PacifiCorp

Port of Kalama

S.E.H. America, Inc.

Sierra Club

Skamania County

Town of Yacolt

US Forest Service – Gifford Pinchot

WA Department of Agriculture

WA Department of Ecology

WA Department of Fish and Wildlife

WA Department of Natural Resources

Weyerhaeuser Corp.

Yakama Indian Nation

[1] Yakima County has opted out of the process pursuant to RCW 90.82.130

Lead Agency and Consultants

Lower Columbia Fish Recovery Board:

Jeff Breckel, Executive Director
Steve Manlow, Salmon Recovery and Watershed Plan Manager
Phil Trask, Watershed and Recovery Plan Coordinator
Melody Tereski, Program Manager
Lorie Clark, Program Assistant
Gary Wade, Habitat Project Coordinator

GeoEngineers, Inc.:

Terry Fisk
Chuck Lindsay
John Koreny

HDR/EES, Consultants:

Andrew Graham
Ronan Igloria
Jeff Hansen
Wade Hathhorn
Jerry Louthain
Kelly O'Rourke

Pacific Groundwater Group:

Linton Wildrick

Pacific Water Resources:

Lew Scholl
Roger Sutherland
Habib Matin
Seth Jelen

Other Consulting Staff:

Michael Barber, PhD

Participants

Sam Adams	City of Battleground
Anita Ashton	City of Camas
John Barnett	Cowlitz Indian Tribe
Marc Boldt	Clark County Board of Commissioners
Charly Boyd	Skamania County Planning
Monte Brachmann	City of Camas Planning
Lynn Briscoe	WA Department of Agriculture
Mike Buckner	Cowlitz Indian Tribe
Mike Conway	City of Washougal
Rich Costello	WA Department of Fish and Wildlife
Brian Cowan	Clark County
Greg Cox	US Forest
Linda Crerar	WA Department of Agriculture
Richard Cyr	Clark Public Utilities
Dick Doi	Friends of the East Fork
Jim Donald	CDID#2
Dick Dyrland	Friends of the East Fork
Paula Ehlers	WA Department of Ecology
Eric Eisemann	City of Ridgefield
Stan Elliott	Chinook Tribe
Mark Engel	WA Department of Natural Resources
Kari Fagerness	Skamania County Planning
Bill Feddeler	Sierra Club
Dave Flemings	Cowlitz County Planning
Earl Ford	US Forest Service
Jim Gajkowski	City of La Center
Ross Graham	Weyerhaeuser Corp.
Donna Hale	WA Department of Fish and Wildlife
Steve Hartsell	WA Department of Natural Resources
Dave Howard	WA Department of Ecology
Steve Huang	WA Department of Natural Resources
Kathleen Johnson	Cowlitz County Board of Commissioners
Peggy Kain	US Forest Service
Steve Kenworthy	City of Ridgefield
Tim Kraft	Responsible Growth Forum
Monte Kress	Port of Kalama
Bert Lake	CDID#2
Steve Langdon	City of Woodland
Steve Lanigan	US Forest Service
Claire Lavendel	US Forest Service
Bob Levin	Columbia River Economic Development Council
Eric Levison	City of Camas Planning
Tom Loranger	WA Department of Ecology

Steve Manlow	WA Department of Fish and Wildlife
Rick Marlow	WA Department of Natural Resources
Carl McCrary	City of Kalama
Matt McCudden	Clark Public Utilities
Al McKee	Skamania County Board of Commissioners
Scott McKinney	WA Department of Ecology
Tony Meyer	Camas-Washougal Wildlife League
Cindy Morgan	Citizen-At-Large
Betty Sue Morris	Clark County Board of Commissioners
Paul Pearce	Skamania County Board of Commissioners
Byron Perry	Responsible Growth Forum
Bart Phillips	Columbia River Economic Development Council
Steve Prather	Clark Public Utilities
Craig Pridemore	Clark County Board of Commissioners
Doug Quinn	Clark Public Utilities
Bud Quinn	Skamania County Board of Commissioners
George Raiter	Cowlitz County Board of Commissioners
Jeff Rasmussen	Cowlitz County Board of Commissioners
Jim Richardson	Skamania County Board of Commissioners
Vicky Ridge-Cooney	City of Vancouver
Joel Rupley	Clark County ESA Program
David Russell	Cowlitz Indian Tribe
Mike Sallis	Cowlitz County
Laura Sauermilch	WA Department of Ecology
Al Schauer	Responsible Growth Forum
Leon Smith	Cowlitz PUD
Harry Snoey	City of Ridgefield
John Sowinski	WA Trout
Elaine Spray	City of Vancouver Planning
Judy Stanton	Clark County Board of Commissioners
Steve Stenberg	SEH America
Teresa Strange	WA Department of Health
Steve Stuart	Clark County Board of Commissioners
Dean Sutherland	Clark Public Utilities
Mike Swanson	City of Vancouver Planning
Dean Swanson	Citizen-At-Large
Don Swanson	Friends of the East Fork
Rod Swanson	Clark County Public Works
Harris Teo	Yakama Indian Nation
Paul Tester	City of Yacolt
Tim Thompson	City of Ridgefield
Kim Titus	US Forest Service
Ruth Tracy	US Forest Service
John Tyler	Clark County ESA Program
Lee Van Tussenbrook	WA Department of Fish and Wildlife
Rob VanderZanden	City of Woodland

Tom Weldon	City of Ridgefield
Kirk Willis	WA Department of Natural Resources
Mark Wilson	Port of Kalama
Jeff Wittler	Clark Public Utilities
Ron Worthington	Cowlitz PUD
Carla Yetter	SEH America

Table of Contents

Tables

Exhibits

Appendices

Appendices for Chapter 7 Bound as Separate Volumes:

Acronyms

ADD	average day demand
afy	acre feet per year
APA	Aquifer Protection Area
ASR	Aquifer Storage and Recovery
BMP	Best Management Practice
CARA	Critical Aquifer Recharge Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CIR	Crop Irrigation Demand
CPU	Clark Public Utilities
CWA	Clean Water Act
DO	Dissolved Oxygen
DOH	Washington State Department of Health
EAP	Environmental Assessment Program
Ecology	Washington State Department of Ecology
EES	Economic and Engineering Services
ENSO	El Nino/Southern Oscillation
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act
FC	Fecal Coliform
FERC	Federal Energy Regulatory Commission
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FTE	full time equivalent
GMA	Growth Management Act
gpm	gallons per minute
GPS	Global Positioning System
GWAC	Ground Water Advisory Committee
GWMA	Ground Water Management Area
GWMP	Ground Water Management Plan
IFIM	Instream Flow Incremental Methodology
IOCs	Inorganic Compounds
LCFRB	Lower Columbia Fish Recovery Board
LFA	Limiting Factors Analysis
LWD	large woody debris
MCLs	Maximum Contaminant Levels
MDD	maximum day demand
mgd	million gallons per day
MOU	Memorandum of Understanding
MTBE	methyl tertiary-butyl ether
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NWPPC	Northwest Power Planning Council
PDO	Pacific Decadal Oscillation
PGG	Pacific Groundwater Group

PWR	Pacific Water Resources, Inc.
PWS	Public Water System
Qa	authorized annual withdrawal/diversion
Qi	authorized instantaneous withdrawal/diversion
Ranney Well	A shallow perforated pipe used to extract shallow ground water beneath a river bed
RCRA	Resource Conservation and Recovery Act
RM	River Mile
SDWA	Safe Drinking Water Act
SOCs	Synthetic Organic Chemicals
SSA	Sole Source Aquifer
SWSL	Surface Water Source Limitation
SWTR	Surface Water Treatment Rule
TAG	Technical Advisory Group
TSCA	Toxic Substances Control Act
TMDL	Total Maximum Daily Load
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Service
VOCs	Volatile Organic Chemicals
WMA	Watershed Management Act
WSDA	Washington State Department of Agriculture
WSU	Washington State University
WRIA	Water Resource Inventory Area

Executive Summary

Introduction and Purpose

Under the State of Washington's Watershed Management Act (Chapter 90.82 RCW) local governments are authorized to initiate a watershed planning process. The process is broad in scope and involves stakeholders and agencies at the local, regional, state and federal levels. The watershed planning program is designed to foster planning for water quantity, water quality, aquatic habitat and instream flow in a comprehensive and integrated fashion.

This Watershed Management Plan has been prepared for Water Resource Inventory Areas (WRIAs) 27 and 28. WRIA 27 comprises the Kalama and Lewis River Basins. WRIA 28 comprises the Salmon Creek, Burnt Bridge Creek, Lacamas Creek, and Washougal River Basins, as well as additional smaller creek basins. Most of the land area within WRIAs 27 and 28 lies within Clark, Cowlitz and Skamania Counties. A very small portion of WRIA 27 also extends into Yakima County. Exhibit ES-1 displays the planning area. WRIAs 27 and 28 include several subbasins that drain to the Columbia River, but do not include the Columbia River itself. Therefore, management of the mainstem Columbia River is not addressed in this plan.

Most of the urban development in WRIAs 27 and 28 is centered in Clark County. Cowlitz County has some urban lands. Skamania County is rural in character and has no incorporated cities or towns. Water needs and appropriate solutions therefore vary from County to County.

The WRIA 27 and 28 Planning Unit met on a monthly basis from 1999 through 2004. During this period the Planning Unit undertook an assessment of water resource conditions, commissioned a series of technical memoranda on water resource issues and solutions, and oversaw preparation of the Management Plan. The Planning Unit was staffed by the Lower Columbia Fish Recovery Board (LCFRB) serving as Lead Agency for this effort. On a parallel track, the LCFRB has also coordinated the development of the Lower Columbia recovery plan for Endangered Species Act listed salmon and other fish and wildlife. Portions of the recovery plan constitute the habitat element of the Watershed Management Plan.

Planning objectives defined by the Planning Unit are listed in Table ES-1. These objectives were used as a basis in developing more detailed policy statements and recommendations within the Plan.

The remainder of this Executive Summary highlights the management policies and recommendations developed in five key areas: Water Supply, Stream Flow, Surface Water Quality, Ground Water Quality, and Habitat. In addition, a summary of implementation considerations for carrying out these elements is provided. More detailed information on these topics can be found in the full Plan document.

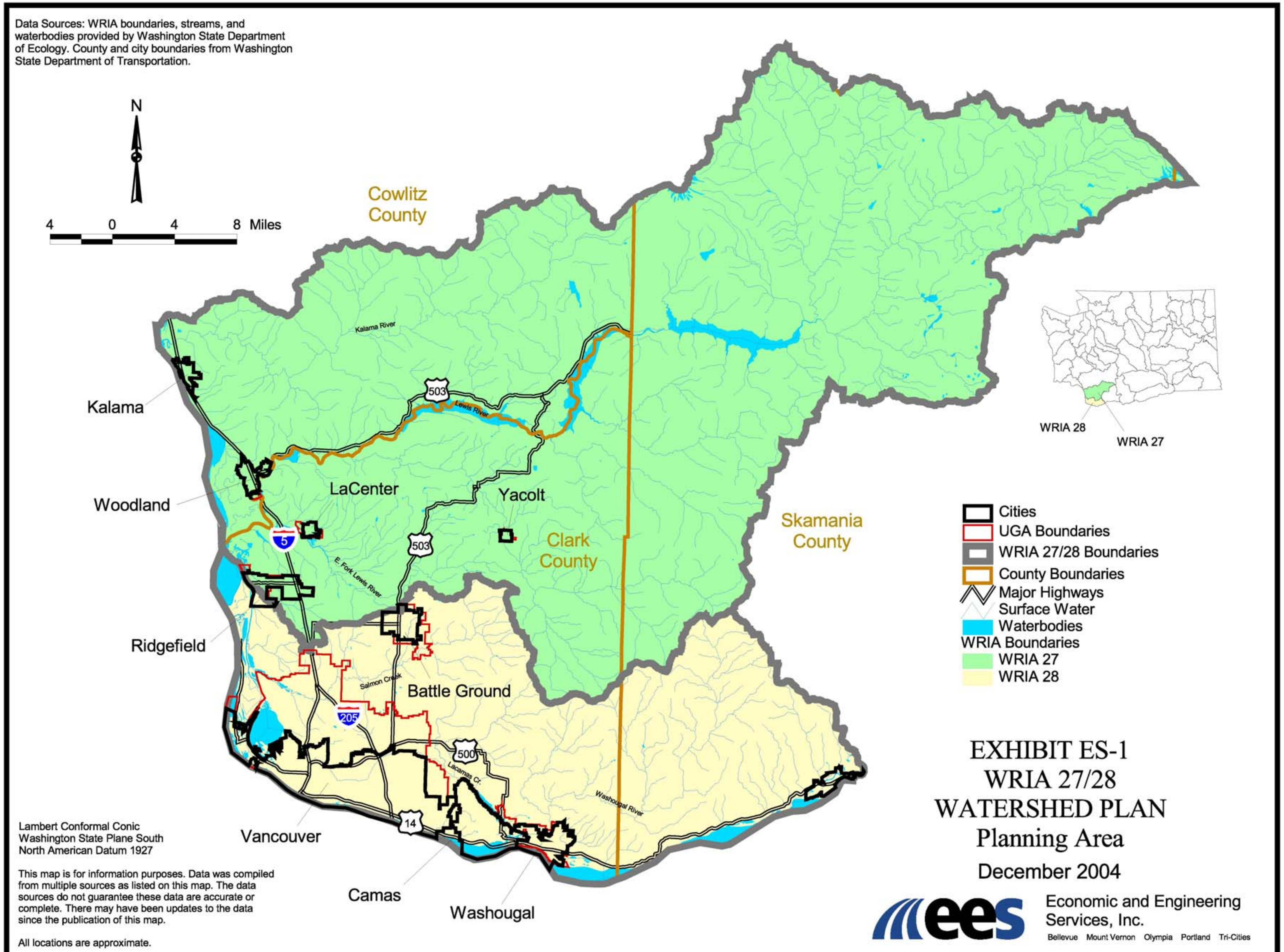

Data Sources: WRIA boundaries, streams, and waterbodies provided by Washington State Department of Ecology. County and city boundaries from Washington State Department of Transportation.
N
4 0 4 8 Miles
Cowlitz County
Kalama River
Kalama
503
Lewis River
Woodland
LaCenter
Yacolt
5
503
E. Fork Lewis River
Clark County
Skamania County
Ridgefield
Salmon Creek
Battle Ground
205
500
Lacamas Cr.
Washougal River
14
Vancouver
Camas
Washougal
WRIA 28
WRIA 27
Cities
UGA Boundaries
WRIA 27/28 Boundaries
County Boundaries
Major Highways
Surface Water
Waterbodies
WRIA Boundaries
WRIA 27
WRIA 28
EXHIBIT ES-1
WRIA 27/28
WATERSHED PLAN
Planning Area
December 2004
Lambert Conformal Conic
Washington State Plane South
North American Datum 1927
This map is for information purposes. Data was compiled from multiple sources as listed on this map. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this map.
All locations are approximate.
ees
Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities

Table ES-1
Planning Objectives

I. Objectives to Protect or Enhance Conditions in the Watershed

- Effectively and efficiently manage water to ensure availability, reliability and predictability for beneficial uses over the long term, considering ongoing changes in population, local economies, and water-use technology.
- Manage stream flows effectively to sustain aquatic biota, including fish populations in their various life stages.
- Protect surface water quality for designated uses, with an emphasis on protection of aquatic biota, including fish species in their various life stages.
- Protect surface and ground water needed for public drinking water supplies.
- Maintain productive habitat and enhance degraded habitat forming processes for indigenous fish species in all life stages.
- Protect and enhance wetlands and floodplains, with associated benefits for flows, water quality, ground water recharge and flood control.

II. Objectives Regarding the Process for Developing and Implementing the Watershed Plan

- Manage water resources in a cost-effective manner, taking into account existing programs, potential partnerships, cost/benefit principles, and opportunities to achieve multiple objectives.
- Ensure strategies contribute to a healthy local and regional economy.
- Ensure plan can be implemented through sustained support by local governments, state agencies, tribes, water-use interests and the public.
- Provide for extensive and meaningful public participation.
- Ensure fairness in distributing costs and burdens of water-resource management actions.
- Improve public understanding of water resources and encourage responsible stewardship.

III. Objectives for Improved Information and Data Management

- Improve scientific basis for decision-making on water-resource issues, through sound data, accepted technical methods, and effective quality assurance/quality control protocols.
- Develop an effective adaptive management program, supported by long-term monitoring and ongoing developments in scientific understanding.

Policies and Recommendations

To achieve the objectives listed above, the Planning Unit carried out a detailed assessment of water resource conditions, and developed a wide-ranging set of policies and recommendations. Table ES-6 at the end of this Executive Summary summarizes all of the policy statements developed in this Watershed Management Plan. Under each policy a set of specific recommendations is then presented. These policies are discussed further in the following sections of this Executive Summary.

Management of Water Supplies

Three principles guided the development of water supply strategies for WRIAs 27 and 28. First, existing water rights cannot be changed or impaired by this Watershed Management Plan. Second, as the region continues to grow and develop, new or expanded water supplies will be needed for communities, businesses, and citizens. Third, diversion of water from streams or pumping from aquifers can deplete stream flows, with unintended consequences for aquatic habitat. The watershed planning effort provided an opportunity to explore strategies for striking a balance among the latter two principles, without impairing existing water rights.

In order to strike this balance, two policies for management of water supplies were developed. These policies are:

Policy WSP-1: Public and private water users throughout WRIAs 27 and 28 should have access to water resources to meet new or expanded needs for water supply consistent with adopted land use plans.

Policy WSP-2: Water resource development to meet new or expanded needs should avoid or minimize effects on stream flows or aquatic habitat in stream reaches where flow conditions are an important factor for sustaining aquatic life, including fish populations in their various life stages.

To put these policies into operation, the Planning Unit reviewed a range of water management strategies. These strategies included development of new surface or ground water supplies; water conservation; water reclamation and reuse; voluntary transfers of water rights; aquifer storage and recovery; and surface water storage.

The Planning Unit also examined the needs of specific communities and other water user groups within WRIAs 27 and 28. Profiles of water needs were developed for Vancouver, Clark Public Utilities, Camas, Battle Ground, Washougal, Woodland, Kalama, and Ridgefield. Water demands were also assessed generally for smaller public water systems throughout the region, and for homeowners who rely on domestic wells. Collectively, the need for water from public water supply and domestic wells is projected to increase by 57 percent from year 2000 to 2020. Further growth is anticipated in the decades following 2020.

In addition, there is a potential that new industrial facilities will need water supplies. While this need is difficult to quantify, the policies developed in the plan are intended to provide for this need in areas where sufficient supplies are available. Needs for additional water in the agricultural sector are not well defined. While this is not a strong growth sector, there are some pending applications for new water rights.

Clark County is the most urbanized of the three counties involved in this planning effort. The two largest water suppliers in Clark County, the City of Vancouver and Clark Public Utilities, have both identified new ground water supplies in the vicinity of Vancouver Lake as a key to meeting local and regional demands in the long term. This supply is advantageous in that it offers abundant quantity with little or no impact on streams that support salmon and other aquatic life. The Planning Unit views this supply as a key resource for the region. There will be challenges in developing this resource, including management of issues related to ground water contamination at Port of Vancouver lands. The Planning Unit recommends that local and State jurisdictions consider this a high priority and work diligently to overcome these challenges.

Stream flow in the lower reaches of streams that flow into the Columbia River in WRIAs 27 and 28 are influenced by tides from the Pacific Ocean, as well as other changes in water level on the Columbia River. Whenever the water level in the Columbia River is higher than the water level of the tributary's natural flow, the tributary is backed up. At some times and places this can extend for miles upstream of the tributary's mouth. At these times and places, diversions for water supply do not influence flows or water levels to any measurable degree.

Because of this effect, the Planning Unit anticipates that water users needing new or expanded rights from tidally influenced reaches should be able to have access to water rights. Policies presented in the stream flow management section of this plan reflect this consideration. This affects the North Fork Lewis River in particular, where relatively abundant flows and a low gradient are combined.

Some communities in WRIAs 27 and 28 have water sources located upstream of tidally influenced reaches. These communities will also need access to water supply. In order to prevent unnecessary impacts on stream flow, however, issuance of new water rights to these communities should be carefully managed. The Planning Unit offers a proactive set of recommendations to address these situations. Communities should evaluate all reasonable alternatives prior to developing a new supply that will reduce late summer stream flows. For example, in some locations ground water from deeper confined aquifers may be more appropriate than shallow ground water sources. Where alternatives are either infeasible or prohibitively expensive, other approaches such as water conservation and development of reclaimed water supplies can help reduce needs for new supplies. The Planning Unit recommends a procedure whereby these alternative solutions must be explored in detail before Ecology issues new water rights that would impact stream flows. Where such rights are issued, mitigation should be provided to offset the effect on stream flow, at least in part.

The Plan presents policies and recommendations on water supply and stream flow in Sections 3 and 4 respectively. These two sections should be reviewed jointly since they are closely interrelated. Section 4 on stream flow management contains provisions that would guide Ecology's decision-making on new water right applications. At the same time, diversions of surface water and pumping from aquifers are not the only human activities that affect stream flows. The stream flow management section of this Watershed Management Plan also addresses a number of other factors that are important influences on stream flow and aquatic habitat.

Management of Stream Flows

This Watershed Management Plan explores tools for managing stream flow that include management of existing and new water supplies, management of land uses that affect the volume and timing of runoff, improved monitoring of stream flow, and target flow goals to guide management actions. In developing recommendations for this Plan, effects on both low flows and high flows were considered.

The range of flow management techniques discussed in this Plan is listed in Table ES-2. Table ES-6 at the end of this Executive Summary lists policies and associated recommendations for stream flow management. Policies SFP-2 through SFP-8 are related to management of water supplies to protect or improve stream flows. Policies SFP-9 through SFP-13 focus on management of land uses as related to stream flows.

Table ES-2
Stream Flow Management Techniques

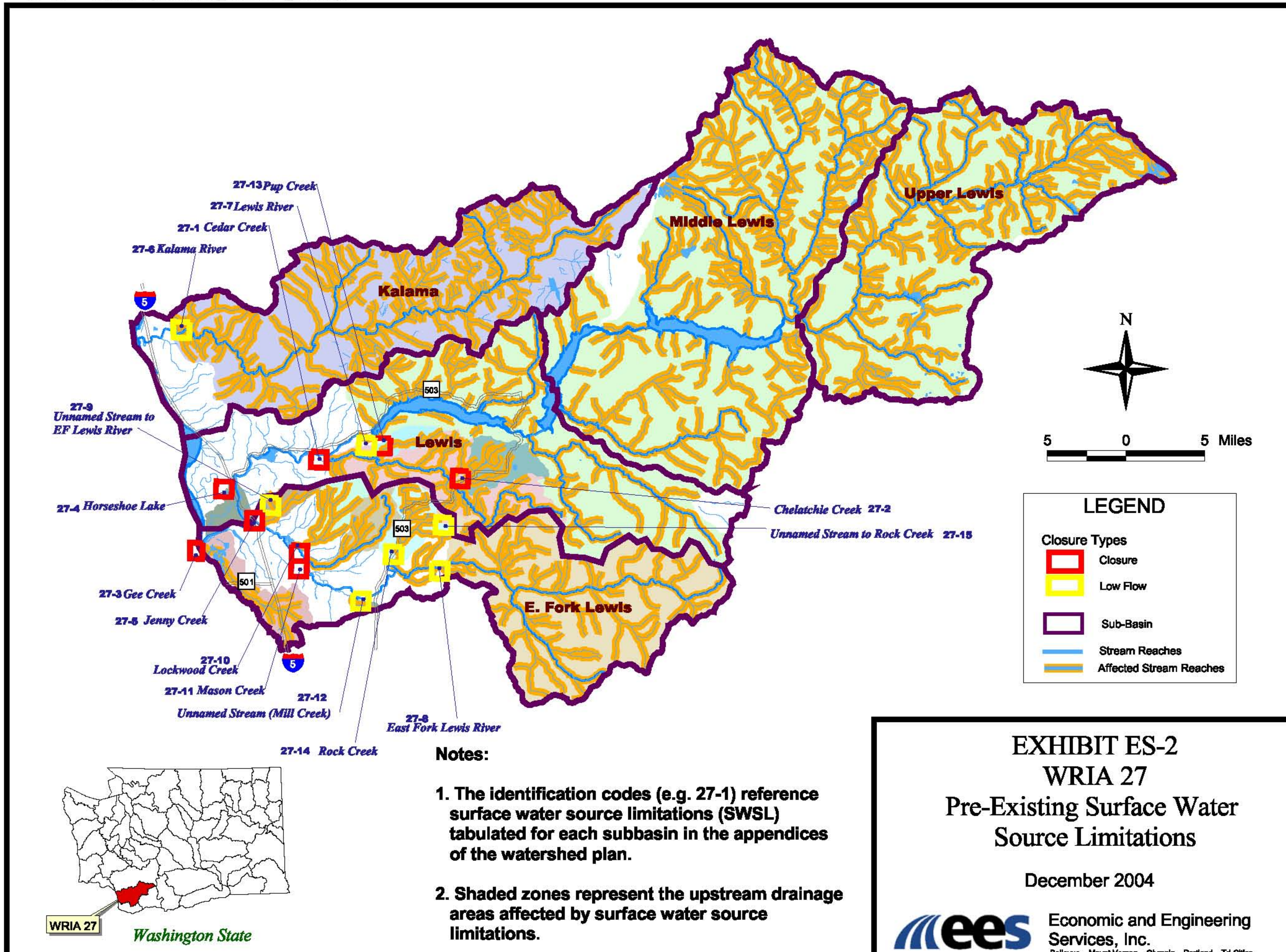
Category	Technique	Affects Low Flow	Affects High Flows
Water Use	Restrict issuance of new water rights	✓	N/A
	Water conservation	✓	N/A
	Curtailment or changed operations in drought conditions	✓	N/A
	Source substitution	✓	N/A
	Transfers to State Trust water rights	✓	N/A
	Enforcement actions against unauthorized water uses	✓	N/A
Land Use	Forest practices	✓	✓
	Development practices and stormwater management	✓	✓
	Floodplain management	✓	✓
	Wetlands management	✓	✓

Stream Flow Protection Rule

Policy SFP-2 warrants particular attention due to the extent of stakeholder interest in availability of water rights and the impact of new water rights on stream flow. For many decades the State of Washington has restricted issuance of water rights in selected basins within WRIAs 27 and 28 via administrative stream closures and minimum instream flows, to protect stream flows from depletion. These pre-existing restrictions are shown on Exhibits ES-2 and ES-3. This Watershed Management Plan recommends that the Washington State Department of Ecology (Ecology) bolster these restrictions on new water rights by formally adopting them as a regulation. The Plan also recommends Ecology extend these restrictions to cover more of WRIAs 27 and 28. The recommended closures and instream flows are presented in Exhibits ES-4 and ES-5 for WRIAs 27 and 28 respectively. The State process for adopting such restrictions includes further opportunities for public input.

In developing this policy, the Planning Unit also intends to provide for needs for new water supplies across the region. The Planning Unit recommends that the regulation adopted to restrict new water rights also provide several important exceptions. First, it should be recognized that existing water rights will not be affected by this rule; only applicants for new water rights will be affected. Second, certain areas where water is backed up by the Columbia River will not be subject to these restrictions. This applies to the lower reach of the Lewis River, which is tidally influenced for several miles upstream of the river's mouth. Water users in this area will not be affected by the new regulation; they will continue to be able to apply for new water rights under normal procedures for water rights processing.

12/6/2004 C:\GIS\Projects\WRIA_25-28\wria_25-28.apr



Notes:

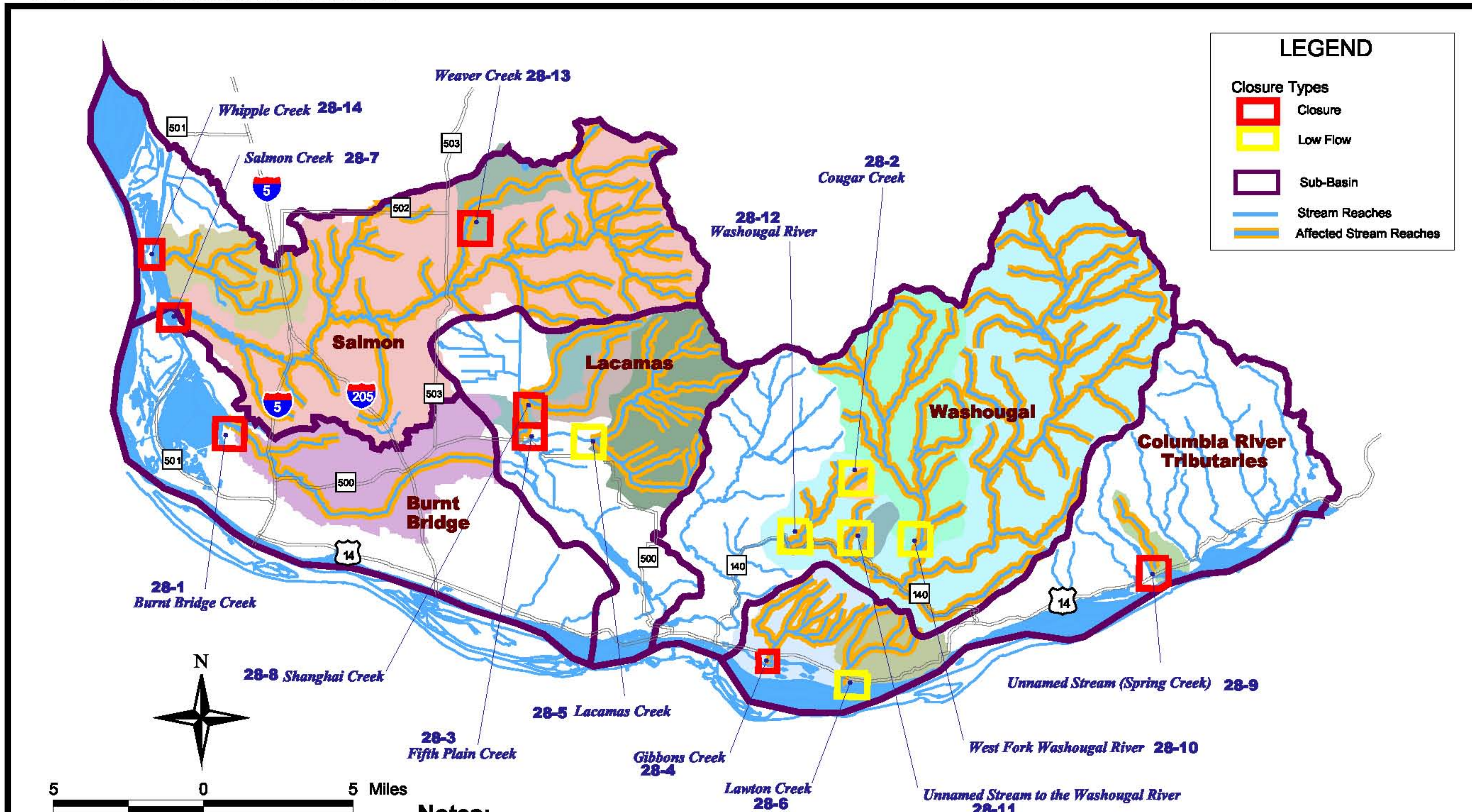
1. The identification codes (e.g. 27-1) reference surface water source limitations (SWSL) tabulated for each subbasin in the appendices of the watershed plan.
2. Shaded zones represent the upstream drainage areas affected by surface water source limitations.

EXHIBIT ES-2
WRIA 27
Pre-Existing Surface Water Source Limitations

December 2004

ees Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities

12/6/2004 C:\GIS\Projects\WRIA_25-28\wria_25-28.apr



Notes:

1. The identification codes (e.g. 28-1) reference surface water source limitations (SWSL) tabulated for each subbasin in the appendices of the watershed plan.

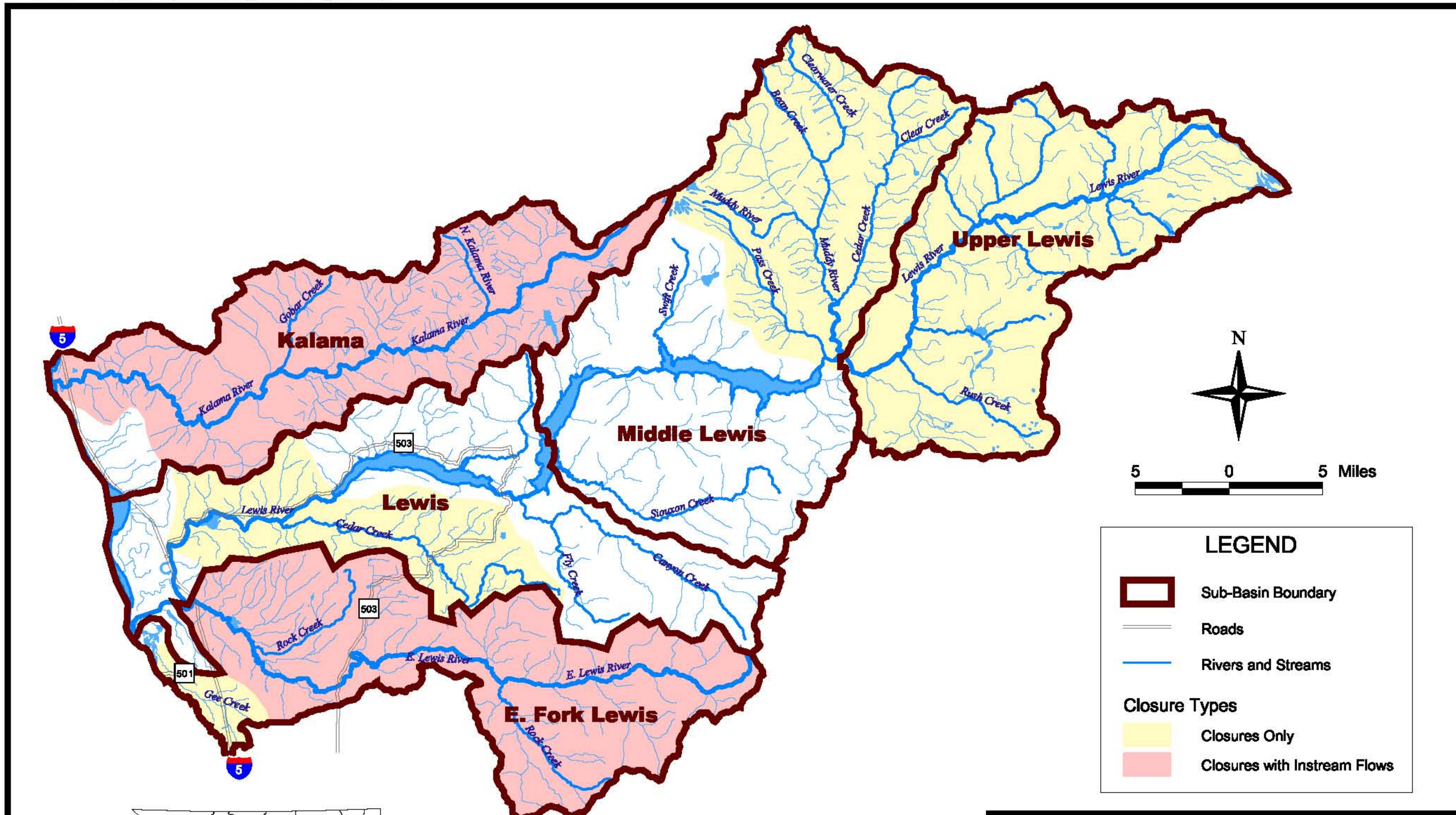
2. Shaded zones represent the upstream drainage areas affected by surface water source limitations.

EXHIBIT ES-3
WRIA 28
Pre-Existing Surface Water Source Limitations

December 2004

Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities

12/6/2004 C:\GIS\Projects\WRIA_25-28\wria_25-28.apr



Notes:

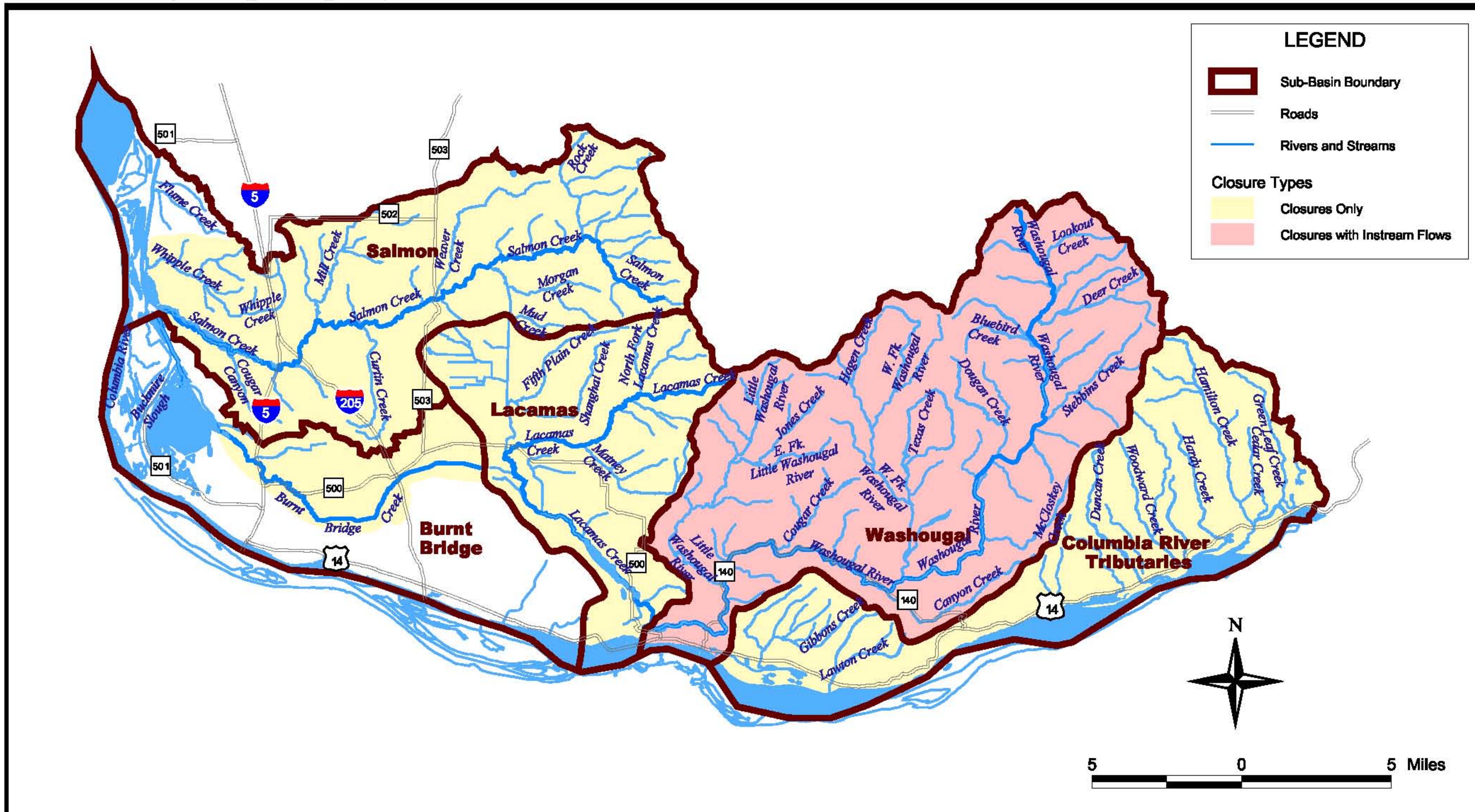
1. Shaded zones represent approximate drainage areas affected by recommended restrictions. See Table H-1 for specifics.
2. Tidal reach areas have no recommended restrictions.

EXHIBIT ES-4
WRIA 27
Recommended Instream Flows and Closures

December 2004

Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities

12/6/2004 C:\GIS\Projects\WRIA_25-28\wria_25-28.apr



Notes:

1. Shaded zones represent approximate drainage areas affected by recommended restrictions. See Table H-1 for specifics.

2. Tidal reach areas have no recommended restrictions.

EXHIBIT ES-5
WRIA 28
Recommended Instream Flows and Closures

December 2004

ees Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities

Third, a pre-defined block of water will be "reserved" for communities, domestic wells and other beneficial uses. These reservations are identified by subbasin. . A water right granted under a reservation shall have a priority date that is the same as the date the rule was adopted. The intent of this provision is to ensure that existing communities will continue to have access to water to meet their needs for growth. However, the quantity of water will be limited. Except for domestic well owners, applicants desiring access to this supply will need to meet stringent conditions to ensure other alternatives have been considered and any new uses are carefully managed and partially mitigated. This approach balances the need for flow protections with the need for additional supply as the region grows.

If a water reservation is to be tapped, the water right applicant must further demonstrate responsible management of the resource, through off-setting actions, water conservation, or similar efforts. Actions should focus on those activities that can directly offset effects of pumping or diversions. For example, buying out and retiring upstream water rights can offset new withdrawals. As a second tier, mitigation may include other types of habitat restoration activities that do not directly offset flow impacts of expanded water supply. These actions should focus on restoration that optimizes habitat relative to instream flow.

These mitigation requirements do not apply to domestic well reservations.

It is important to clarify the relationship between reservations and domestic wells. Under current state law a person installing a domestic well to withdraw up to 5,000 gallons per day (including a well serving multiple residences) does not need to apply for a water right permit. The Watershed Management Plan makes no change to this exemption. However, through discussions with Ecology, the Planning Unit concluded that the ability of landowners to install domestic wells could be at risk under current law, in any area where a stream closure or minimum instream flow has been established. There are many such areas in WRIAs 27 and 28. The establishment of a water supply reservation for domestic wells in each subbasin is intended to protect the rights of landowners to install domestic wells, even in subbasins where stream closures and/or minimum instream flows have been established.

Table ES-3 provides a summary of the water right reservations developed for WRIAs 27 and 28, based upon an analysis of water needs through 2020. The net stream flow depletion allowance depicted in the table reflects the mitigation element described above. As the need is identified through the plan review process outlined in Chapter 8, the water right restrictions and reservations should be evaluated to determine whether changes are needed to achieve the objectives of this Watershed Management Plan. For example, reservations may need to be increased as growth occurs beyond 2020 if such increases are compatible with objectives for aquatic habitat protection. If the rule adopted by Ecology is amended based on rule and/or plan evaluation, the Planning Unit intends the quantity of water reserved not be decreased.

Additional exceptions from water right restrictions include temporary uses of water for environmental restoration purposes, non-consumptive uses such as fish propagation and hydropower, and uses limited to the high flow season, as long as the use is not large enough to compromise habitat-forming processes.

Table ES-3
Water Right Reservation Summary for WRIAs 27/28

Water User [1]	Net Stream flow Depletion Allowance After Mitigation (cfs) [2]
Kalama River Subbasin [5]	
Kalama	1.92
Small Systems and Domestic Wells	0.35
Subbasin Total	**2.26**
North Fork Lewis Subbasin	
Cowlitz County Portion	
Small Systems and Domestic Wells	0.26
Clark County Portion	
Small Systems and Domestic Wells	0.49
Skamania County Portion	
Domestic Wells	0.40
Small Systems	0.40
Commercial	0.21 [6]
Subbasin Total	**1.76**
East Fork Lewis Subbasin [5]	
Clark County Portion	
CPU, Battle Ground, and Ridgefield [4]	2.20
Small Systems and Domestic Wells	0.66
Skamania County Portion	
Small Systems and Domestic Wells	0.00
Subbasin Total	**2.85**
Salmon Creek Subbasin	
CPU, Battle Ground, and Ridgefield [4]	0.13
Small Systems and Domestic Wells	0.12
Subbasin Total	**0.24**
Burnt Bridge Creek Subbasin	
Vancouver	0.02
Small Systems and Domestic Wells	0.00
Subbasin Total	**0.02**
Lacamas Creek Subbasin	
Camas	0.50
CPU	0.30
Small Systems and Domestic Wells	0.36
Subbasin Total	**1.16**
Washougal River Subbasin [5]	
Clark County Portion	
Washougal	0.00 [3]
Small Systems and Domestic Wells	0.36
Skamania County Portion	
Small Systems and Domestic Wells	0.74 [7]
Subbasin Total	**1.10**
Columbia River Tributaries Subbasin	
Clark County Portion	
Small Systems and Domestic Wells	0.22
Skamania County Portion	
Small Systems and Domestic Wells	0.22
Subbasin Total	**0.44**

Notes:
[1] Categories of water users include:
Large Public Water Systems, which are listed individually.
Small Systems, which refers to Public Water Systems not listed individually and required to apply for a water rights permit.
Domestic Wells, including those serving multiple homes but exempt from the requirement to apply for a water right permit.
Other Beneficial Uses, such as self-supplied industrial uses.
[2] Calculated based upon an estimate of additional water rights needed to meet water demands through 2020. Incorporates the effects of offsetting and mitigation activities. The allowance applies only to mainstem flows; it is not intended to allow for extensive dewatering of smaller water bodies.
[3] Current water rights are sufficient to meet needs through year 2020. Therefore no reservation is established.

(4) Wells serving CPU, Battle Ground, and Ridgefield may draw partly from the East Fork Lewis River Subbasin and partly from the Salmon Creek Subbasin. Therefore, the stream flow depletion is split between these subbasins, based on information provided by CPU.
(5) In the lower reaches of this subbasin, there may be opportunity to increase reservation amounts, pending further study to refine understanding of flow impacts.
(6) Withdrawal impacts shall be limited to the mainstem North Fork Lewis River above Swift Reservoir only.
(7) During future plan review, the size of this reservation will be reconsidered in light of Skamania County's request for 1.15 cfs needed to accommodate approximately 3109 homes.

The Planning Unit believes the modified restrictions on new water rights will strengthen protections of flows needed for aquatic habitat, while providing sufficient supplies for the region's communities. The provision for periodic evaluation of the adopted rule is intended to allow for flexibility and adaptation as growth occurs over time and as new information on aquatic resources is collected.

Lewis River and Hydroelectric Operations

PacifiCorp operates the Lewis River Hydroelectric Project. Operations of this project, including releases designed to support stream flows in the Lower Lewis River Basin, are determined by the FERC license for this project. The Planning Unit acknowledges the importance of management of these facilities. However, the Planning Unit determined it should not duplicate the analysis and procedures related to FERC licensing. Therefore, the Planning Unit has not reviewed or analyzed Project operations.

Forest Practices

87 percent of WRIAs 27 and 28 is forested. The forested lands are typically located in the middle and upper portions of each subbasin. They include federal, state and private lands.

Based on changes in the timber economy in recent years, harvest rates for southwest Washington State over the next 50 years are expected to be lower, compared with harvests of the last 50 years. At the same time, regeneration of formerly harvested forests is likely to continue. Moreover, the Forests and Fish Rules adopted by the State will have a significant impact on forest management practices. In general, the WRIA 27 and 28 Planning Unit anticipates these changes will result in increased forest cover at the regional scale. Similar effects are anticipated on federal lands, based on the Northwest Forest Plan.

A modeling study commissioned as part of this watershed planning effort concluded that as clearcut areas are replanted and where existing younger timber matures, the predominant effect is anticipated to be a reduction in peak flows coupled with a reduction in low flows. Peak flows are expected to decrease due to delay of runoff as forest cover increases. Low flows are expected to decrease because of the net increase in evapotranspiration, which removes water from the watershed[1].

[1] Despite potential reductions in low flows, changes in forest practices are expected to improve aquatic habitat on the whole and improve prospects for recovery of salmon in the region.

Policy SFP-8 is based on this expectation, and calls on forest managers to consider stream flow effects in making forest management decisions. This policy also calls for monitoring of forest lands over time, including their effects on stream flow.

Flow Monitoring Needs

Accurate, long term data on flows is needed for effective management of flow conditions. At this time the only long-term, continuously-recording flow gauges in WRIAs 27 and 28 are in the Lewis River Basin. In addition, CPU has additional gauges on Salmon Creek. Clark County has gauges on other streams, but these have not been in place for long periods and could be discontinued depending on County funding priorities. None of the other streams in WRIAs 27 and 28 have long-term, continuous flow gauges at this time. Even in the Lewis River Basin, additional gauges would be needed to track changes in flow due to development, water withdrawals and other factors in the more populated areas. The Planning Unit offers the following policy statement:

Policy SFP-1: For purposes of improving stream flow management in the region, it is important that existing stream gauges be maintained over the long term and that additional, permanent stream gauges be installed.

Recommendations for stream gauging at specific sites are provided in Table ES-6.

Target Flows

One way the effectiveness of stream flow management can be quantified and monitored is through establishment of "target flows." As used in this watershed plan, the term "target flow" means a realistic flow regime that could be achieved in most years by following sound management techniques over a long period of time. The flow regime is defined by a set of flow statistics that include both low flows and high flows. For purposes of this plan, provisional target flows have been established for two streams, the East Fork Lewis River and Washougal River. These target flows reflect existing conditions on these two streams. Management practices should seek to avoid deterioration of flow conditions and, if possible, should improve flow conditions. Additional target flows can be developed for other streams in the future, to assist in the overall stream flow management program recommended in this Watershed Management Plan.

Management of Surface Water Quality

The primary vehicle for achieving compliance with state criteria for surface water quality is Ecology's program for Total Maximum Daily Loads (TMDLs), also known as Water Cleanup Plans. Rather than attempt to duplicate efforts of the TMDL program, the WRIA 27 and 28 Planning Unit determined it would be most valuable to provide guidance to Ecology in terms of prioritizing its water cleanup plans. In developing the Watershed Management Plan, the Planning Unit relied primarily on the 1998 303(d) list of impaired waters. Development of the "2002/2004" list was under way and this updated list was also reviewed. However, the more recent list has not been formally adopted by the State or approved by the federal government at this time. Therefore the 1998 list was used to develop recommendations. Once finalized, the

2002/2004 list should be revisited during the implementation phase of the Watershed Management Plan.

The Planning Unit recommends that Ecology develop TMDLs according to the priority list shown in Table ES-4. These priorities should be revisited at such time as the 2002/2004 303(d) list is approved by Ecology and the federal government.

Table ES-4
Summary Recommendations to Prioritize Cleanup Plans in WRIAs 27 and 28

Priority for Cleanup Plan (TMDL)	Water Quality Impaired Sub-basin	Basis
1st	East Fork Lewis River	▪ Significant development anticipated ▪ Water quality threatens listed salmon species ▪ Potential human health impacts from contact recreation
2nd	Salmon Creek*	▪ Significant development anticipated ▪ Water quality threatens listed salmon species ▪ Potential human health impacts from contact recreation
3rd	Lacamas Creek	▪ Significant development anticipated ▪ Potential human health impacts from contact recreation ▪ Potential fisheries impact below dam
4th	Burnt Bridge Creek	▪ Programs in place to address water quality impacts for Burnt Bridge Creek
5th	Kalama River	▪ Limited temperature impairments in Kalama River

* Ranked 2nd because a TMDL is already developed in Salmon Creek for turbidity and fecal coliform.

The Planning Unit also recommends that monitoring of water quality be improved in WRIAs 27 and 28. Two categories of information needed were identified. First it is valuable to have water quality monitoring data to characterize water quality conditions in surface waters. A program of expanded monitoring is proposed for this purpose. Sampling of 25 sites across the region is proposed, in addition to those sites already being sampled on a regular basis. Sampling parameters include flow, dissolved oxygen, pH, specific conductance, temperature, total suspended solids, coliform bacteria, nitrogen and phosphorus. The estimated cost is $214,600 in the first year, and $154,650 annually in subsequent years. These costs are in addition to the current, ongoing monitoring activities.

Second, it is valuable to gather information on site-specific sources of water quality impairment. This provides a basis for actions to improve water quality. Since major “point sources” are already identified and regulated through an existing permit program, the main focus should be non-point sources. This Watershed Management Plan presents an initial framework to assess non-point sources of water quality impairment. The framework is intended to serve as a basis for development of a more detailed assessment approach during the implementation phase of the watershed plan effort. Once sites or areas are identified in each subbasin, follow-up actions can be defined, such as outreach and technical assistance to landowners, specific projects to eliminate or control sources, or, where appropriate, enforcement actions.

Management of Ground Water Quality

Ground water is an abundant resource in the more populous areas of WRIAs 27 and 28, particularly in lowland areas of Clark County. Given the importance of this resource, it is particularly critical that ground water quality be protected. Five management objectives were developed for ground water quality in this Watershed Management Plan:

- Improve public understanding and awareness of issues related to drinking water quality;
- Assess susceptibility of ground water supplies to contamination on a regional basis;
- Improve local wellhead protection programs;
- Implement management strategies to minimize impacts of land use activities on ground water supplies
- Clean up ground water contamination.

These objectives are generally consistent with Clark County's existing Ground Water Management Program. For each recommended objective, a discussion of the purpose, rationale, and relationship to other objectives is presented. Specific actions and implementation considerations for each objective are also discussed.

Management of Fish Habitat Conditions

Early in the watershed planning process, the Planning Unit elected to work collaboratively with the Lower Columbia Fish Recovery Board to develop the habitat element of the watershed plan. This unique arrangement was significant to the lower Columbia Region because it ensured a high degree of interconnectedness between watershed planning and the recovery of Endangered Species Act-listed species. In particular, the habitat element was developed using water quality, quantity and instream flow information from the Planning Unit's efforts coupled with other habitat data and modeling efforts developed through the recovery planning process. The result is a highly integrated habitat element for the watershed management plan that is the same as found in the recovery plan.

Each subbasin includes an extensive review of the available habitat information and analyses as well as extensive new analysis of stream condition, watershed conditions, and habitat forming processes. Modeling tools were applied that highlight a series of habitat perturbations in these watersheds that need to be addressed. Qualified local experts were convened to provide input to models where needed or where other data sources were lacking. Model outputs were also compared to other independent assessments of limiting factors to corroborate results. The outputs of these models identify reach scale issues that need to be addressed and provide a prioritization scheme for proposed actions.

A series of Subbasin Plans (Volumes II.F-II.I) describe local conditions and detail implementation at the subbasin level. Each subbasin plan includes:

- An ***overview summary*** of key priorities.

- An ***assessment*** that describes the subbasin, species of interest, subbasin habitat conditions, stream habitat limitations, watershed process limitations, other factors such as hatcheries, harvest, hydropower, and out-of-subbasin effects. The assessment includes qualitative and quantitative information.
- A ***program and project inventory*** describing significant activities in the subbasin.
- A ***management plan*** that details a subbasin vision, biological objectives, integrated strategy, and specific measures and actions in each threat category.

The following descriptions give a brief regional perspective for each subbasin:

Kalama Subbasin

This subbasin is particularly important to regional recovery. Populations of fall Chinook, spring Chinook, winter steelhead and summer steelhead will need to be restored to a high level of viability to meet regional recovery objectives. Coho will need to improve to a medium level of viability and chum established and stabilized. Priority actions include:

- Managing forests to restore watershed processes,
- Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.) managing growth and development to protect watershed processes and habitat conditions. This includes limiting the effects of conversion of agricultural and timber lands to developed uses,
- Restoring passage at culverts and other artificial barriers,
- Aligning hatchery priorities with conservation objectives, and
- Reducing out-of-subbasin impacts.

Lewis Subbasin

This subbasin is particularly important to regional recovery by virtue of its large size and diverse habitats. It includes upper North Fork, lower North Fork, and East Fork watersheds. One or more populations of tule fall Chinook, bright fall Chinook, spring Chinook, chum, winter steelhead, summer steelhead, and coho are present and many need to be restored to high levels of viability to meet regional recovery objectives. Priority actions include:

- Restoring access above dams in the upper portion of the North Fork,
- Protecting intact forests in headwaters,
- Managing forest land to protect and restore watershed processes,
- Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.) managing growth and development to protect watershed processes and habitat conditions. This includes limiting the effects of conversion of agricultural and timber lands to developed uses,
- Restoring passage at culverts and other artificial barriers,

- Restoring lowland floodplain function, riparian conditions, and stream habitat diversity
- Addressing immediate risks with short term habitat fixes,
- Aligning hatchery priorities with conservation objectives, and
- Reducing out-of-subbasin impacts.

Lower Columbia Tributaries

This subbasin includes a series of small tributaries between the Lewis River and Bonneville Dam including Salmon, Lake, Duncan, Hardy, and Hamilton creeks. Salmon and Lake Creeks have been heavily urbanized while the gorge tributaries are largely in forest lands. The urban streams will play a limited role in salmon recovery. Populations of fall chinook, winter steelhead, chum and coho in lower gorge tributaries will be important to recovery. Priority actions include:

- Restoring floodplain function, riparian conditions, and stream habitat diversity,
- Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.) managing growth and development to protect watershed processes and habitat conditions. This includes limiting the effects of conversion of agricultural and timber lands to developed uses,
- Managing forests to restore watershed processes,
- Restoring passage at culverts and other artificial barriers,
- Addressing immediate risks with short term habitat fixes,
- Aligning hatchery priorities with conservation objectives, and
- Reducing out-of-subbasin impacts.

Washougal Subbasin

This subbasin is particularly important to regional recovery because it contains fall chinook, chum, and summer steelhead that will need to be restored to a high level of viability and coho and winter steelhead that will need to be restored to a medium level of viability. The subbasin is diverse with significant portions in forest, agriculture, rural residential, and city uses. Priority actions include:

- Protecting intact forests in headwaters,
- Managing forest land to protect and restore watershed processes,
- Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.) managing growth and development to protect watershed processes and habitat conditions. This includes limiting the effects of conversion of agricultural and timber lands to developed uses,
- Restoring passage at culverts and other artificial barriers,

- Restoring lowland floodplain function, riparian conditions, and stream habitat diversity
- Addressing immediate risks with short term habitat fixes,
- Aligning hatchery priorities with conservation objectives, and reducing out-of-subbasin impacts.

Plan Implementation

It is evident from the discussion above that the Watershed Management Plan encompasses a broad range of issues and activities. No one organization has authorities or capabilities in all of these areas. Like the planning effort itself, the implementation process will need to involve a diverse group of agencies, organizations and stakeholders working collaboratively.

It will be important that any rules adopted by the State of Washington to implement this watershed plan remain consistent with the intent expressed by the Planning Unit in this Watershed Management Plan. The strategies presented in this Watershed Management Plan are intended to provide a balanced suite of actions to manage water resources in the planning area. In the event that a State rule-making process, legislative action, or court decision substantially alters implementation of the provisions outlined in the Plan, the other organizations with implementation responsibilities reserve the right to re-visit their implementation commitments as well. This is particularly true for County governments, which have the role of adopting the plan through the approval process under Chapter 90.82.130 RCW.

Implementation of Specific Actions from Watershed Management Plan

Table ES-5 lists all of the organizations identified for roles in implementation. A selected group of these organizations are identified for “lead” roles. Lead organizations include each County government, City governments, public water systems, the Department of Ecology, State agencies with land-management responsibilities (e.g., Department of Natural Resources); private industry with large plants; landowners and agricultural producers; the U.S. Forest Service; and LCFRB. In some cases, the “lead” organization may directly carry out the action. In other cases, the lead organization will take responsibility for organizing an effective approach to implementation by multiple parties. This may include seeking outside sources of funding and securing commitments for actions by other parties. It is recognized that actions listed in this plan are subject to availability of funding resources. The next section of this Executive Summary describes a coordinated approach to pursuing necessary funding. Table ES-5 also provides information on relative costs and potential funding sources for each type of action.

Throughout this Watershed Management Plan, various terms are used in relation to management actions, activities and recommendations. The terms “shall”, “may” and “should” are frequently used, and are defined as follows:

- The term “shall” is mandatory;
- The term “may” is permissive and does not impose a mandatory requirement;

- The term “should” is a recommendation and does not impose a mandatory requirement.

Lead roles were identified based on a general understanding of the various functions and activities of each organization. However, it is recognized that authority or responsibility for undertaking specific actions may be associated with entities other than those identified as lead. Roles can vary significantly between otherwise similar organizations depending on legal authorities, staffing, and budget limitations. It should be noted that these roles are not mandatory and cannot become operational without the formal approval of specific activities by elected boards and commissions, or upper level managers at the respective organizations. The Planning Unit requests each organization consider its recommended role(s) and provide a written indication of its capability and intent to carry out these actions. Where potential discrepancies in roles exist, appropriate lead organizations will be determined during the implementation phase. In accordance with RCW 90.82.130 (3), roles and commitments become effective upon acceptance and approval by the designated lead organization. Where actions are accepted, follow-up steps during the implementation phase should include decisions on funding sources, budgeting, staffing, work plans, and protocols for tracking and reporting progress towards Plan objectives.

Many agencies and jurisdictions are currently funding programs that align closely with the objectives and recommendations of this Plan. In many cases, existing expenditures can be effectively integrated with this Plan, reducing the overall financial impact. For other actions, new or expanded funding must be sought in order to provide for implementation. Table ES-5 lists some possible sources of funding for these actions. Full discussion of these funding sources is presented in Section 8 of the Plan.

Table ES-5
Implementation Considerations for Watershed Management Plan

Priority(1)	Activity	Implementers(3)	Financial/ Economic Costs(2)	Potential Funding Sources
Category: Water Supply				
High	Public Water Systems develop new or expanded supplies. Requires engineering studies; approval of water system plan; water rights processing; other permitting; SEPA compliance; construction; operations & maintenance. Standard procedures exist for all of these (See Section 3.3.1).	*Lead*: Public Water System *Others*: DOH, Ecology	Medium	*Main*: Water rates and hookup charges in affected service area *Additional*: Grants or low-interest loans from existing state & federal programs
High	Planning studies to explore alternative sources of supply to replace an existing source (selected communities) (See Section 3.3.2).	*Lead*: Public Water System	Low	*Main*: Water rates in affected service area
High	Replace an existing source of supply with a different source to reduce impacts on stream flow. Requires engineering studies; water rights processing; other permitting; inter-local agreements or contracts; construction; operations & maintenance (See Section 3.3.2).	*Lead*: Public Water System *Others*: DOH, Ecology, adjacent water system(s) to serve as wholesaler	Medium to High	*Main*: Leg. appropriation *Additional*: Water rates in affected service area
Medium	Develop map of region's aquifers with emphasis on surface water hydraulic continuity (See Section 3.3.1).	*Lead:* Ecology *Other:* Public water systems	Medium	*Main:* Grants, water purveyor revenues
Medium	Enhanced conservation exceeding state requirements in selected communities (See Section 3.3.1).	*Lead*: Public Water System *Other*: Ecology, Conservation Districts	Low to medium	*Main*: public water system *Additional*: Grants from DOH or Ecology
Medium	Industrial supplies: Expand conservation & reuse; develop non-potable sources; connect to municipal systems (See Section 3.5.3).	*Lead*: Private industry (large plants) *Others*: Ecology & DOH (technical assistance; water rights processing if applicable)	Low to High (Varies by facility)	*Main*: Private industry *Additional*: Leg. Appropriations
Low	Consider the effects of individual domestic wells when modifying or adopting comprehensive plans, zoning designations, or other land use regulations. (See Section 3.5.2).	*Lead*: Counties, cities	Low	*Main*: counties, cities general fund, permitting fees, or grants
Low	Agricultural supplies: switch from surface to ground water. Discourage new uses of surface water (use ground water instead) (See Section 3.5.4).	*Lead*: Landowner *Others*: Ecology, Conservation Districts	Low to medium	*Main*: Landowner *Additional*: Leg. Appropriations
Low	Within authorities and as staffing and funding allow, develop water-level monitoring program for aquifers (See Section 4.2).	*Lead:* Water purveyors *Others:* USGS, counties	Medium	*Main:* Grants, water purveyor revenues

Table ES-5 (cont.)
Implementation Considerations for Watershed Management Plan

Priority[1]	Activity	Implementers[3]	Financial/ Economic Costs[2]	Potential Funding Sources
Category: Stream Flow Management				
High	Maintain existing stream gauges. Install new gauges at selected locations. Select exact sites; permit and construct gauges; O&M; data management (See Section 4.2).	*Lead*: Ecology *Other*: USGS, LCFRB, Counties	Medium	*Main*: Leg. appropriations (Ecology budget); Congr. appropriations (USGS budget); *Additional*: Counties; Public Water Systems
High	Adopt restrictions on issuance of new water rights in State Rule (See Section 4.4.1).	*Lead*: Ecology *Other*: LCFRB	Low	*Main*: Ecology (staff time) *Additional*: LCFRB (staff time)
High	Selected actions involving water supply and intended to protect stream flow. See water supply items listed above.	*See Section 3.6*	*See Section 3.6*	*See Section 3.6*
High	Establish target flow monitoring and management program (See Section 4.3).	*Lead*: LCFRB and Planning Unit or successor organization *Other*: Ecology, DFW		*Main*: Phase 4 implementation funds *Additional*: TBD
High	Initial surveys in selected subbasins to identify unauthorized uses and take enforcement actions. Follow-up in other basins if warranted (See Section 4.4.6).	*Lead*: Ecology *Other*: N/A	Low to medium	*Main*: Leg. appropriations (Ecology budget & staffing) *Additional*: N/A
High	Consider and address effects of forest practices on stream flow. Monitor effectiveness of F&F Rules and NW Forest Plan. Report to public periodically (See Section 4.5.1).	*Lead*: DNR, USFS *Other*: Private forest landowners	Low to medium	*Main*: Leg. appropriations (DNR budget); Congr. appropriations (USFS budget), Timber producers *Additional*: N/A
High	Within authorities, protect floodplains from modifications that would impair hydrologic functions or habitat (See Section 4.5.3).	*Lead*: Counties, cities, State agencies with land management responsibilities *Other*: DFW	Low	*Main*: County permitting fees or general fund revenues, grants *Additional*: State agency budgets
Medium	Review effects of stormwater discharges on stream flow and habitat. Where needed to protect key habitat, implement programs that exceed minimum requirements (See Section 4.5.2).	*Lead*: Counties, Cities *Other*: Ecology	Low to Medium	*Main*: County, City general funds; Stormwater assessment and fees, grants *Additional*: N/A

Table ES-5 (cont.)
Implementation Considerations for Watershed Management Plan

Priority[1]	Activity	Implementers[3]	Financial/ Economic Costs[2]	Potential Funding Sources
Medium	Purchase or lease of water rights from willing sellers, for State Trust program (See Section 4.4.5).	*Lead*: Ecology *Other*: N/A	Low to medium	*Main*: Leg. appropriations (Ecology budget) *Additional*: N/A
Medium	Within authorities, identify floodplain restoration projects and implement where feasible (See Section 4.5.3).	*Lead*: Counties, cities, State agencies with land management responsibilities *Other*: DFW	Medium to High	*Main*: State or federal grants; Leg. Appropriations *Additional*: N/A
Medium	Large water users and hydropower facilities: short-term drought response curtailment programs, to protect stream flows (See Section 4.4.7).	*Lead*: Selected public water systems; hydropower operators *Other*: N/A	Low to medium	*Main*: Large water users and hydropower facilities *Additional*: N/A
Medium	Evaluate the need to take additional actions addressing shallow aquifer interactions (See Section 4.5.5).	*Lead:* Planning Unit or successor organization *Other:* N/A	Low	*Main:* Phase 4 implementation funds *Additional:* TBD
Medium	Develop clear guidance for mitigation (See Section 3.3.1).	*Lead:* Ecology *Other:* N/A	Low	*Main:* Leg. Appropriations (Ecology budget) *Additional:* N/A
Low	When modifying or adopting comprehensive plans, zoning designations, or other land use regulations, consider the water balance implications of allowing extension of sewer service to communities formerly served by septic systems (See Section 4.5.2).	*Lead*: Counties, Cities *Other*: sewer agencies if different from Counties, Cities.	Low	*Main*: Counties, Cities general funds, permitting fees, grants *Additional*: N/A
Low	Water conservation by farmers practicing irrigated agriculture. Technical assistance by Conservation District in each county (See Section 4.4.2).	*Lead*: Agricultural producer *Other*: Conservation Districts	Medium	*Main*: Agricultural producer *Additional*: Leg. Appropriations (Cons. Commission & CD budgets).
Low	Source substitution for selected areas served by domestic wells: relatively higher densities and likelihood of stream impacts; dependent on feasibility and cost (See Section 4.4.4).	*Lead*: Counties, cities, local governments, Ecology, and/or others as appropriate. *Other*: Public water systems, landowners	Medium to high	*Main*: Assessments on affected properties (local improvement districts), grants *Additional*: Federal and State salmon recovery funding; Leg. appropriations
Medium	Wetlands inventories and ordinances: assess and protect hydrologic functions, consider strengthening mitigation ratios (See Section 4.5.4).	*Lead*: Counties and Planning Unit *Other*: N/A		*Main*: County development fees or general fund revenues (note staffing impact), grants *Additional*: N/A

Table ES-5 (cont.)
Implementation Considerations for Watershed Management Plan

Priority(1)	Activity	Implementers(3)	Financial/ Economic Costs(2)	Potential Funding Sources
Category: Surface Water Quality				
Medium	Develop water body cleanup plans (TMDLs) for subbasins, in prioritized sequence as indicated in Watershed Management Plan. Carry out necessary modeling, reporting, public involvement, and waste load allocations (See Section 5.3.2).	*Lead*: Ecology *Other*: Local governments, Conservation Districts, other interested parties	High	*Main*: Leg. appropriations (Ecology budget) *Additional*: N/A
Medium	Within authorities, develop full-scale assessment strategy for non-point sources (See Section 5.5).	Lead: counties *Other*: Ecology, conservation districts, USFS, DNR	Low	Phase 4 implementation Grant
Medium	Within authorities, carry out source assessment of non-point sources (See Section 5.5).	Same as above	Medium	TBD, (combination of State, federal, and local sources)
Medium	Actions to correct sources of impairment (See Section 5.5).	*Lead:* Party causing impairment *Other:* Ecology, conservation districts	Medium to High	TBD (combination of State, federal, local and private sources)
Low	Within authorities and as staffing and funding allow, expand water quality monitoring activities to improve understanding of status and trends. Install monitoring equipment; collect and analyze samples; manage and analyze data; report results (see Section 5.4.2).	Shared efforts by State, local, federal agencies Ecology will take lead in promoting cooperative arrangements among agencies	High	Combination of State, local, federal funding sources (to be developed further in Implementation Phase)
Category: Ground Water Quality				
High	Within authorities, improve public awareness of ground water quality issues. Information outlets. Mass-media campaign. Schools program. Public opinion surveys (See Section 6.5.1).	*Lead*: County health departments *Others*: Cities, DOH.	Medium	*Main*: grants Substantial staffing needs
High	Within authorities, assess susceptibility of ground water supplies to contamination. Risk assessment. Evaluate data management and improve if necessary. Regional mapping (See Section 6.5.2).	*Lead*: County health departments *Others*: Cities, Ecology, DOH.	Low to Medium	*Main*: grants Substantial staffing needs
Medium	Within authorities, improve local wellhead protection. Determine which Group A Systems have wellhead program. Apply technical assistance and enforcement to meet state requirements. Facilitate use of computer modeling. Encourage Group B systems to voluntarily establish wellhead programs (See Section 6.5.3).	Lead: DOH and County health departments *Others*: Public water systems	Medium to High	*Main*: Grants Substantial staffing needs
Low	Within authorities, coordinate and promote management strategies to prevent impacts to ground water quality from land use activities (See Section 6.5.4).	*Lead*: County health departments *Others*: County planning departments, conservation districts, Ecology, Wash. Dept. of Agriculture, NRCS	Medium to High	*Main*: Grants Substantial staffing needs

Table ES-5 (cont.) Implementation Considerations for Watershed Management Plan				
Priority[1]	Activity	Implementers[3]	Financial/ Economic Costs[2]	Potential Funding Sources
Low	Within authorities, clean up sources of ground water contamination. Evaluate need for greater involvement by local organizations. Evaluate need for independent cleanup actions outside Ecology programs (See Section 6.5.5).	*Lead*: County health departments *Others*: Ecology, Public Water Systems, Wash. Dept. of Agriculture	Medium to High	*Main*: Grants

(1) Priority in context of all actions in Watershed Management Plan.
(2) Preliminary, generalized estimates of financial or economic cost of the action. Expressed as total cost, whether up-front or over a period of time up to ten years. High: greater than $500,000; Medium: $50,000 to $500,000; Low: less than $50,000.
(3) “Lead” implementer would take responsibility for organizing efforts under this action, including pursuing funding sources listed in the far right column.
Abbreviations: SEPA = State Environmental Policy Act, DOH = Department of Health, Leg. = Legislative

Need for Coordination and Oversight

With a diverse group of organizations involved in implementing the Plan, and an implementation period that may span many years, it will be important to put in place a mechanism for oversight and coordination of the implementation process. The State Legislature has authorized Ecology to provide Phase 4 Implementation Grants of up to $125,000 per year for up to three years for a Planning Unit covering two WRIAs and half this amount for two additional years. It is recommended that LCFRB pursue this funding on behalf of the Planning Unit, and that the Planning Unit itself transition from planning functions to coordination and oversight of the implementation process.

Coordination and oversight functions include collaborative pursuit of additional funding sources for implementation of specific programs, tracking implementation actions by the various organizations involved, providing ongoing information to the public, and carrying out adaptive management of plan elements. In addition, this function may include periodic updating of the Plan to ensure it remains relevant and effective in managing water resource conditions in WRIAs 27 and 28.

The Planning Unit will not take on any regulatory responsibilities or authorities. Regulatory activity will continue to be the responsibility of State or federal agencies and local governments, consistent with existing law.

It is suggested that, at a minimum, a core group be organized from Planning Unit members to carry out the coordination and oversight role. This core group could include at least the counties; affected Tribes, representatives of the various cities in WRIAs 27 and 28, Clark Public Utilities, and the Department of Ecology. Other groups in the region may also elect to participate. An interlocal agreement may be useful in defining coordination and oversight responsibilities, as well as other implementation commitments by the respective organizations involved in this effort.

The Phase 4 implementation grants, by themselves, are not sufficient to implement the Plan. Instead, this should be viewed as "seed money" that can be used to pursue grants and leverage other resources for Plan implementation.

Table ES-6
Watershed Management Policies and Recommendations
WRIAs 27 and 28

Code	Issue	Policy or Recommendation
Water Supply Policies and Recommendations		
Policy WSP-1 (Pg 3-10)	Access to water supplies	Public and private water users throughout WRIAs 27 and 28 should have access to water resources to meet new or expanded needs for water supply consistent with adopted land use plans.
Recommendation (Pg. 3-13)	Water reservations	In order to satisfy the goals associated with the establishment of closures and/or instream flows, and the goals associated with providing a secure source of water for future public water supply, it is recommended that in each basin a block of water be reserved for future public water supply that would not be subject to the closures and/or instream flows established by rules for WRIAs 27 and 28.
Recommendation (Pg. 3-15)	Regional water supply options – Columbia River	The Planning Unit views the Columbia River and ground water in hydraulic continuity with the Columbia River as a major water resource to meet water supply needs. As new water supplies are needed, it is preferable they be withdrawn from the Columbia River, adjacent lowland reaches of tributaries subject to tidal effects, and/or associated ground waters, rather than from flow-limited reaches of streams tributary to the Columbia. This approach can meet regional supply needs, while protecting important aquatic habitat in the region. The tidal reach of the mainstem Lewis River is an example of a source covered under this recommendation.
Recommendation (Pg 3-18)	Water supply – City of Vancouver	The Planning Unit endorses the City of Vancouver's plan to develop a new wellfield near Vancouver Lake. Permitting agencies should make every effort to facilitate the development of the Pleistocene Alluvial Aquifer and encourage its use over other sources.
Recommendation (Pg 3-19)	Water Supply – Clark Public Utilities	The Planning Unit endorses the development of the Vancouver Lake well field. CPU should consider sale of water from this supply source to other purveyors throughout Clark County, for use in meeting future demands. Permitting agencies should make every effort to facilitate the development of the Pleistocence Alluvial Aquifer and encourage its use over other sources.
Recommendation (Pg. 3-14)	Vancouver Lake Wellfield - Relation to Remediation Activities at Port of Vancouver	A concern has been raised that development and pumping of the Vancouver Lake well field could inadvertently interfere with efforts to contain a contaminant plume underlying Port of Vancouver lands. CPU and the City of Vancouver anticipate working closely with the Port and environmental and health agencies to find a solution. Because of the regional importance of the ground water resource at Vancouver Lake, the Planning Unit recommends that all affected parties work together to create a solution that allows for development of this source of supply as quickly as possible.
Recommendation (Pg 3-19)	Water Supply – Clark Public Utilities	The Planning Unit endorses the development of additional wells in the Pioneer area to serve as a public water supply The supply is subject to off-setting and habitat mitigating measures outlined in Section 3.3.1.
Recommendation (Pg 3-22)	Water supply – City of Washougal	The City of Washougal should follow procedures outlined in Section 3.3.1 as it relates to the installation of a new well near the center of town.
Recommendation (Pg 3-23)	Water supply – City of Woodland	The City of Woodland's Ranney Well is located within the tidal influence of the North Fork Lewis. The Planning Unit is not recommending protective measures in this reach. The Planning Unit supports expansion of the Ranney Well water supply.
Recommendation (Pg 3-23)	Water supply – City of Kalama	The Planning Unit endorses the City of Kalama's plans to increase water rights for withdrawal from its Ranney Well of up to an additional 1.92 cfs subject to provisions outlined in Section 3.3.1. The Planning Unit recognizes that the purchase of off-setting rights is not feasible in the Kalama River, and the 1.92 cfs of additional water rights is not subject to this provision; however, habitat mitigation requirements should be implemented commensurate with flow reduction impacts consistent with Section 3.3.1.

Table ES-6 (cont.)
Watershed Management Policies and Recommendations
WRIAs 27 and 28

Code	Issue	Policy or Recommendation
Recommendation (Pg 3-28)	Domestic wells (exempt wells)	Based upon the results of the analysis described in Section 3.5.2, and considering the relatively small amount of water withdrawals comprised by this category of water use, the Planning Unit recommends that a reservation of water be identified in rule language that provides for domestic well use, even within closed basins. However, this is not intended to promote use of domestic wells in lands zoned for urban densities. In addition, this recommendation is intended for areas served by septic systems that return water to the shallow ground water locally. Where homes are not served by septic systems, or where sewer service is extended to an area, extension of public water supply may be needed. This issue is discussed in greater detail in Section 4.3.2, which includes a stream flow management policy aimed at anticipating and mitigating water balance implications of extending sewer services to developing areas.
Recommendation (Pg. 4-12)	Monitoring aquifer levels	The Planning Unit recommends a water-level monitoring program be developed for aquifers in the region. Details of this program will be developed during the implementation phase.
Recommendation (Pg. 3-31)	Water supply – large industrial plants	Where feasible, industries requiring additional sources of supply in the future should connect to existing municipal water supplies. Where not feasible due to technical issues, logistics, or cost, then it is recommended that the industry evaluate alternative sources as described in Section 3.3.1.
Policy WSP-2 (Pg 3-10)	Stream flow protection in developing supplies	Water resource development to meet new or expanded needs should avoid or minimize effects on stream flows or aquatic habitat in stream reaches where flow conditions are an important factor for sustaining aquatic life, including fish populations in their various life stages.
Recommendation (Pg 3-11)	Procedure for Evaluating New or Expanded Supplies	It is recommended the procedure outlined in Section 3.31 be followed for municipalities requesting new or expanded water rights. This procedure involves evaluation of potential effects on stream flow and assessment of alternatives that could avoid impacts to stream flow. If the only feasible supply will affect stream flow, then off-setting and mitigating actions should be included in the water supply development proposal.
Recommendation (Pg 3-12)	Aquifer Mapping	The Planning Unit recommends that a map be developed during the implementation phase of the watershed planning process that would depict locations of deep aquifers suitable for water supply development. Such a map could be developed in partnership with the USGS, and will involve a study to identify aquifers that are not in hydraulic continuity with streams.
Recommendation (Pg 3-14)	Procedure for Evaluating Existing Supplies	For cases in which *existing* municipal supplies (as contrasted with planned *future* supplies) have the potential to negatively impact flows in critical stream reaches, the Planning Unit recommends that selected communities voluntarily consider enhancing their conservation efforts and undertake a review of alternative sources of supply, similar to that described in Section 3.3.1. It is recommended that, where feasible, these water suppliers cease or limit the use of certain existing supplies and develop alternative sources of supply that are less likely to impact flows in critical stream reaches. It is also recommended that implementation of such alternatives be eligible for funding from regional, state, or federal funding programs (see Section 3.6). This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State. Water suppliers in this situation should also consider availability of regional supplies (Section 3.3.3). It is important to note that existing municipal water rights are not subject to relinquishment if use of the rights ceases or is limited.

Table ES-6 (cont.)
Watershed Management Policies and Recommendations
WRIAs 27 and 28

Code	Issue	Policy or Recommendation
Recommendation (Pg 3-16)	New Developments and Industrial Suppliers	In general, the Planning Unit recommends that new urban or suburban developments or industrial facilities that require new or expanded water supplies shall seek to obtain water from existing municipal or other water suppliers rather than developing separate sources of supply. (Note: this would not apply to agricultural uses). If an existing municipal supplier or other water supplier is not available, then the new development or industrial facility should explore water supply sources that are not in hydraulic continuity with surface water or explore the feasibility of developing tidal and/or Columbia River sources. If none of these options are available, Ecology may consider issuing water rights that entirely off-set the net impact to stream flow.
Recommendation (Pg 3-19)	Salmon Creek Management Plan – CPU	The Planning Unit endorses CPU's current efforts regarding management of the Salmon Creek Basin.
Recommendation (Pg 3-20)	Surface water sources – Camas	Due to the impacts upon stream flows in Boulder and Jones Creeks of the City's surface water diversions, Camas should undertake a review of alternative sources of supply, similar to that discussed in Section 3.3.1. The City's existing plans for new ground water development near the Washougal River should be considered in this process, if the new wells are anticipated to not have negative impacts upon the river. If new water rights are secured by the City, the Jones and Boulder Creek sources should be retired, or used during periods of high flow only as a condition of the new water right. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Recommendation (Pg 3-20)	Columbia River supply -- Camas	The Planning Unit recommends that the City re-evaluate development of a non-potable Columbia River supply, considering the substantial amount of water used for industrial purposes in the City. The Planning Unit commits to aiding the City in identifying and obtaining funding sources for implementation of such a project, most likely through programs administered by Ecology and DOH (see Recommendation in Section 8.3). This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Recommendation (Pg. 3-20)	Georgia Pacific Conservation efforts	The Planning Unit recommends that the City of Camas provide technical assistance and financial support to Georgia Pacific in developing water conservation measures that would reduce dependency on surface water from Lacamas Creek and ground water from the lower Washougal River vicinity. Any ground water savings realized through conservation could be available to help meet the City's growth needs. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Recommendation (Pg 3-27)	Water supply – small Group A systems	In those cases where new supplies are required for small Group A systems, it is recommended that a review of alternative sources of supply be conducted (see Section 3.3.1), with an emphasis placed upon evaluating the purchase of water from an existing major water purveyor (see Section 3.3.3). If new sources are required and a reserved block of water is not available, then the net impact to surface flows should be off-set by acquiring existing upstream water rights.
Recommendation (Pg 3-31)	Conservation and reuse – industrial needs	The Planning Unit places an emphasis upon water conservation and reuse with respect to industries with large water demands. Ecology and the Washington State Department of Health (DOH) should develop technical assistance and funding opportunities focused specifically upon the needs of self-supplied industries, to aid in reducing current water demands.
Recommendation (Pg 3-31)	Columbia River supply – industry	The Planning Unit recommends that large, self-supplied industrial water users evaluate development of Columbia River non-potable supplies, similar to that considered by the City of Camas. The Planning Unit commits to aiding industries in identifying and obtaining funding sources for implementation of such a project, most likely through programs administered by Ecology and DOH (see Recommendation in Section 8.3).

Table ES-6 (cont.)
Watershed Management Policies and Recommendations
WRIAs 27 and 28

Code	Issue	Policy or Recommendation
Recommendation (Pg 3-33)	New supply – agriculture	The Planning Unit does not endorse the use of surface water for meeting additional future agricultural water demand.
Recommendation (Pg 3-33)	Existing supply – agriculture	The Planning Unit encourages agricultural water right holders to request changes of existing surface water rights to ground water rights not in hydraulic continuity with surface waters. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Recommendation (Pg 3-33)	Transfer of Agricultural Water Rights	Given the availability of existing water rights, the Planning Unit endorses the transfer of ground water rights from one user to another to meet future agricultural water demands. To promote the public interest, the Planning Unit encourages the Department of Ecology to expedite processing of agricultural ground water right transfers between agricultural water users.
Recommendation (Pg. 3-33)	Agricultural – new ground water supplies	The Planning Unit recommends that Ecology process water right requests pertaining to future agricultural ground water demand, subject to consistency with the Planning Unit's water supply policy (Section 3.3.1) and successful completion of Ecology's water right application review process.
Recommendation (Pg 3-20)	Regional supply options– Camas	The Planning Unit recommends that the City of Camas evaluate regional supply options such as those discussed in Section 3.3.3. These include the development of a wellfield supply near the Steigerwald Wildlife Refuge or, if other opportunities prove infeasible, the potential purchase of water from Vancouver. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Recommendation (Pg 3-21)	Conservation – Battle Ground	Battle Ground should enhance its current conservation efforts, with the goal of reducing the production required of existing wells. This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State.
Recommendation (Pg 3-21)	Alternative sources – Battle Ground	Due to the potential for withdrawal from the City's existing wells to impact stream flows in the East Fork Lewis River and Salmon Creek, Battle Ground should undertake a review of alternative sources of supply, similar to that discussed in Section 3.3.1. The City's plans for a new well should also be subject to Section 3.3.1. Use of reclaimed water may also be of value. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Recommendation (Pg 3-21)	CPU wholesale supply – Battle Ground	It is likely that new water supplies available to Battle Ground will have hydraulic continuity with the East Fork Lewis and Salmon Creek. Due to the regional significance of the East Fork Lewis to salmon recovery and foreseeable population growth, purchase of water from a CPU regional water source is critical. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Recommendation (Pg 3-22)	Stream Flow Augmentation – Battle Ground	The Planning Unit endorses the City of Battle Ground's efforts to develop a new wastewater treatment plant and to augment streamflows with Class-A Reclaimed water, provided water quality in receiving waters is also maintained or improved. The Planning Unit also supports consideration of mitigation credits for stream flow augmentation. Mitigation credits should reflect net stream-flow benefits in relation to withdrawal impact areas. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Recommendation (Pg. 4-48)	Salmon Creek MOU	The Planning Unit recommends that parties (i.e., Ecology, Clark County, and Clark Public Utilities) to the 1992 Salmon Creek MOU continue to implement the management plan. In addition, the parties to the MOU are encouraged to review the policies discussed in Sections 4.5 and 4.6 to assess whether additional stream flow management strategies are warranted in the Salmon Creek Subbasin.
Recommendation (Pg 3-22)	Regional supply options – Washougal	The Planning Unit recommends that the City of Washougal consider use of regional sources. These include the development of a wellfield supply near the Steigerwald Wildlife Refuge or, if other opportunities prove infeasible, the potential purchase of water from Vancouver. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

Table ES-6 (cont.)
Watershed Management Policies and Recommendations
WRIAs 27 and 28

Code	Issue	Policy or Recommendation
Recommendation (Pg 3-22)	Conservation – Ridgefield	Ridgefield should enhance its current conservation efforts, with the goal of reducing the production required of existing wells, to protect flows in Gee Creek. This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State.
Recommendation (Pg 3-24)	Gee Creek Restoration – Ridgefield	The Planning Unit recommends that the City of Ridgefield coordinate with the Watershed Stewards Program to identify any actions it may take to aid in the Gee Creek restoration effort. If low flows are identified as an issue needing to be addressed, the City should undertake a review of alternative sources of supply, similar to that discussed in Section 3.3.1. The City's existing plans for new wells should be considered in this exercise, if the new wells are anticipated to have less of an effect upon stream flows than current sources. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Recommendation (Pg 3-24)	CPU wholesale supply – Ridgefield	The Planning Unit recommends that the City consider purchasing water from CPU to aid in meeting future demands, utilizing the recently installed fire flow intertie. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Stream Flow Policies and Recommendations		
Policy SFP-1 (Pg 4-11)	Flow monitoring	For purposes of improving stream flow management in the region, it is important that existing stream gauges be maintained over the long-term and that additional, permanent stream gauges be installed.
Recommendation (Pg 4-46, 4-58)	Stream gauges – Various rivers	The Plan recommends stream gauges be installed on the East Fork Lewis and Washougal Rivers.
Recommendation (Pg 4-43, 4-45, 4-56, 4-57)	Target Flows – East Fork Lewis River and Washougal River	For the main stem of the East Fork Lewis River and Washougal River, it is recommended that target flows be established for management purposes. Target flows should address both low flows and peak flows. The suite of flow-management techniques discussed for these streams should be designed with the goal of protecting these flows from degradation; and if possible improving the flow regime.
Recommendation (Pg. 4-62)	Mitigation guidelines	The Department of Ecology should develop clear guidance for mitigation for use by water rights applicants. An existing Ecology document listing examples of mitigation can be used as a starting point.

Table ES-6 (cont.)
Watershed Management Policies and Recommendations
WRIAs 27 and 28

Code	Issue	Policy or Recommendation
Policy SFP-2 (Pg 4-19)	Restrictions on New Water Rights	The Department of Ecology should adopt State Rules (WACs) under its Instream Resources Protection Program to restrict issuance of new water rights in WRIAs 27 and 28. In all affected streams reaches a closure should be established, but with certain exceptions as indicated below. Existing water rights shall not be affected by this policy. For each stream that flows into the Columbia River, the zone where water levels are substantially affected by tidal influence and backwater from the Columbia River shall not be closed to issuance of new water rights. The location of the lower most extent of the closure is identified in this Plan. The rules adopted shall not prevent issuance of water rights for selected purposes and conditions. These include: ▪ New uses for domestic wells, based on the amount of water required to meet estimated needs. This quantity represents the net depletion of stream flow in each subbasin by all domestic wells installed after the effective date of the rule; ▪ New uses for small community systems and other beneficial uses, up to a predefined, limited "block" of water. These quantities represent the net depletion of stream flow in each subbasin for these categories of water use. Access to this block shall be granted only after consideration of items as listed for municipal systems, below. ▪ New uses for municipal water systems, based on the amount of water required to meet estimated needs. This quantity represents net depletion of stream flow in each subbasin. Access to this block should be granted only after consideration of practicable alternative supplies, demonstration of appropriate measures to ensure water-use efficiency, and consideration of requirements that offset and mitigate the depletion of stream flow or provide other types of aquatic habitat benefits. The Planning Unit supports consideration of mitigation credits for stream flow augmentation. Mitigation credits should reflect net stream-flow benefits in relation to withdrawal impact areas; ▪ Use of a water right reservation is intended to occur within the same subbasin for which the reservation is designated. Exceptions are not encouraged unless it can be demonstrated that overall net benefits to instream flows in the affected subbasin would result. ▪ Small, temporary uses of water for environmental restoration purposes not exceeding one year in duration. ▪ Non-consumptive uses such as fish propagation or hydropower. ▪ New uses limited to the high flow season, where the nature of the proposed use is such that water will not be taken in the low-flow season. However, this is not intended to allow withdrawals large enough to compromise habitat-forming processes of any stream. The Planning Unit recommends that minimum instream flows be adopted as an additional element of the State Rules in selected basins where sufficient data is available. The minimum instream flows will be used in processing applications for changes or transfers of existing water rights. However, the blocks of water reserved for domestic, municipal, and other beneficial uses (see above) shall not be subject to minimum instream flow conditions. The Planning Unit recommends the rule be evaluated after Plan adoption, as the need is identified through the Plan review process outlined in Chapter 8; and that revisions to the rule be considered if needed. Increases to water supply reservations may be considered if compatible with aquatic habitat protection objectives. In addition, water reservation quantities may be shifted among water use categories to better address actual needs. However, the total reservation quantity in each subbasin shall not be decreased. Consistent with Chapter 90.82.130 any process to revise the rule should use a form of negotiated rulemaking that uses the same processes that applied in WRIAs 27 and 28 for developing this Watershed Management Plan. Rule review should consider a quantitative comparison between stream flows and population targets from the Salmon Recovery Plan developed by LCFRB. The Planning Unit does not intend for Ecology to defer processing of water rights, pending rule adoption.

Table ES-6 (cont.)
Watershed Management Policies and Recommendations
WRIAs 27 and 28

Code	Issue	Policy or Recommendation
Recommendation (Pg. 4-62)	Mitigation guidelines	The Department of Ecology should develop clear guidance for mitigation for use by water rights applicants. An existing Ecology document listing examples of mitigation can be used as a starting point.
Policy SFP-3 (Pg 4-23)	Water Conservation	Water conservation is part of a sound comprehensive water resources management program. In general, adherence to State requirements for municipal water conservation, as modified from time to time, will be sufficient for most communities within WRIAs 27 and 28. Conservation activities that exceed state requirements should be carried out in selected communities where water use has the potential to cause significant impairment of stream flow conditions. Based on the Planning Unit's assessment of watershed conditions, these communities include Battle Ground, Ridgefield, Yacolt, and Camas (see Sections on East Fork Lewis River and Washougal River for further discussion of these communities). This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State. Water conservation actions by farmers practicing irrigated agriculture may be warranted in selected locations, where there would be significant benefits to stream flows. The Conservation District in each County should provide technical assistance to farmers to identify water conservation opportunities and funding sources.
Recommendation (Pg. 4-54)	Camas - conservation	The City of Camas should enhance its existing conservation program to reduce water diversions from Jones and Boulder Creeks. However, if source substitution is pursued instead, this may be unnecessary. This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State.
Recommendation (Pg. 4-41)	Battle Ground, Ridgefield, Yacolt - conservation	The Cities of Battle Ground, Ridgefield, and Yacolt should enhance their existing water conservation programs to protect stream flows. This may be unnecessary, however, if source substitution is pursued instead (see below). This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State.
Policy SFP-4 (Pg 4-25)	Short-Term Drought Response	Where major surface water diversions or ground water withdrawals have a direct effect on stream flows on a time scale of weeks or less, the water user should consider adopting voluntary procedures to alter operations in the event of a State-declared drought emergency affecting WRIAs 27 and/or 28. The water user should adopt policies and procedures in advance, to allow for quickly altering operations to minimize or eliminate the depletion of stream flow to the extent feasible in the event such a drought occurs. This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State. For hydropower operations such as the Lewis River project, it is assumed that FERC license conditions fully address releases under low flow conditions, including drought conditions. Efforts should continue to identify small surface water users that could implement this type of management strategy to improve low flow conditions.
Recommendation (Pg. 4-54)	Camas – curtailment during drought	The City of Camas should develop a curtailment plan to reduce diversions from Jones and Boulder Creeks in the event of a state-declared drought emergency. (This approach would not be needed, if an alternative source is developed to replace these diversions.) This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

Table ES-6 (cont.)
Watershed Management Policies and Recommendations
WRIAs 27 and 28

Code	Issue	Policy or Recommendation
Policy SFP-5 (Pg 4-26)	Source Substitution	Communities using water sources (surface or ground water) that significantly reduce base flows in any stream that provides important fish habitat within WRIAs 27 and 28 should consider alternative sources of supply that eliminate or minimize these effects. It is anticipated that this would require examination of cost, potential rate impacts, reliability considerations, and evaluation of other feasibility criteria. This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State. In limited cases, this policy may apply to rural areas where residents rely on domestic wells (exempt wells). When modifying or adopting comprehensive plans, zoning designations, or other land use regulations, Clark and Cowlitz counties, cities, local governments, Ecology, and/or others as appropriate should assess this possibility through a water-balance analysis, in selected rural areas where extensive new development is expected to occur or where there is substantial existing development served by exempt wells. The intent is to explore solutions for small creeks where a large number of existing domestic wells may deplete stream flows. Under the right circumstances, if a different source could be used to replace individual wells, effects on stream flow could potentially be reduced or eliminated. Local community views should be included in this process.
Recommendation (Pg. 4-41)	Battle Ground and Ridgefield– source substitution	The Cities of Battle Ground and Ridgefield should consider wholesale purchases of water from CPU to eliminate water-supply impacts on stream flow. This is preferred over water conservation, because of greater benefits to flow. It is anticipated that this would require examination of cost, potential rate impacts, reliability considerations, and other feasibility criteria. (Note: This recommendation is also stated in Section 3.4.) This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State.
Recommendation (Pg. 4-55)	Camas – source substitution	The City of Camas should consider alternative sources of supply to reduce or cease use of surface water diversions on Boulder and Jones Creeks. Such alternatives include installation of new wells, purchases from City of Vancouver and development of non-potable source of supply. It is anticipated that this would require examination of cost, potential rate impacts, reliability considerations, and evaluation of other feasibility criteria. This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State.
Recommendation (Pg 4-51)	Source substitution – Georgia Pacific Mill	Identify and carry out actions to reduce the impact of Georgia-Pacific's water use on Lacamas Creek. These actions may include a combination of source-substitution; water conservation; and/or water reclamation and reuse within the paper mill. The State of Washington should offer technical assistance for this purpose. In addition, the State of Washington should identify funding mechanisms that could, in part, contribute to reduction of water usage at the mill. This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State.
Policy SFP-6 (Pg 4-27)	Transfer of Water Rights to State Trust	Ecology should use its existing State Trust program, and funding provided by the State Legislature, to identify and acquire water rights from water users willing to sell or donate their water rights in WRIAs 27 and 28, where transfers to the State Trust would provide a significant benefit to fish habitat.
Recommendation (Pg 4-42)	Battle Ground, Ridgefield, and Yacolt – state trust water rights	If source substitution is pursued and if water rights are no longer needed for primary or backup supply, Battle Ground, Ridgefield, Yacolt and Camas should consider transferring water rights to the State Trust. This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State.
Recommendation (Pg. 4-55)	Camas – state trust water rights	If the City of Camas reduces or eliminates diversions from Jones and Boulder Creeks, and if these water rights are no longer needed for primary or backup supply, they could potentially be transferred to the State Trust. This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State.

Table ES-6 (cont.)
Watershed Management Policies and Recommendations
WRIAs 27 and 28

Code	Issue	Policy or Recommendation
Policy SFP-7 (Pg 4-27)	Enforcement, Unauthorized Uses	Ecology should conduct or support initial surveys in selected subbasins to determine whether unauthorized water uses are occurring on streams deemed critical to salmon recovery within WRIAs 27 and 28. If these surveys identify extensive unauthorized uses, they should be expanded to additional subbasins and carried out on a regular, periodic basis (e.g. once every five years). Where unauthorized uses are identified, Ecology should take enforcement actions to eliminate these uses. An alternative or additional approach would be the establishment of a watermaster that has regulatory authority to regulate illegal water diversions. Further development of this concept is recommended during the implementation phase.
Policy SFP-8 (Pg 4-28)	FERC License – Lewis River	The Planning Unit relies on the FERC licensing process to provide protections for flow and other habitat factors associated with hydroelectric facilities on the Lewis River.
Policy SFP-9 (Pg 4-29)	Forest Practices	The USFS, State DNR and private landowners should consider effects of forest management practices on stream flow and other fish habitat factors, in making forest management decisions. The Planning Unit anticipates that existing programs under the State's Forests and Fish regulations DNR's Habitat Conservation Plan, and the federal government's Northwest Forest Plan will provide the regulatory framework needed in this regard. The State and federal governments should monitor the effectiveness of these programs and periodically provide public documentation of their effectiveness in protecting fish habitat, including flow conditions, in WRIAs 27 and 28.
Policy SFP-10 (Pg 4-30)	Stormwater Management	Clark County, Cowlitz County, and the Cities of Vancouver, Camas, Washougal, and Battle Ground should continue to carry out their legally mandated responsibilities with regard to stormwater management. The remaining cities in all three counties should review their stormwater management ordinances to determine whether they are adequately protective of fish habitat in local streams that may be affected by future development. Skamania County should voluntarily consider developing such an ordinance. Where enhanced stormwater management needs are identified, revisions to local ordinances should be considered in light of the guidance and BMPs provided in Ecology's Manual. The focus should be on upgrading development practices and mitigation requirements in areas where stream flow and fish habitat may be compromised as development occurs. Costs, expected magnitude of benefits, and feasibility considerations should be included in this review.
Policy SFP-11 (Pg 4-31)	Sewer Extensions	When modifying or adopting comprehensive plans, zoning designations, or other land use regulations, jurisdictions should consider the water balance implications of allowing extension of sewer service to developing areas. The Planning Unit recognizes that provision of sewer service can provide substantial water quality benefits. However, where sewer service is extended to replace septic systems, and residents continue to rely on water wells, stream flows may be reduced. This effect should be anticipated and mitigated where applicable. This is particularly important in areas with relatively dense development near small streams.
Policy SFP-12 (Pg 4-32)	Floodplain Management	Within authorities, local jurisdictions and state agencies with land-management responsibilities should protect existing floodplains from modifications that would impair their hydrologic functions and habitat value. Local jurisdictions and state agencies with land-management responsibilities should identify floodplain restoration projects, subject to local input, cost-benefit analysis, and availability of funding. Where these factors are favorable, and where substantial benefits to flow or other habitat factors are identified, these projects should be pursued for implementation.

Table ES-6 (cont.)
Watershed Management Policies and Recommendations
WRIAs 27 and 28

Code	Issue	Policy or Recommendation
Policy SFP-13 (Pg 4-33)	Wetlands Management	In conjunction with the Planning Unit, Counties should explore funding opportunities for conducting a county-wide wetland assessment that includes evaluation of hydrological functions. Counties should also require evaluation of hydrological function as part of any site-specific wetland assessments conducted under their critical areas, wetland or other land use ordinances. Their wetlands ordinances should be modified as needed to include hydrologic functions in the wetland protection hierarchy. Counties should review and consider strengthening mitigation ratios, for selected wetland areas that offer significant hydrologic functions or other fish habitat benefits.
Recommendation (Pg. 4-33)	Other activities affecting shallow aquifer interactions	Evaluate the need to take additional actions to prevent disruption of shallow aquifer recharge, subsurface flow patterns, and aquifer discharge that support the stream flow regime in low flow periods.
Surface Water Quality Policies and Recommendations		
Policy SWQ-1 (Pg 5-1, 5-9)	TMDLs	The Washington State Department of Ecology's program to set Total Maximum Daily Loads (TMDLs) for water bodies that do not meet state water quality standards is the primary vehicle for addressing water quality at the regional scale.
Recommendation (Pg. 5-11)	TMDLs	The Planning Unit recommends that Ecology develop TMDLs according to the priority list shown in Table 5-3. At such time as the 2002/2004 303(d) list is approved by Ecology and EPA, these priorities should be revisited.
Recommendation (pg. 5-17)	Assessment of Sources of Impairment	It is recommended that a detailed assessment strategy be developed for WRIAs 27 and 28 to identify sources of water quality impairment (specific sites or areas). Following completion of the strategy, it is recommended that funds be sought to carry out this assessment and take corrective actions where needed.
Ground Water Quality Policies and Recommendations		
Pg 6-13	Ground Water Quality	The Planning Unit recommends that steps be taken to: ▪ Improve public understanding and awareness of issues related to drinking water quality; ▪ Assess susceptibility of ground water supplies to contamination on a regional basis; ▪ Improve local wellhead protection programs; ▪ Implement management strategies to minimize impacts of land use activities on ground water supplies ▪ Clean up ground water contamination.
Implementation		
Recommendation (Pg. 8-3)	Implementation – Coordination and Oversight	In order to provide a venue for these activities, it is recommended that the WRIAs 27 and 28 Planning Unit transition from planning functions to coordination and oversight functions. The purpose is to foster an organized and collaborative approach, as many individual organizations carry out specific actions under their jurisdictions, and to secure funding for implementation. It is also recommended that LCFRB continue to provide staff resources to support the Planning Unit in this activity. Funding for these purposes can be based on the State Phase 4 grants for the first five years of the implementation phase. An interlocal agreement may be useful in defining coordination and oversight responsibilities. Such an agreement may also be beneficial in further defining other implementation commitments among the organizations involved, beyond the level of detail presented in this Plan

Section 1
Introduction and Purpose

Water Resource Inventory Areas (WRIAs) 27 and 28 are located in southwest Washington State, and comprise all of Clark County, southern Cowlitz County, portions of western and north-central Skamania County, and a very small portion of Yakima County.[1] A variety of needs must be met by surface and ground waters in this region of the state. Population in the region has been growing rapidly, creating a need for increased water supply. Agricultural producers need continued access to water for irrigation and stock watering. Large industrial facilities require water for their operations. Local streams provide habitat for fish species that have recently been listed under the federal Endangered Species Act (ESA) and sustain non-listed fish and wildlife as well. Finally, the region's rivers, streams, and lakes offer fishing, boating and other recreational opportunities and natural beauty for residents and visitors to the area.

This Watershed Management Plan (Plan) addresses a range of issues related to water resources in WRIAs 27 and 28, including water supply, stream flow management, water quality, and fish habitat. It reviews alternative approaches for managing water resources in the area and recommends selected strategies for implementation.

1.1 Legal Basis for Planning

In 1998, the Washington State Legislature passed the Watershed Management Act (WMA – Chapter 90.82 RCW) to provide a framework for citizens, interest groups, and government organizations to resolve water resource issues in each of the State's 62 WRIAs. The WMA offers funding for areas that wish to undertake planning and specifies ground rules for use of the funding.

The WMA provides for formation of a Planning Unit to develop a watershed plan, and provides a process for local counties to approve the plan or identify needed changes. The WMA identifies four topics that can be addressed as part of a watershed plan. Water quantity must be addressed if grant funding is received. Water quality, habitat, and recommendations regarding setting of instream flows can also be addressed, but are optional under the law. The law specifies certain types of information that must be gathered in preparing a watershed plan. It also identifies a range of water-resource management strategies that must be considered. The law states that watershed plans must be consistent with efforts already under way in each watershed, and should not duplicate these efforts.

The law also identifies a number of limitations on watershed plans. For example, they may not conflict with existing law, modify laws, ordinances or permits, or impair existing water rights. The Plan cannot impose obligations on any organization without its consent.

[1] Only 520 acres of Yakima County, on the western slope of Mt. Adams, is within the Planning Area. This constitutes less than 0.05 percent of the entire planning area. As such, Yakima County is not included in the analysis and recommendations presented in this Watershed Management Plan.

1.2 Application of Watershed Planning in WRIAs 27 and 28

A Planning Unit was formed for WRIAs 27 and 28 in 1999, with monthly meetings held from then through 2004. Planning Unit representation is listed at the front of this document, following the title page. The Lower Columbia Fish Recovery Board (LCFRB) was selected to serve as the lead agency to receive and manage State grant money on behalf of the Planning Unit, and provide staffing and facilitation throughout the planning process. In 2000, each Initiating Government adopted by resolution all four elements in the scope of planning: Water Quantity, Water Quality, Instream Flows, and Habitat.

The Planning Unit and LCFRB have worked closely with professional service providers to assess watershed conditions and develop the Watershed Plan. This Plan was prepared by HDR/EES under the direction of LCFRB and the Planning Unit.

In accordance with the Watershed Management Act, this Plan has been developed in three phases. Phase I was an organizing phase, held in 1999 under the direction of the Initiating Governments[2]. During Phase I the Planning Unit was organized, and the mission statement, ground rules, and operating principles were adopted (Appendices A, B, and C). A detailed work program was developed and funds for Phase 2 and 3 planning were obtained.

Phase II was an assessment phase, to gather technical information regarding the region's water resources and associated needs. A Level 1 Assessment was carried out from November 2000 to June 2001 to assess existing conditions in the watershed. A final set of technical memoranda comprising the Level 1 Assessment was issued in June 2001 (GeoEngineers, 2001).

A Level 2 Assessment was also carried out to provide in-depth technical studies. Level 2 Assessment reports were completed in Fall 2003 (PGG, 2003; PGG, 2003b; PWR, 2003).

In May of 2002 an All-Commissioners meeting was convened for Clark, Cowlitz, and Skamania County Commissions where the Level 1 materials were reviewed (two additional counties participated for an adjacent watershed planning process in WRIAs 25 and 26). The Commissioners were provided an overview of additional studies that would be conducted and the draft plan development process. They were also provided information on integrating the watershed management plan into the regional ESA[3] salmon recovery plan. It was determined staff would meet again with each county individually to review the draft watershed management plan in 2004.

Phase III of the process was the Planning Phase, carried out primarily from 2002 through 2004. This process was carried out in three stages. First, goals and objectives were established through a Planning Unit workshop and subsequent meetings. Second, a series of technical memoranda was developed to provide review and analysis of key issues and alternative strategies in the areas of water supply, flow management, surface water quality, and ground water quality. Finally, this Watershed Management Plan document was prepared, integrating all aspects of the planning process and recommending water resource management strategies.

---

[2] Initiating Governments for this planning area include the four counties, the largest city in each WRIA, the largest water purveyor for each WRIA, the Chinook and Cowlitz Tribes, and the Yakama Nation.
[3] The Federally established Endangered Species Act

The technical memoranda from all three phases are listed in Table 1-1. Together, they provide the background and basis for the water resource management alternatives presented and are cited extensively throughout this Plan document.

Table 1-1
Technical Memoranda Prepared During Planning Process

Assessment Phase: Level 1 Assessment[(1)]	
Task 1A:	Water Quantity, Subtask 0100: Water Quantity Assessment and Subtask 0400: Streamflow Evaluation (June 2001)
Task 1A:	Water Quantity, Subtask 0200: Water Use Assessment (June 2001)
Task 1A:	Water Quantity, Subtask 0300: Water Rights Estimate and Subtask 0500: Stream Administrative Status (June 2001)
Task 1A:	Water Quantity, Subtask 0600: Hydraulic Continuity Evaluation (June 2001)
Task 1A:	Water Quantity, Subtask 0700: Seasonal/Cyclical Precipitation Analysis (June 2001)
Task 1A:	Water Quantity, Subtask 0900: Seasonal Water Balance (June 2001)
Task 1A:	Water Quantity, Subtask 0800: Land Use Evaluation (June 2001)
Task 1B:	Water Quality Assessment, Subtask 0100 Compliance with Standards; Subtask 0200: Pollution Sources; Subtask 0300: Pollution Impact Evaluation; Subtask 0400: Surface Water Mitigation Actions (June 2001)
Task 2:	Future Projections Analysis (June 2001)
Task 3:	Conclusions and Level II Recommendations (June 2001)
Assessment Phase: Level 2 Assessment	
TM No. 10 (Task 8A):	East Fork Lewis River Watershed Ground water/Surface-Water Relationships (PGG, 2003)
TM No. 11 (Task 8B):	Effect of Exempt Wells on Baseflow Washougal River Watershed (PGG, 2003)
TM No. 12 (Task 6):	Hydrologic Modeling of Effects of Land Use Changes WRIAs 27 and 28 East Fork of the Lewis River and Washougal River (PWR, Draft, December 2003)
Planning Phase[(2)]	
TM No. 1 (Task 2):	Assessment of Key Issues and Existing Plans for Major Water Users (August 2002)
TM No. 2 (Task 3):	Water Reclamation and Reuse Opportunities in WRIAs 27and 28 (September 2002)
TM No. 3 (Task 3):	Comparison of Potential Water Supply Management Strategies (November 2002)
TM No. 4 (Task 5):	Instream Flow Conditions in Four Pilot Streams (Barber, December 2002)
TM No. 5 (Task 5):	Instream Flow Management Approaches in Four Pilot Streams (October 2002)
TM No. 6 (Task 7):	Ground water Development Scenarios (Kennedy-Jenks, November 2002)
TM No. 7 (Task 4):	Assessment of Priorities for Surface Water Cleanup Plans (TMDLs) (June 2003)
TM No. 8 (Task 5):	Strategies for Managing Flows in Two Pilot Subbasins (July 2003)
TM No. 9 (Task 10):	Management Actions to Protect Ground Water Quality (July 2003)
TM No. 13 (Task 4):	Surface Water Quality Monitoring Strategy for WRIAs 27 and 28 (Barber, May 2004)
TM No. 14 (Task 2-170):	Tidal Effects as Related to Stream Flow Protection Rule (December 2004)

TM = Technical Memorandum
(1) All Level 1 Assessment documents prepared by GeoEngineers
(2) All Planning Phase Technical Memoranda prepared by EES, except TM No. 4 and 13, prepared by Dr. Michael Barber; and TM No. 6 prepared by Kennedy-Jenks.

1.3 Planning Objectives

In February 2002 a workshop was held to identify objectives to guide the Phase III planning process. The list of objectives developed at the workshop was refined by the Planning Unit at a subsequent meeting in March 2002. The resulting list of objectives is presented in Table 1-2. The activities carried out during Phase III and the recommendations presented in this Watershed Management Plan were designed to meet this set of objectives.

Table 1-2
Planning Objectives

I. Objectives to Protect or Enhance Conditions in the Watershed

- Effectively and efficiently manage water to ensure availability, reliability and predictability for beneficial uses over the long term, considering ongoing changes in population, local economies, and water-use technology.
- Manage stream flows effectively to sustain aquatic biota, including fish populations in their various life stages
- Protect surface water quality for designated uses, with an emphasis on protection of aquatic biota, including fish species in their various life stages.
- Protect surface and ground water needed for public drinking water supplies.
- Maintain productive habitat and enhance degraded habitat forming processes for indigenous fish species in all life stages.
- Protect and enhance wetlands and floodplains, with associated benefits for flows, water quality, ground water recharge and flood control.

II. Objectives Regarding the Process for Developing and Implementing Watershed Plan

- Manage water resources in a cost-effective manner, taking into account existing programs, potential partnerships, cost/benefit principles, and opportunities to achieve multiple objectives
- Ensure strategies contribute to a healthy local and regional economy.
- Ensure plan can be implemented through sustained support by local governments, state agencies, tribes, water-use interests and the public
- Provide for extensive and meaningful public participation
- Ensure fairness in distributing costs and burdens of water-resource management actions
- Improve public understanding of water resources and encourage responsible stewardship.

III. Objectives for Improved Information and Data Management

- Improve scientific basis for decision-making on water-resource issues, through sound data, accepted technical methods, and effective quality assurance/quality control protocols.
- Develop an effective adaptive management program, supported by long-term monitoring and ongoing developments in scientific understanding

1.4 Organization of this Document

This document is organized into eight sections, as follows:

Section 1: Introduction and Purpose
Section 2: Existing Conditions
Section 3: Management of Water Supplies
Section 4: Management of Stream Flows
Section 5: Management of Surface Water Quality
Section 6: Management of Ground Water Quality
Section 7: Management of Fish Habitat Conditions (Non-Flow)
Section 8: Plan Implementation Considerations

There are several appendices containing additional information on the analysis and strategies recommended in this Plan. Appendices providing detailed information on the habitat element are contained in four volumes bound separately and covering habitat protection and restoration actions for the Kalama, Lewis, Lower Columbia tributaries, and Washougal Subbasins, respectively.

Section 2
Existing Conditions

This section summarizes existing conditions in Water Resource Inventory Areas (WRIAs) 27 and 28, including water supply systems, surface and ground water resources, surface and ground water quality, and fish habitat. This section provides basic background information in an overview format. More information on many of these topics is provided in subsequent sections of this Plan.

The information contained in this section was drawn primarily from the Assessment Phase of the watershed planning effort and various technical memoranda developed during the Assessment and Planning Phases (see Table 1-1). For detailed information, the reader should refer to those documents, which are available from the Lower Columbia Fish Recovery Board (LCFRB).

2.1 Physical Setting

Exhibit 2-1 displays key features of WRIAs 27 and 28. The planning area occupies approximately 1,800 square miles, including all of Clark County and portions of Cowlitz and Skamania Counties. The Columbia River is not included within the planning area. Although the river may be discussed as it is a source of supply for some users, this Plan does not address management of the Columbia River.

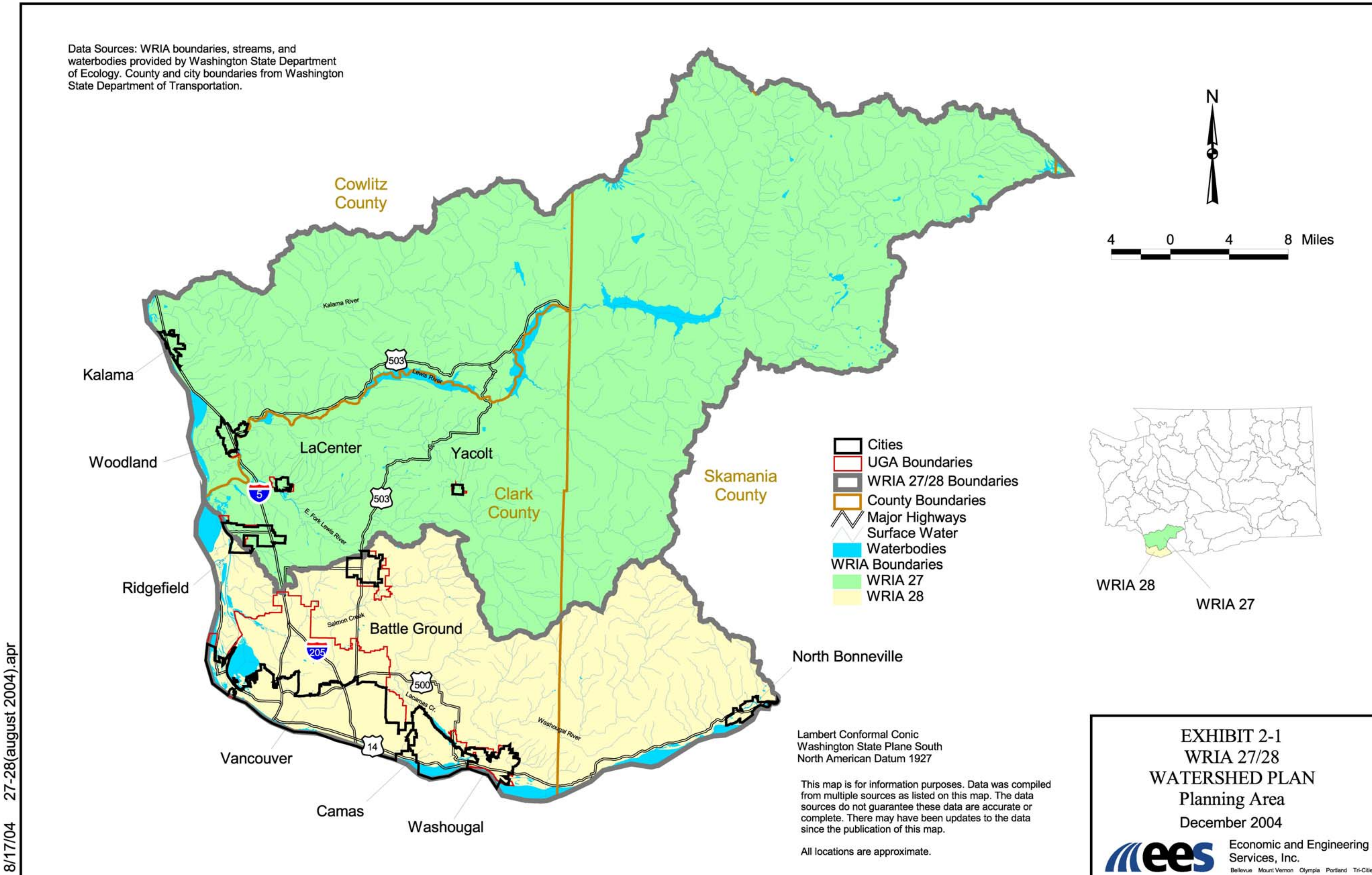
The physiography of the area is widely varied, ranging from temperate lowlands near sea level to high mountainous terrain at elevations over 12,000 feet. Its headwaters are situated along the crest of the Cascade Range.

For the purposes of this Plan, the Planning Unit defined eight subbasins within WRIAs 27 and 28. As shown on Exhibit 2-2, the eight subbasins are:

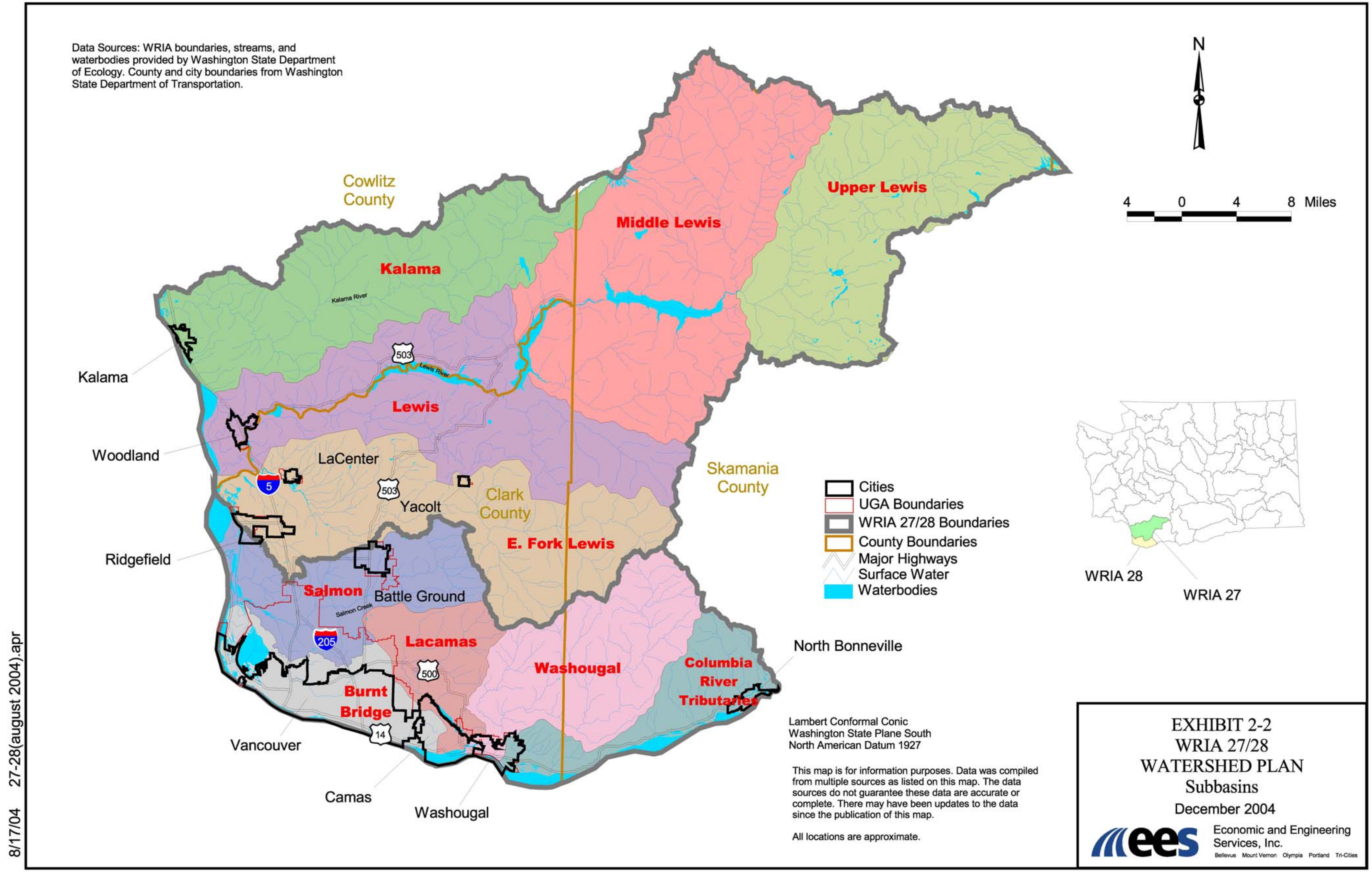
WRIA 27	WRIA 28
Kalama River	Salmon Creek
North Fork Lewis River (lower, middle, upper)	Burnt Bridge Creek
East Fork Lewis River	Lacamas Creek
	Washougal River
	Columbia River Tributaries

In the habitat volumes (appendices bound in separate volumes), the WRIA 27 subbasins are grouped as the Kalama and Lewis Subbasins. The WRIA 28 subbasins are grouped as the Lower Columbia Tributaries and Washougal Subbasins.

Throughout the basin, precipitation is widely varied with an annual average precipitation of approximately 40 inches per year near Vancouver to over 170 inches per year at Mt. St. Helens. The majority of the subbasins are lower elevation, rain-dominated watersheds.



8/17/04 27-28(august 2004).apr


Data Sources: WRIA boundaries, streams, and waterbodies provided by Washington State Department of Ecology. County and city boundaries from Washington State Department of Transportation.
N
4 0 4 8 Miles
Cowlitz County
Skamania County
Clark County
Kalama
Middle Lewis
Upper Lewis
Lewis
E. Fork Lewis
Salmon
Lacamas
Washougal
Burnt Bridge
Columbia River Tributaries
Kalama River
Lewis River
Salmon Creek
Kalama
Woodland
LaCenter
Yacolt
Ridgefield
Battle Ground
Vancouver
Camas
Washougal
North Bonneville
503
5
205
500
14
Cities
UGA Boundaries
WRIA 27/28 Boundaries
County Boundaries
Major Highways
Surface Water
Waterbodies
WRIA 28
WRIA 27
Lambert Conformal Conic
Washington State Plane South
North American Datum 1927
This map is for information purposes. Data was compiled from multiple sources as listed on this map. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this map.
All locations are approximate.
EXHIBIT 2-2
WRIA 27/28
WATERSHED PLAN
Subbasins
December 2004
Economic and Engineering Services, Inc.
8/17/04 27-28(august 2004).apr

2.2 Land Use, Economy, and Population

Existing land use in WRIAs 27 and 28 is approximately 87 percent forested and brush lands (including barren, undeveloped lands around Mt. St. Helens), 7 percent agricultural, and 6 percent urban, suburban, and rural residential land. Table 2-1 provides a summary of the land use in the three counties included in the planning area.

Table 2-1
WRIAs 27 and 28 Land Use (in acres)

County [1]	Forested	Agricultural	Urban/Suburban/ Rural Residential[2]	Total
Clark	280,633	74,176	64,170	418,979
Cowlitz	208,926	8,227	1,635	218,788
Skamania	506,094	2,627	7,100	515,822
Total	**995, 653**	**85,030**	**72,905**	**1,153,589**

Source: Clark County and Washington State Department of Ecology Geographical Information System data, and Skamania County land use data.

(1) Only includes those county lands located within the WRIAs 27 and 28 boundaries.

(2) Includes rural non-resource lands (e.g., 5-acre residential lots).

The WRIAs 27 and 28 landscape is evolving, as agricultural use diminishes, timber harvest declines, and urbanization expands. In Clark County, for example, many agricultural lands have transitioned to rural non-resource lands (e.g., 5-acre residential lots). The southwest Washington manufacturing economy is comprised primarily of wood processing, paper manufacturing, high-tech industries, and food processing. The local agricultural economy is composed mainly of hay and berry production, livestock and dairy industries, and nurseries. Forestry remains an important component of the Skamania County economy despite timber harvest declines.

The population of WRIAs 27 and 28 was approximately 360,000 in year 2000. As depicted in Table 2-2, this population is expected to increase by over 185,000 people between 2000 and 2020.

Table 2-2
WRIAs 27 and 28 Population Projection

County	2000	2020
Clark	345,238	520,818
Cowlitz	12,822	21,840
Skamania	3,291	4,241
Total	**361,351**	**546,899**

Source: Year 2000 population is based upon U.S. Census 2000 data. Year 2020 population is based upon projections of municipal water providers and County planning staff.

Note: The entire county is not included, only the portion within the WRIAs.

Of the three counties with lands in WRIAs 27 and 28, Clark County is much more populous and includes a number of urban areas. Cowlitz County is generally rural, but with some small urban areas. Skamania County is generally rural, with low population densities.

2.3 Sources of Water Supply and Projected Water Supply Needs

Communities in WRIAs 27 and 28 rely upon a variety of systems to meet their needs for domestic water supply, commercial and industrial supply, and agricultural supply. Such systems include large municipal systems, small public water systems, domestic wells, and wells and diversions owned by self-supplied industrial and agricultural users.

Skamania County is more rural in character than Clark or Cowlitz Counties. There are no large municipal systems in Skamania County. The County's residents rely on exempt wells for domestic supplies or are served by small Group A or Group B water systems.

The majority of water needs throughout WRIAs 27 and 28 are met by ground water supplies. All municipal and domestic water sources are ground water wells, with the exception of two creeks that provide a portion of the City of Camas' supply. The Cities of Kalama and Woodland obtain ground water through Ranney well systems, which tap shallow ground water sources adjacent to surface waters. Ground water is also expected to serve the majority of growth in WRIAs 27 and 28 over the next 20 years.

Excluding industries that utilize Columbia River water, ground water sources supply approximately 60 percent of the water required of self-supplied commercial and industrial facilities[1]. Agricultural demands are met by a similar combination of ground and surface water supplies (i.e., 60 percent ground water, 40 percent surface water).

Table 2-3 presents current and projected demands through year 2020 for water use in the above-mentioned categories. The growth in municipal and domestic demand is expected to be served primarily by the following large municipal water systems:

City of Battle Ground	City of Ridgefield
City of Camas	City of Vancouver
Clark Public Utilities	City of Washougal
City of Kalama	City of Woodland

As additional supplies and water rights will be necessary to meet the increased demands in this category of water use, the Watershed Plan's water supply discussion focuses primarily on this category (see Section 3).

In Skamania County there are no large urban centers. Growth in demand is expected to be served by exempt wells and small public water systems.

The growth in self-supplied industrial demand includes the possible restart of ALCOA facilities, for which supplies and water rights already exist, and expansion of existing Shin-Etsu Handotai America (SEH) facilities. No growth in total agricultural water demands is expected in the near future.

[1] Of the 40 percent of self-supplied commercial/industrial demand met by non-Columbia River surface water supplies, one user (Georgia-Pacific, which uses water from Lacamas Lake, near the City of Camas) accounts for 99 percent.

Table 2-3
WRIAs 27 and 28 Water Demand Projections (in acre-feet/year)

Water Use Category	2000	2020
Municipal and Domestic (1)	53,946	84,691
Self-Supplied Industrial (2)	119,832	158,868
Agricultural	10,810	10,810
Total	**184,588**	**254,369**

Source: Municipal water use obtained from purveyor water system plans (see Section 3). Domestic water use calculated from Washington State Department of Health data (Drinking Water Automated Information Network, 2002). Self-supplied industrial water use estimated from water rights data (Washington State Department of Ecology Water Rights Application Tracking System, 2002). Agricultural water use calculated via crop irrigation requirements (GeoEngineers, 2001).

(1) Majority of growth expected to be served by municipal water systems.

(2) Excludes industries using Columbia River supplies. Increase in demand accounts for possible restart of ALCOA facilities (for which supplies already exist) and expansion of existing SEH facilities.

2.4 Surface Water Resources

The major river systems located within WRIAs 27 and 28 are the Kalama, Lewis (North Fork and East Fork), and Washougal Rivers. Other primary surface water bodies of interest are Salmon, Burnt Bridge, and Lacamas Creeks. Exhibit 2-1 identifies these major water bodies. Table 2-4 provides a summary of the major water features and their drainage areas, organized by subbasin.

Table 2-4
Description of Major Surface Water Bodies – WRIAs 27 and 28

Subbasin	Major Surface Water Features	Area (square miles)
Kalama	Kalama River	224
Lewis	North Fork Lewis River	848
Lower Lewis	Lake Merwin, Yale Lake	255
Middle Lewis	Yale Lake, Swift Lake	361
Upper Lewis		232
East Fork Lewis	East Fork Lewis River	236
Salmon Creek	Salmon Creek, Lake River	118
Burnt Bridge Creek	Burnt Bridge Creek, Vancouver Lake, Lake River, Columbia Slope Streams	79
Lacamas Creek	Lacamas Creek, Lacamas Lake	65
Washougal River	Washougal River	148
Columbia River Tributaries	Gibbons Creek, Duncan Creek, others	85

There are limited stream gauges throughout WRIAs 27 and 28 that have relatively recent measurements, long periods of record, and are free of multiple long data gaps. Table 2-5 provides a summary of the existing US Geological Survey (USGS) gauges that meet these criteria.

Table 2-5
Stream Gauge Locations and Record Summary – WRIAs 27 and 28

USGS Station No.	Name/Location	Drainage Area (square miles)	Period of Record
14212000	Salmon Creek near Battle Ground	18.3	1944-1975, 1988-1990, 1992-Present
14143500	Washougal River near Washougal	108	1945-1981
14144000	Little Washougal River near Washougal	23.3	1951-1956
14211895	Burnt Bridge Creek at 112th Ave, at Vancouver	8	1999-Present
14211898	Burnt Bridge Creek at 19th St, at Vancouver	18	1999-Present
14213200	Lewis River near Trout Lake	127	1959-1972
14216000	Lewis River above Muddy River near Cougar	227	1955-1970
14218000	Lewis River near Cougar	481	1924-1958
14220500	Lewis River at Ariel	731	1922-Present
14222500	East Fork Lewis River near Heisson	125	1930-Present
14223500	Kalama River below Italian Creek near Kalama	198	1947-1975
14223600	Kalama River above Spencer Creek near Kalama	202	1980

Table 2-6 provides a summary of average January and August flows for four of the major surface water bodies, illustrating the range in flows throughout the basin, both on a geographic and temporal basis.

Determinations of minimum instream flow requirements for fish habitat, as would be established by Ecology, via rule adoption or administrative processes, have not been determined for any of the subbasins. However, some tributary streams have been closed administratively to further appropriations (see Section 4).

Table 2-6
Average Flows for Selected Streams – WRIAs 27 and 28

Stream	Average January Flow (cfs)	Average August Flow (cfs)
Kalama River	2,321	314
East Fork Lewis River	1,419	83
Salmon Creek	405	19
Washougal River	1,683	105

2.4.1 Hydropower Projects

PacifiCorp owns three hydroelectric projects on the Lewis River – Merwin, Yale and Swift No. 1. Cowlitz PUD owns the Swift No. 2 Hydroelectric Project. Operations of these four projects have significant impacts on the river's flow levels. While the Planning Unit does not have control over operation of the projects and the associated instream flow impacts, the projects are described here since the impact to flows is substantial. The primary purpose of the projects is to generate electricity, although the stated purpose also includes flood control, recreation, and natural resources use.

Traveling upriver, PacifiCorp's first dam is Merwin Dam located approximately 20 miles upstream from the confluence of the Lewis and Columbia Rivers. The dam impounds Lake Merwin and serves as a re-regulating facility to control flows downstream of the

Project. The second dam is Yale Dam, which is located approximately 15 miles upstream of Merwin Dam and serves as a peaking facility. The third dam is Swift (No. 1) Dam, which is located 10.5 miles upstream of Yale Dam and serves to impound water in Swift Reservoir. Below Swift No. 1 is the PUD's Swift No. 2 Powerhouse, which is located at the end of a 3.2 mile power canal. The projects are in the process of being relicensed through the Federal Energy Regulatory Commission (FERC).

As the Lewis River Project goes through the FERC relicensing procedure, a schedule will be established for instream flow requirements for release from Merwin Dam. Once the instream flows are agreed to by the parties involved in the relicensing procedure, these flows will become a condition of the operating license. These flows will then be a primary factor affecting stream flows on the mainstem Lewis River from Merwin Dam to the mouth of the River.

Maximum flows are addressed by the current licenses by requiring adequate flood storage behind the three dams. Low flows are addressed by provisions associated with the FERC license that require minimum releases from Merwin Dam. These releases vary, depending on flow conditions. These requirements range from 1,200 cfs during drier months to as high as 5,400 cfs during wet months. These maximum and minimum flow regimes will be addressed, and possibly altered, during the relicensing process and resulting settlement agreement. Additional discussion of stream flow management is presented in Section 4.

2.4.2 Potential Effects of Climate Change

Climate change can impact instream flows in three ways due to its impact on temperature and precipitation: change minimum flow volumes, change flooding probability, and change flow timing. While the Planning Unit clearly does not have control over climate change, it is important to consider climate change in order to understand its impact and since water resource management decisions can serve to mitigate unwanted impacts.

There are three types of climate change: El Nino/Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and global warming. Scientific understanding of these three phenomena varies. ENSO is well understood by the scientific community. PDO is less well understood by the scientific community. Global warming is the least understood, and a minority of the scientific community discounts its existence and/or causes.

ENSO-caused shifts in climate are driven by changes in the temperature of equatorial Pacific Ocean water temperatures. In the default situation, called ENSO neutral, the equatorial Pacific Ocean water temperature is cold in the east and warm in the west. Two changes, or phases, from this norm can occur. The warm phase, also called El Nino, occurs when the eastern portion of the Pacific Ocean is warmer than average. The cool phase, also called La Nina, occurs when the eastern portion of the Pacific Ocean is cooler than average. The impact of ENSO in North America is strongest from October to March. The life of each ENSO event (i.e. an El Nino) ranges from 6-18 months and a complete cycle can take 2-7 years. As mentioned above, the scientific community has a strong understanding of ENSO and events can often be forecasted 6-9 months in advance.

PDO is very similar to ENSO except for the following three aspects. First, PDO has a stronger impact in the north Pacific Ocean than in the equatorial Pacific Ocean. Second, the timing of PDO is much longer with an event life of 20-30 years and complete cycles taking 50-70 years. Third, as mentioned above, the scientific community has a less robust understanding of PDO, which means less understanding of its impact and less capability for prediction.

The third type of climate change is global warming, which is the warming of the earth's surface temperature. Certain elements of global warming are well understood and accepted, while other elements are less understood and accepted. Well understood elements include documentation that the temperature has indeed risen (approximately 1 degree F since the late 19^{th} century); that greenhouse gases (primarily carbon dioxide, methane, and nitrous oxide) trap heat; and that humans contribute the majority of greenhouse gases to the atmosphere. Elements that are less well understood include the causal link between human contributions of greenhouse gases and warming, as well as how fast temperatures rise due to the presence of greenhouse gases. Finally, the element with the least understanding is the impact of increased temperatures, although global warming is predicted to impact many subject areas including water resources.

The impacts of climate change upon watersheds may be determined based upon the hydrologic type of the watersheds being analyzed. The WRIAs 27 and 28 subbasins are rain-dominated watersheds, as opposed to snow-dominated or transient (a combination of rain- and snow-dominated), since they have a single peak in the winter months. As such, the potential effects of climate change upon surface water flows in WRIAs 27 and 28 are summarized as follows:

- Low flows will be decreased in warm phases of ENSO and PDO. Low flows will be increased in cool phases of ENSO and PDO. The impact of global warming on low flows is uncertain.
- The probability of flooding will decrease in warm phases of ENSO and PDO. Flooding probability will increase in cool phases of ENSO and PDO, as well as due to global warming.
- No impact to flow timing is expected, since timing remains unchanged for rain-dominated basins.

This information regarding changes to low flows, flood probability, and flow timing should be helpful for managing rivers in WRIAs 27 and 28. For dammed rivers, such as the North Fork Lewis, this information could be incorporated into the operating rules for the rivers. For undammed rivers, this information can be used to inform strategies discussed later in the Watershed Plan including conservation, source substitution, land use practices, wetland protection, and floodplain management.

2.4.3 Tidally Influenced Stream Reaches

The lower reaches of streams discharging to the Columbia River within WRIAs 27 and 28 are influenced by tides from the Pacific Ocean. In these reaches, water is backed up, reducing velocities and increasing depth. This effect on flow is important in the context of this watershed management plan, because water withdrawals in a tidally influenced reach will have a different effect than water withdrawals in a free-flowing reach.

Tidally influenced streams and rivers occur in all of the WRIAs 27 and 28 subbasins that have tributaries to the Columbia River. These subbasins include: Kalama, Lewis, East Fork Lewis, Salmon, Burnt Bridge, Washougal, and Columbia River Tributaries subbasins. The magnitude and timing of daily fluctuations in water levels in tidally-influenced reaches vary. Major factors include the distance from the mouth of the tributary to the mouth of the Columbia River, and the daily variation in tidal levels at the mouth of the Columbia River. A brief review of tidal data shows that the tidal influence extends up the Columbia River beyond the City of Vancouver, where the range of daily tidal fluctuation can be as much as two to three feet. Depending on the phase of the moon and other factors, the range of tidal variation may be less.

Within tributaries to the Columbia River themselves, the extent of tidal influence depends on the gradient of the tributary stream valley. A relatively flat tributary valley may have tidal influence for several miles upstream of its confluence with the Columbia River. A steeper tributary stream may have only a short reach with tidal influence. Information is available from different agencies that have estimated the extent of tidal influence in these tributaries. The Washington Department of Fish and Wildlife (WDFW) has estimated the extent of tidal influence. In addition, each tributary was assigned a tidal reach for the Ecosystem Diagnosis and Treatment (EDT) model developed for tributaries entering the Columbia. The average reach lengths for tidal reaches were determined from professional knowledge of each tributary gained through stream surveys. For the major streams that flow into the Columbia River, the Planning Unit reviewed the extent of tidal influence. This information was used to develop the stream flow management strategy described in Section 4.

2.5 Ground Water Resources

Ground water in the southwest portion of WRIAs 27 and 28 is used much more extensively for water supply than is ground water in the northern and eastern portions of the basin.

The geology within WRIAs 27 and 28 can generally be divided into two regions. The entire north and eastern portions of the study area consists of the Cascade and Kalama volcanic rocks (basalt formations). This area includes most of the Kalama River subbasin, much of the Lewis River subbasin, the eastern half of the East Fork Lewis River subbasin, and most of the Washougal River subbasin. The ability of the volcanic rocks to store and move water varies widely depending on the structure of the rocks. Minimal information is available on the ground water production of these units. However, ground water production is expected to be low, since very little sand and gravel overlies, or is present within, the rock formations. Essentially, ground water in the northern portion of the basin is not highly utilized because of the impervious nature of the rocks.

The southwestern portion of WRIAs 27 and 28, including the Salmon Creek subbasin, Burnt Bridge Creek subbasin, the western half of the East Fork Lewis River subbasin and the Lacamas

Creek subbasin is filled with up to 1,600 feet of unconsolidated deposits. Some of the layers are capable of high ground water production. Clark County residents and businesses use these aquifers almost exclusively as their source of water supply.

The southwestern portion of WRIAs 27 and 28, including the Salmon Creek subbasin, Burnt Bridge Creek subbasin, the western half of the East Fork Lewis River subbasin and the Lacamas Creek subbasin is filled with layers of approximately 1,400 feet of unconsolidated sediments. The unconsolidated sediments consist of layers of coarse-grained sand, gravel, and cobble deposits and layers of fine-grained silt and clay deposits. The coarse-grained deposits contain the principal aquifers within the planning area and the fine grained deposits act as aquitards or confining units, which separate the aquifers from one another. Some of the aquifers are capable of high ground water production and serve as the primary sources of supply to the larger water purveyors, industrial users, and others in Clark County. The most productive aquifer occurs within the Pleistocene Alluvial deposits which exist as a shallow unconfined aquifer in southern and western portions of Clark County. For example, many of the City of Vancouver's wells are completed in the Upper and Lower Orchards Aquifers, which are within the Pleistocene Alluvial deposit. Other important aquifers (in order of increasing depth) include the Upper and Lower Troutdale Aquifers and the Sand and Gravel Aquifer. The Pleistocene Alluvial and the Upper Troutdale Aquifers are considered to be most susceptible to contamination due to the lack of significant overlying confining units. Extensive confining units overlie the Lower Troutdale and Sand and Gravel Aquifers and provide protection from contaminant impacts.

2.6 Water Rights

Water rights were inventoried by GeoEngineers during the Assessment Phase of the watershed planning process. The inventory was based on Ecology's Water Rights Application Tracking System (WRATS) database. Tables and maps summarizing water rights are presented in Appendix D.

2.7 Surface Water Quality

Protection and improvement of surface water quality is an important objective linked to the Watershed Plan. However, programs already exist to protect and improve water quality, and it is not the intent of this Plan to duplicate such programs. These include some locally based water quality assessment efforts, such as Clark County's coordinated water quality monitoring program to ascertain the surface and ground water quality conditions under State stormwater pollution control requirements. In addition, the primary vehicle for achieving compliance with State criteria for surface water quality is the Washington State Department of Ecology's (Ecology) Total Maximum Daily Load (TMDL) program, also known as Water Cleanup Plans.

As required by section 303(d) of the federal Clean Water Act (CWA), each state must identify its polluted waterbody segments and submit a list of these water quality limited estuaries, lakes, and streams to the U.S. Environmental Protection Agency (USEPA). To qualify for the list, it must be determined through water quality monitoring that the waterbody segment does not meet state surface water quality standards and that water quality is not expected to improve within the next four years. The standards are the criteria to ensure that water may be beneficially used for multiple purposes such as fishing, swimming, drinking, and fish habitat.

At the time this Watershed Management Plan was developed, Ecology's 1998 303(d) list served as the State's official list of impaired water bodies. Development of the "2002/2004" list was underway, and a draft of this new list is included as Appendix E of this plan. However, the 1998 list was used to develop recommendations. Once finalized, the 2002/2004 list should be revisited during the implementation phase of the Watershed Management Plan.

Twenty-five waterbody segments in the WRIAs 27 and 28 planning area are on Ecology's 1998 303(d) list. A summary of these impaired waterbody segments and the parameters in violation of water quality standards are found in Table 2-7. This list should not be considered an exhaustive inventory of all segments in the study area with water quality impairments, as there is a lack of quality data quantifying water quality violations in many cases; rather, the list includes only those that were formally listed on the 1998 list.

Table 2-7
1998 303(d) List[1] of Impaired Waterbody Segments in WRIAs 27 and 28

Listed Waterbody Segment	Parameter(s)[2] in Violation of Water Quality Standards
Kalama River Subbasin	
Hatchery (Fallert) Creek	Temp
Kalama River	Temp
East Fork Lewis River Subbasin	
East Fork Lewis River	Temp, FC
Lockwood Creek	FC
McCormick Creek	Temp, FC
Rock Creek (lower)	FC
Rock Creek (upper)	FC
Yacolt Creek	FC
Burnt Bridge Creek Subbasin	
Burnt Bridge Creek	DO, Temp, pH, FC
Salmon Creek Subbasin	
Cougar Canyon Creek	DO
Curtin Creek	FC
Lake River	Temp, FC, Sediment Bioassay
Mill Creek	FC
Salmon Creek[3]	Temp, FC, Turbidity
Weaver (Woodin) Creek [3,5]	FC
Lacamas Creek Subbasin	
China Ditch	DO, Temp
China Lateral	DO, Temp
Cowpie Creek	DO
Dwyer Creek	DO, pH
Fifth Plain Creek	DO, Temp, pH, FC
Lacamas Creek	DO, Temp, pH, FC
Matney Creek	DO, Temp, pH
Mill Ditch	DO, Temp, pH
Shanghai Creek	DO, Temp, pH
Columbia River Tributaries Subbasin	
Gibbons Creek[4]	FC

(1) From the 1998 303(d) List; Department of Ecology, State of Washington.
(2) Parameter Abbreviations: Temp (Temperature); FC (Fecal Coliform); DO (Dissolved Oxygen).
(3) TMDL was written to address fecal coliform and turbidity on Salmon Creek and fecal coliform on Weaver Creek.
(4) A TMDL was written to address fecal coliform for Gibbons Creek in 1996.
(5) USEPA approved a TMDL for biological oxygen demand and ammonia TMDL for Weaver Creek in 1993.

Only the North Fork Lewis River and Washougal River subbasins do not contain waterbody segments that are officially listed as impaired[2]. Temperature and fecal coliform are the most common parameters in violation of standards within the planning area, with 15 and 14 impaired waterbody segments, respectively. Twelve segments are listed for violations of dissolved oxygen standards, while eight are listed for violations of pH.

Temperature and dissolved oxygen are important parameters for aquatic life. Higher temperatures can increase stress on organisms that are adapted for cool waters. Higher temperatures also reduce the quantity of oxygen that water can hold in solution. Oxygen

[2] Data collected by Clark County separately does indicate temperature issues for the Washougal River.

depletion affects fish and invertebrates since these organisms depend on oxygen for respiration. Fecal coliform bacteria serve as an indicator of harmful bacteria and other pathogens that can affect public health. This is especially important for waters used for recreational purposes or drinking water supplies. The parameter pH is important because many aquatic organisms are adapted to a relatively narrow range of pH and are stressed when pH levels outside that range occur. In addition, pH controls water chemistry, such as the solubility of inorganic compounds. Further information on these parameters and on State water quality standards is provided in the Technical Memorandum entitled “Task 1B Water Quality Assessment” prepared as part of the Level 1 Technical Assessment of WRIAs 27 and 28.

2.8 Ground Water Quality

A variety of factors have the potential to contribute to the degradation in quality of ground water supplies, upon which many communities rely as a primary source of drinking water. Such factors include point and non-point pollution sources, shallow aquifer depth, and unprotected ground water supplies.

Information on ground water quality is fairly limited in WRIAs 27 and 28. However, the information available suggests that, in most areas, water quality is currently in good condition in the primary aquifers used for drinking water supply[3]. Levels of monitored water quality parameters are generally within federal requirements, although there are elevated levels of inorganic constituents such as iron and manganese that require treatment in some of the deeper wells screened in the Lower Troutdale and Sand and Gravel Aquifers. Furthermore, numerous commercial and industrial land uses and activities especially in the Vancouver area potentially threaten water quality. There are already instances where ground water contamination has been identified and treatment is necessary in order to meet drinking water standards.

2.9 Habitat Conditions

The LCFRB is leading a collaborative approach to restoring threatened anadromous fish species and rebuilding other focal fish and wildlife species in the Washington Lower Columbia River region. This approach integrates several different planning efforts, including Endangered Species Act (ESA) recovery planning, Northwest Power Planning Council (NWPPC) subbasin planning, and state salmon recovery planning, into a single regional planning process. A regional recovery/subbasin plan has been prepared. The recovery planning process includes two Phases. Phase I was the development of a technical foundation. The foundation was used in Phase II analyses to evaluate scenarios, strategies, and actions to further recovery.

The technical foundation is a comprehensive summary of information on subject fish and wildlife species, limiting factors, and subbasins included in the plan. Included are synopses of published and unpublished information as well as new analyses undertaken as part of the planning effort.

[3] There are some concerns that development of a ground water supply in the Vancouver Lake area may result in enlargement of a nearby contaminant plume (see Section 3.3.3 for details).

The planning effort focuses on six salmonid species. Four are listed as threatened under the ESA: chum, chinook, steelhead, and bull trout. One species, coho, is proposed for listing. Another species, coastal cutthroat, is included as a species of regional interest. These six species comprise 85 individual populations. The plan also addresses selected anadromous and resident fish and wildlife of interest under the NPCC subbasin planning process, including sturgeon, Pacific lamprey, smelt, northern pikeminnow, shad, introduced gamefish, dusky Canada goose, Caspian terns, Columbia white-tailed deer, sandhill crane, western pond turtle, and selected neo-tropical birds.

Subbasin habitat conditions that have an influence on salmonid population health include passage barriers, stream flow, water quality, nutrient loads, habitat diversity, substrate and sediment, woody debris, channel stability, riparian function, and floodplain function. Summary descriptions of the habitat conditions in the WRIAs 27 and 28 subbasins are provided below, based upon information in the Review Draft LCFRB Recovery/Subbasin Plan Technical Foundation Executive Summary. Summary descriptions of the habitat conditions in the WRIAs 27 and 28 subbasins provided below were excerpted from the November 2004 Draft Subbasin Plans for the WRIAs 27 and 28 subbasins. Additional characterization of the habitat conditions of these subbasins is included in the Salmon Recovery Plan, which was developed concurrently with this Watershed Plan by the Lower Columbia Fish Recovery Board (refer to Section 7 of this plan).

- **Kalama River Subbasin** – The lower Kalama mainstem from the mouth to Dee Creek contains productive habitat for fall Chinook, chum, and coho. These reaches are primarily impacted by forest practices, though agriculture and rural development affect riparian areas and floodplains in the lowest reaches. The most effective recovery measures will involve riparian and floodplain restoration in the lower reaches, as well as addressing basin-wide forest and road conditions. The middle mainstem Kalama and major tributaries (i.e., Gobar Creek) contain productive habitats for steelhead and spring Chinook. Coho, fall Chinook, and chum do not typically ascend lower Kalama Falls to access these habitats. Forestry is the dominant land use surrounding these reaches. Stream-adjacent roadways impact riparian function. The most effective recovery measures will include preservation and restoration of riparian and upland forest and road conditions. The upper Kalama mainstem and tributaries (i.e., NF Kalama) are used primarily by summer steelhead. These reaches are heavily impacted by forest practices, and thus, the most effective recovery measures will include preservation and restoration of riparian and upland forest and road conditions.
- **Lewis River Subbasin** – The most critical reaches in the lower Lewis River lie between Ross Creek and Merwin Dam. These reaches are most important for chum, fall Chinook, and coho. Winter steelhead also utilize these reaches. The middle mainstem basin is largely in private land ownership with some areas of state forest land. Hydropower operations, agriculture, and rural development have the greatest impacts. Effective recovery measures in the middle mainstem will involve managing regulated flows from the hydropower system, addressing agricultural and rural/suburban development impacts to floodplains and riparian areas, and ensuring that land-use planning effectively protects habitat and watershed processes.

Also in the lower Lewis River, Cedar Creek reaches are most important for winter steelhead, though other species make limited use of these habitats. Lower Cedar Creek (mouth to Pup Creek) and the reach downstream of the Chelatchie Creek confluence are the most critical. Forest practices on private commercial timber lands in the upper watershed have impacted sediment supply and hydrologic processes in Cedar Creek reaches. Agriculture and rural residential uses have impacted riparian areas and floodplains. Recovery measures will need to address agricultural impacts along stream corridors and forest practices in the upper basin.

Most of the potentially productive habitat in the upper Lewis is in the upper mainstem above Swift Reservoir. The contributing basin is almost entirely within the Gifford Pinchot National Forest. The major impacts stem from the effects of forest practices on watershed processes. The Muddy Creek system includes the large tributaries Clear Creek and Clearwater Creek. This system, particularly the mainstem Muddy and Smith Creek, were heavily impacted by the 1980 Mount St. Helens eruption. Intensive post-eruption timber harvests and road building further impacted these streams. Historically, these reaches were most important for coho but also provided productive winter steelhead and spring chinook habitat. Pine Creek is believed to have historically provided habitat primarily for winter steelhead. This system was impacted by the 1980 Mount St. Helens eruption but has recovered rapidly. Although there has been considerable timber harvest and roading in this system, including some riparian timber harvests, stream conditions are currently good for winter steelhead. Bull trout will benefit from many of the same recovery measures identified for anadromous species, especially restoration and preservation of watershed processes on forested lands. Targeted riparian and stream channel restoration may benefit bull trout in reaches of Cougar, Pine, and Rush creeks.

- **East Fork Lewis River Subbasin** – The lower mainstem East Fork Lewis contains important spawning and rearing habitats for fall Chinook, chum, and coho. This mixed use area is heavily impacted by agriculture, rural residential development, and gravel mining. Effective restoration measures will involve riparian restoration, reductions in streambank erosion, re-connection of floodplains, and restoration of mining related impairments and future avulsion risks. Land-use planning/growth management is critical to make sure that expanding development and land-use conversions do not continue to impair habitat conditions or habitat-forming processes.
- The middle mainstem East Fork Lewis and Rock Creek are most important for winter steelhead, although summer steelhead also utilize these reaches to some degree. There are agricultural and rural residential uses along these reaches but forestry impacts dominate. Effective restoration measures will include riparian restoration and restoration of watershed processes related to forest practices (i.e., forest road and timber harvest impacts). Summer steelhead use the greatest proportion of upper East Fork Lewis reaches. Winter steelhead may utilize some of these reaches but they rarely make significant use of reaches above Sunset Falls. Nearly the entire upper basin is within the Gifford Pinchot National Forest and forestry impacts dominate. Past wildfires have had a lasting impact on channels. The recovery emphasis is for preservation and restoration. Effective restoration measures will include riparian restoration and watershed process restoration related to forest practices.
- **Salmon Creek Subbasin** – The lower mainstem Salmon Creek reaches with the greatest potential production are located in the vicinity of Salmon Creek County Park, near the I-5

crossing. These reaches historically provided productive habitats for fall Chinook, chum, coho, and winter steelhead. This area is heavily impacted by urban and rural development in the expanding Vancouver metropolitan area. Effective recovery measures will involve land-use planning that adequately protects habitat-forming processes in sensitive areas (wetlands, floodplains, riparian corridors). Restoration of riparian areas along these and upstream reaches will also yield important benefits. A few potentially productive reaches for coho and winter steelhead are located on the mainstem between the Hwy 503 crossing and Salmon Falls. Rock Creek and other, smaller, tributaries (e.g., Morgan Creek) also contain potentially productive habitats for coho. These reaches are heavily impacted by agricultural uses and rural residential development. As with the lower basin, the upper basin is expected to continue to develop rapidly. In light of the continue growth, there needs to be emphasis on land-use planning that provides adequate protections to sensitive areas. In addition, riparian and floodplain restoration that targets impacts related to grazing and rural development will yield important benefits to salmonid habitat.

- **Burnt Bridge Creek Subbasin** - Burnt Bridge Creek contains spawning habitats for Fall Chinook, coho, winter steelhead, and cutthroat trout. The creek is heavily impacted by channelization, diking, dredging, and draining and rerouting of flows. As a result, most of the wetlands and off-channel habitat, and riparian vegetation have been removed. The recovery plan identifies the Salmon Creek Subbasin (including Burnt Bridge Creek) as "stabilizing" which means that fish populations cannot degrade further; therefore actions will be required to maintain Burnt Bridge Creek populations at their current levels.

- **Washougal River Subbasin** – Urban and suburban development in the lower Washougal mainstem has significantly altered and degraded watershed processes and habitat conditions. These areas are critically important for chum and fall Chinook spawning and fry colonization. The restoration and protection of the Washougal reach flowing through the town of Washougal provides high potential for fall Chinook. The tidally influenced reaches are the most important for chum. Riparian and floodplain functions are degraded in these areas due to streamside development and channelization features associated with residential/urban development, agriculture, and roadways. Needed habitat measures in the lower mainstem will involve protection of remaining functional habitat, riparian restoration, re-establishing connections between the stream channel and floodplain areas, storm water controls, and measures that address the potential impacts from expanding urban and suburban development around Washougal and Camas.

  The middle mainstem is important for fall Chinook and coho spawning, incubation, and fry colonization. It is also used by steelhead for rearing. As the human population continues to grow in Clark County, this mixed-use area of rural residents and small farms and woodlands is likely to experience conversion to more intensive residential use. Riparian areas have been degraded through streamside development and roads. Sediments, lack of habitat diversity, and temperature are the most significant limiting factors in this area.

  Upper mainstem reaches are important summer and winter rearing areas for summer steelhead. The habitat conditions and watershed processes associated with these reaches are influenced primarily by actions on public and private timberland. While these lands have relatively intact landscape conditions, sediment supply processes are thought to be moderately impaired due to the prevalence of forest roads on unstable slopes. The potential for effective passive restoration is high through upgrading or obliterating roads and improving drainage systems.

The West Fork Washougal is important for summer steelhead spawning and rearing. Winter steelhead also make limited use of these reaches. Most of the basin is in private or state forestland with a small amount of crop and pasture land in the lower portion of the basin. Portions of the headwaters (i.e., Hagen Creek basin) have intact forest conditions, while most other areas have been extensively harvested and heavily roaded. An additional habitat concern in the West Fork Basin is a dam on Wildboy Creek, which blocks several miles of potentially productive habitat. The Little Washougal Basin provides important habitat for winter steelhead adult holding, spawning, and rearing. Most other species (especially coho) also use these reaches. The basin is mixed use and is comprised mostly of private and state forest land with agricultural uses and rural residential development within the lower river valley. The City of Camas water withdrawals from Jones and Boulder creeks create an increased risk of critically low summer flows. Effective habitat measures in the Little Washougal will involve riparian restoration, reestablishing connections between the stream channel and floodplains, growth management, water withdrawal management, and watershed process restoration and preservation on forest lands.

- **Lower Columbia Tributaries Subbasin** – Lower Hamilton Creek contains potentially good spawning habitat but conditions have been impacted by development around the City of North Bonneville and by the Hwy 14 crossing. The artificially created Hamilton Springs spawning channel provides important chum spawning habitat. Effective recovery measures here will include riparian and floodplain restoration, in particular addressing channel confinement adjacent to N. Bonneville and associated with the Hwy 14 crossing. Addressing upstream sediment inputs will also help these reaches to recover. Upper Hamilton and upper Greenleaf creeks contain good quality habitat for winter steelhead and coho. Further up Hamilton Creek, the gradient increases dramatically with several large falls that cannot be ascended. The upper reaches of Hamilton Creek currently supports a significant portion of the production for these populations. Most of the good spawning habitat in Duncan Creek is located just above Duncan Lake. This area is most important for chum and coho although it is also used by fall Chinook and winter steelhead. Access to spawning areas in Duncan Creek has recently been improved by the construction of a dam that lowers lake levels during salmonid migration periods. Recovery measures in Hardy Creek will primarily involve floodplain and riparian restoration.

  Although Gibbons and Lawton creeks do not support significant abundance of anadromous salmonids, they nevertheless contain some potentially productive habitat that is in need of restoration and preservation. These streams are threatened primarily by expanding development from the town of Washougal. Effective recovery measures will entail floodplain reconnection, riparian reforestation, and landuse planning that is adequate to protect habitat-forming processes in sensitive areas (i.e., wetlands, riparian areas, floodplains).

2.10 Tier System for Ranking Stream Reaches

The LCFRB has developed a Minimum Actions Recovery Scenario working draft which identifies specific fish populations and recovery goals to meet the recovery criteria developed by NOAA-Fisheries Technical Recovery Team. These criteria address abundance, productivity, diversity, spatial distribution, and habitat.

This scenario ranked populations using four categories or tiers for identified stream reaches. The tier designations are based on a combination of: a) priority of each fish population for restoration and b) potential for preservation or restoration of stream reaches. The tiers are listed and briefly described below in priority order from highest to lowest. A more detailed description of the development of these "tiers" and their application is included in the Salmon Recovery Plan, which is being developed concurrently with this Watershed Plan by the Lower Columbia Fish Recovery Board (refer to Section 7 of this plan).

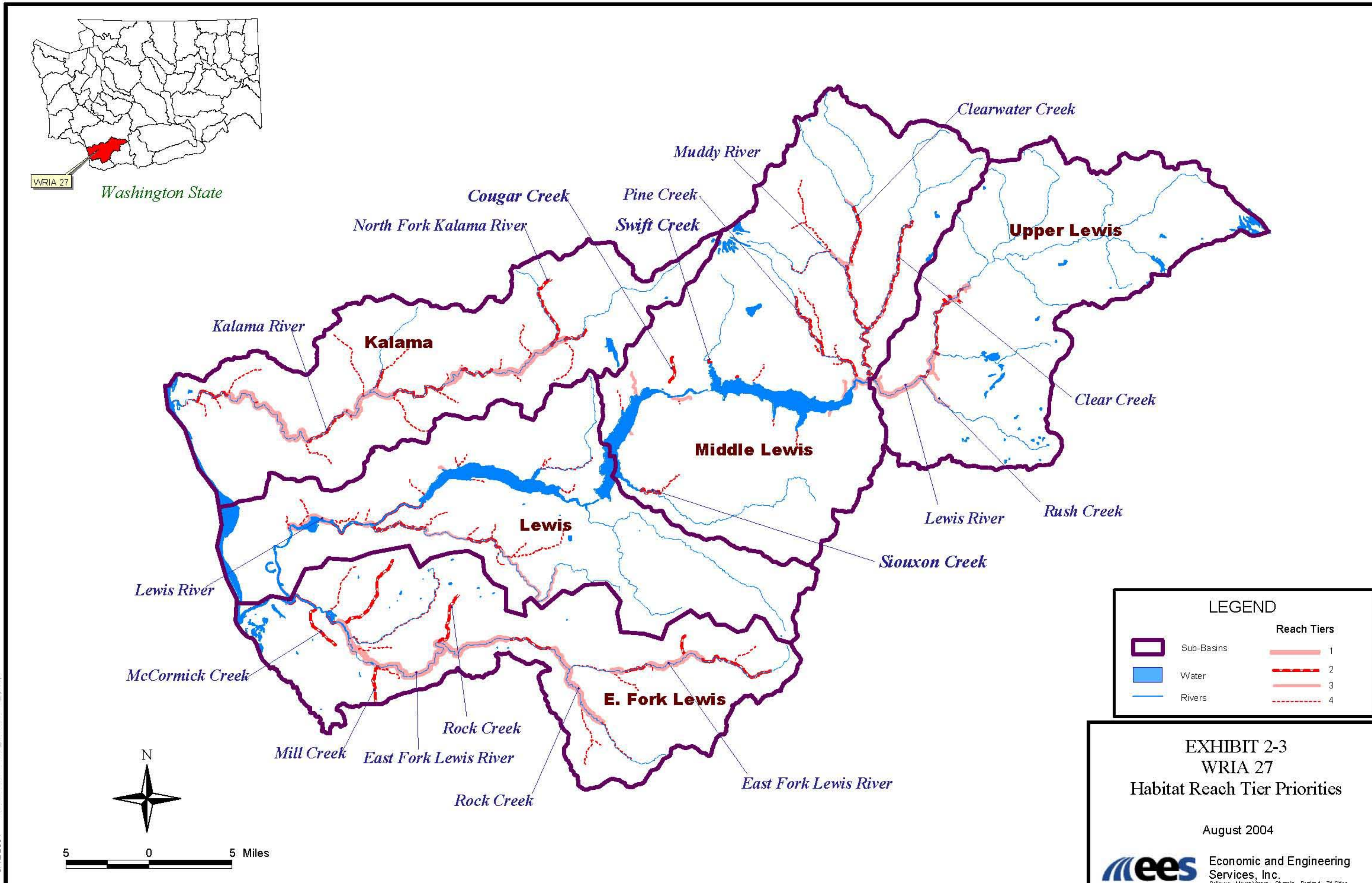
Tier 1 Reaches include all high potential reaches for one or more primary populations.

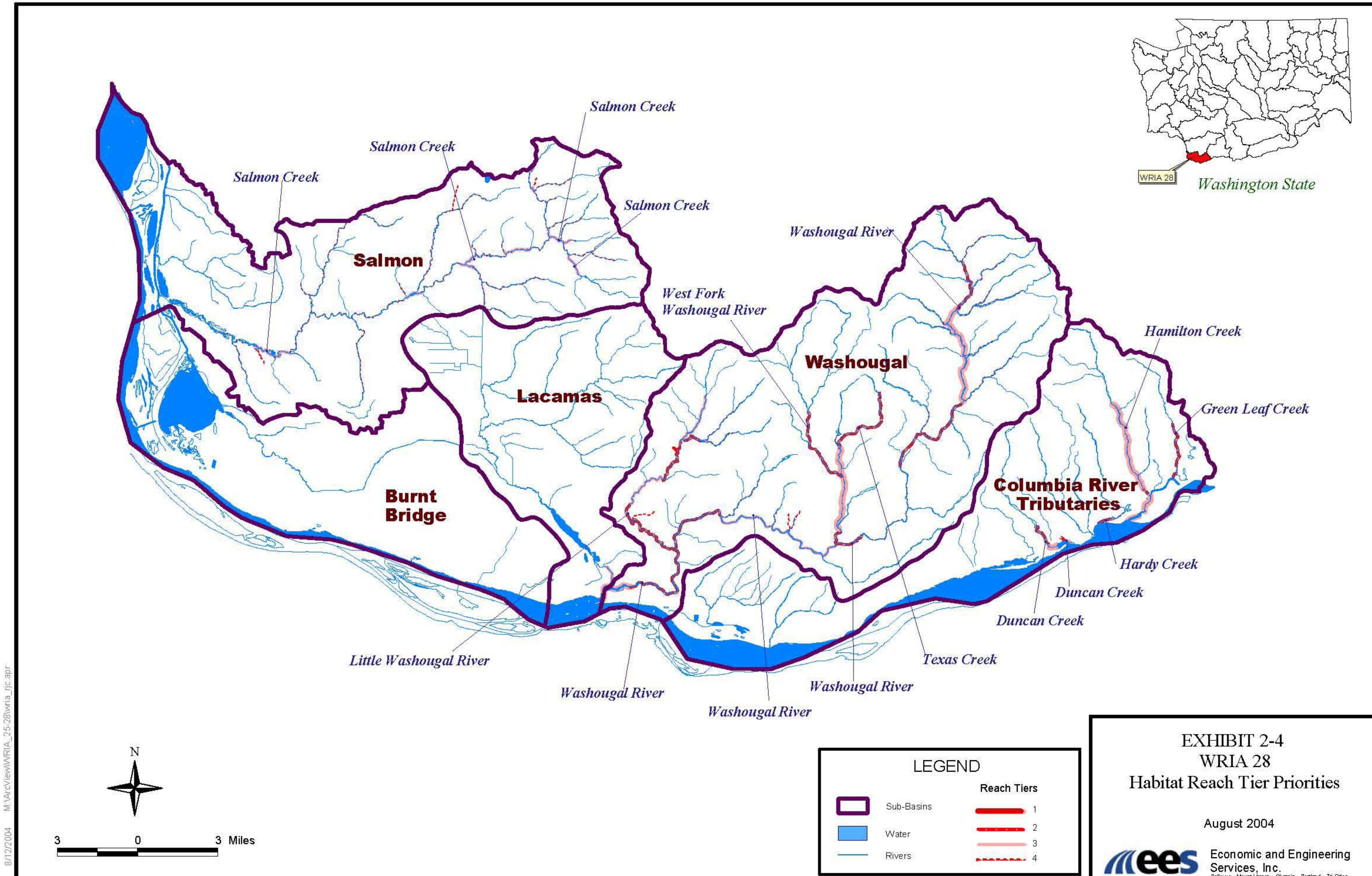
Tier 2 Reaches include all reaches not included in Tier 1 and which are medium potential reaches for one or more primary species and/or all high potential reaches for one or more contributing populations.

Tier 3 Reaches include all reaches not included in Tiers 1 and 2 and which are medium potential reaches for contributing populations and/or high potential reaches for stabilizing populations; and

Tier 4 Reaches include reaches not included in Tiers 1, 2 and 3 and which are medium potential reaches for stabilizing populations and/or low potential reaches for all populations.

Exhibit 2-3 shows the Tier designations for stream reaches for each of the subbasins within WRIA 27, and Exhibit 2-4 shows these designations for subbasins within WRIA 28.


WRIA 27
Washington State
Clearwater Creek
Muddy River
Cougar Creek
Pine Creek
North Fork Kalama River
Swift Creek
Upper Lewis
Kalama River
Kalama
Clear Creek
Middle Lewis
Lewis
Lewis River
Rush Creek
Siouxon Creek
Lewis River
LEGEND
Reach Tiers
Sub-Basins
1
2
Water
3
Rivers
4
McCormick Creek
E. Fork Lewis
Rock Creek
Mill Creek
East Fork Lewis River
East Fork Lewis River
Rock Creek
N
5
0
5 Miles
EXHIBIT 2-3
WRIA 27
Habitat Reach Tier Priorities
August 2004
Economic and Engineering Services, Inc.
8/12/2004 M:\ArcView\WRIA_25-28\wria_rjc.apr



Washington State
WRIA 28
Salmon Creek
Salmon Creek
Salmon Creek
Salmon Creek
Salmon
Washougal River
West Fork Washougal River
Washougal
Lacamas
Hamilton Creek
Green Leaf Creek
Columbia River Tributaries
Burnt Bridge
Hardy Creek
Duncan Creek
Duncan Creek
Little Washougal River
Texas Creek
Washougal River
Washougal River
Washougal River
N
3 0 3 Miles
LEGEND
Sub-Basins
Water
Rivers
Reach Tiers
1
2
3
4
EXHIBIT 2-4
WRIA 28
Habitat Reach Tier Priorities
August 2004
ees
Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities
8/12/2004 M:\ArcView\WRIA_25-28\wria_rjc.apr

Section 3
Management of Water Supplies

3.1 Introduction

The WRIAs 27 and 28 planning area, including Skamania, Clark, Cowlitz and Yakima Counties, represents a diversity of water supply needs. This is primarily due to the wide range of land uses that span from public and private resource lands to rural mixed use lands to suburban and urban lands. To confound matters, Clark County had the highest percentage population increase in the State (45 percent) between 1990 and 2000. Population growth at high rates is expected to continue and will have tremendous impacts on the cities of Battleground, Washougal, Camas, Ridgefield and Woodland. These impacts will ripple through the more rural areas of Skamania and Cowlitz Counties as population growth fuels the conversion of resource and rural lands into mixed use and suburban lands. The demand created by this growth represents a significant challenge for public and private water purveyors as they apply for new water rights, upgrade or replace treatment plants, and maintain and expand distribution systems. How this challenge is addressed has important ramifications for residents of Southwest Washington in terms of economic vitality, watershed health, and quality of life.

Just as water supply for people is growing in demand, instream flows throughout basins in the planning area are vital for fish and wildlife species. In fact, four species of salmonids are listed as Threatened under the Endangered Species Act. These include Chum, Chinook, Steelhead, and Bull Trout. Adequate amounts of cool, clean water are perhaps the most important habitat attribute for these species. In general terms, for every unit of water that is diverted from a stream, there is a corresponding loss of habitat that occurs. While there are many threats to these and other species, the loss of instream habitat as a result of flow diversion represents a threat that cannot be overcome—fish need water to survive. This challenge also has important ramifications for residents of Southwest Washington in terms of economic vitality, watershed health, and quality of life.

The WRIAs 27 and 28 Planning Unit has grappled with these different, but highly correlated challenges since its creation in 1999. The following statements characterize the Planning Unit's vision for meeting these challenges:

- Water supplies to meet future demand should avoid or minimize impacting stream flows;
- Regional supply options will be important in meeting future demand in Clark County; and
- If no practicable alternative to impacting stream flows exists, then off-setting activities must accompany new water rights.

3.1.1 Population and Water Demand Projections

The total population of WRIAs 27 and 28 is expected to increase by approximately 50 percent over the next 20 years. Table 3-1 and Exhibit 3-1 provide summaries of this change, illustrating a population increase of over 185,000 new people between 2000 and

2020. Year 2000 population figures are based upon Census 2000 data, while year 2020 population forecasts are based upon water supplier and County growth estimates.

Table 3-1
Water Service Area Population and Demand Projections, Municipal and Domestic

	Year 2000				Year 2020			
	Population Served (1)	ADD (1) (2) (mgd)	MDD (1) (3) (mgd)	Annual Demand (4) (afy)	Population Served (1)	ADD (1) (2) (mgd)	MDD (1) (3) (mgd)	Annual Demand (4) (afy)
Clark County (entire County, portions in both WRIA 27 and 28) (5)								
Major Public Water Systems								
Vancouver (11)	194,132	24.90	48.31	27,913	261,468	33.50	64.99	37,554
Clark Public Utilities (12)	77,065	9.51	21.50	10,661	113,335	14.19	28.19	15,907
Camas (13)	12,636	3.58	7.50	4,013	30,859	8.51	14.27	9,540
Washougal (14)	8,792	1.57	3.18	1,759	17,222	2.80	5.96	3,139
Battle Ground (15)	9,234	1.11	2.08	1,241	29,000	3.48	6.52	3,898
Ridgefield (16)	2,147	0.53	1.06	594	15,000	3.70	7.41	4,151
Small Public Water Systems								
Community and Group B (8)	14,077	1.41	2.82	1,578	14,077	1.41	2.82	1,578
Non-Community (9)	3,283	0.33	0.66	368	3,283	0.33	0.66	368
Individual Household Wells (10)	27,155	2.72	5.43	3,044	36,574	3.66	7.31	4,100
SUB-TOTAL	345,238	45.65	92.52	51,171	520,818	71.57	138.12	80,234
Cowlitz County (that portion within WRIA 27) (6)								
Major Public Water Systems								
Woodland (17)	3,914	0.72	1.59	808	6,933	1.28	2.81	1,432
Kalama (18)	3,000	0.79	1.45	881	6,847	1.47	2.72	1,647
Small Public Water Systems								
Community and Group B (8)	740	0.07	0.15	83	740	0.07	0.15	83
Non-Community (9)	360	0.04	0.07	40	360	0.04	0.07	40
Individual Household Wells (10)	5,168	0.52	1.03	579	6,961	0.70	1.39	780
SUB-TOTAL	12,822	2.13	4.29	2,392	21,840	3.55	7.14	3,982
Skamania County (that portion within WRIA 28) (7)								
Small Public Water Systems								
Community and Group B (8)	1,847	0.18	0.37	207	1,847	0.18	0.37	207
Non-Community (9)	128	0.01	0.03	14	128	0.01	0.03	14
Individual Household Wells (10)	1,444	0.14	0.29	162	2,267	0.23	0.45	254
SUB-TOTAL	3,291	0.34	0.68	383	4,241	0.42	0.85	475
WRIA 27/28 TOTAL	361,351	48.12	97.49	53,946	546,899	75.55	146.11	84,691

NOTES:
ADD = Average Daily Demand; MDD = Maximum Daily Demand
MGD = Million Gallons per Day; AFY = Acre-Feet per Year
To convert a value in mgd to afy, multiply mgd by 1,121.

(1) Projections obtained from water system plans for various years were placed on an even footing to allow for comparison. This was done by computing an annual growth rate for the data provided, then applying this growth rate to generate values for years 2000 and 2020.

(2) For Small Public Water Systems and Individual Household Wells, ADD was calculated based on a water use factor of 100 gallons per capita per day, based on Clark Public Utilities (CPU) data.

(3) Where data was not available directly from a public water system, MDD was calculated by applying a peaking factor of 2.0 to ADD.

(4) Direct conversion from ADD value.

(5) All of Clark County is within the WRIA 27/28 boundaries. 2000 total population based on Census 2000 estimate.

(6) Council of Governments staff.

(7) Only a portion of Skamania County is within WRIA 28. 2000 total population based on Census 2000 estimate, with allocation to WRIA 28 determined by County staff. The portion of Skamania County that lies within WRIA 27 was excluded from population and water demand analysis, as there is very little population and water use in this area.

(8) 2000 population calculated as number of residential connections (as listed in DOH's Drinking Water Automated Information Network (DWAIN) database, January 2001) multiplied by 2.9 people per connection (based upon CPU data).
2020 population assumed to equal the 2000 population.

(9) Includes both Transient and Non-Transient Non-Community water systems.
Although no resident population is served by such systems, a population estimate was made to generate an estimate of water demand.
2000 population calculated as number of total non-community connections (as listed in DOH's DWAIN database) divided by 2 and multiplied by 2.9 people per connection (based upon CPU data).
2020 population assumed to equal the 2000 population.

(10) 2000 population estimate calculated as the total County population minus the population served by all other forms of water purveyance (excluding non-community).
Skamania County).

(11) City of Vancouver Water System Plan Update (2003) data and personal communication with City staff.

(12) Clark Public Utilities Water System Plan (December 2001) and personal communication with staff.

(13) City of Camas 2001 Water System Comprehensive Plan and personal communication with City staff.

(14) City of Washougal Water System Plan Update (January 2002) and personal communication with City staff.

(15) City of Battle Ground Water System Plan Update (October 1998) and personal communication with City staff.

(16) City of Ridgefield Water System Plan Update (1996) and personal communication with City staff.

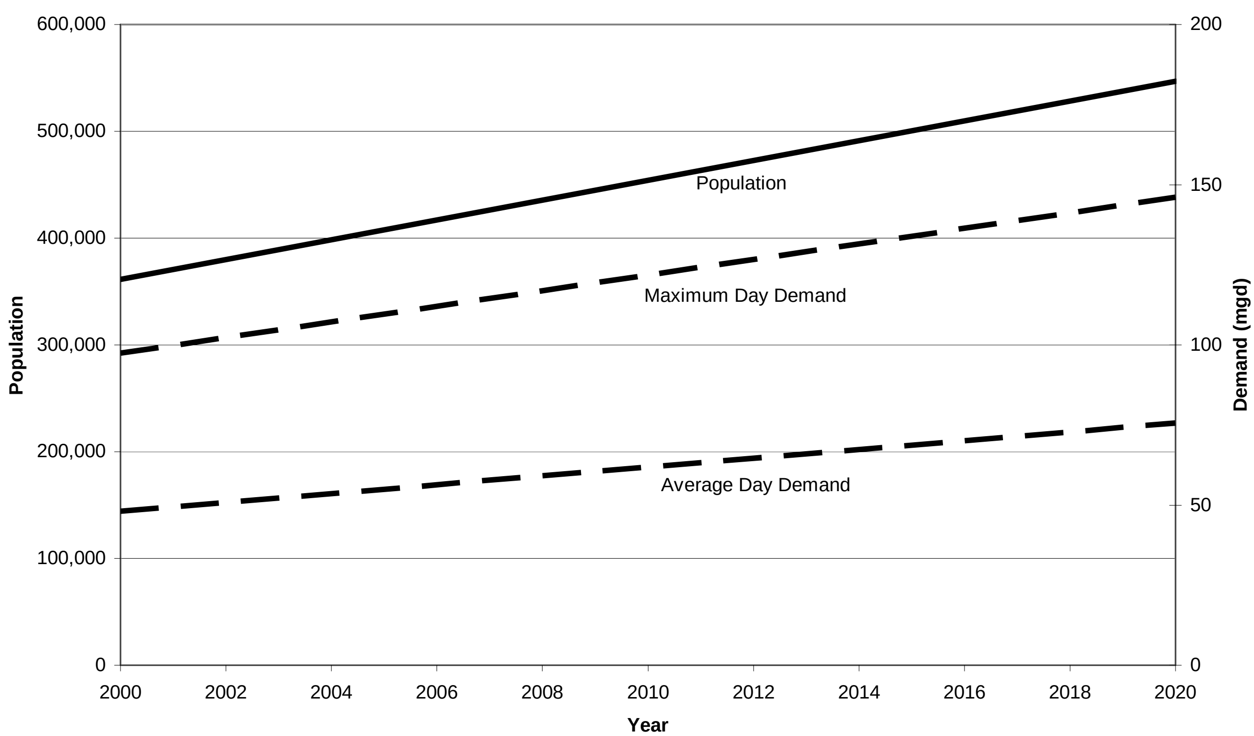
(17) City of Woodland Water Treatment Plant Pre-Design Report (December 1997) and personal communication with City staff.

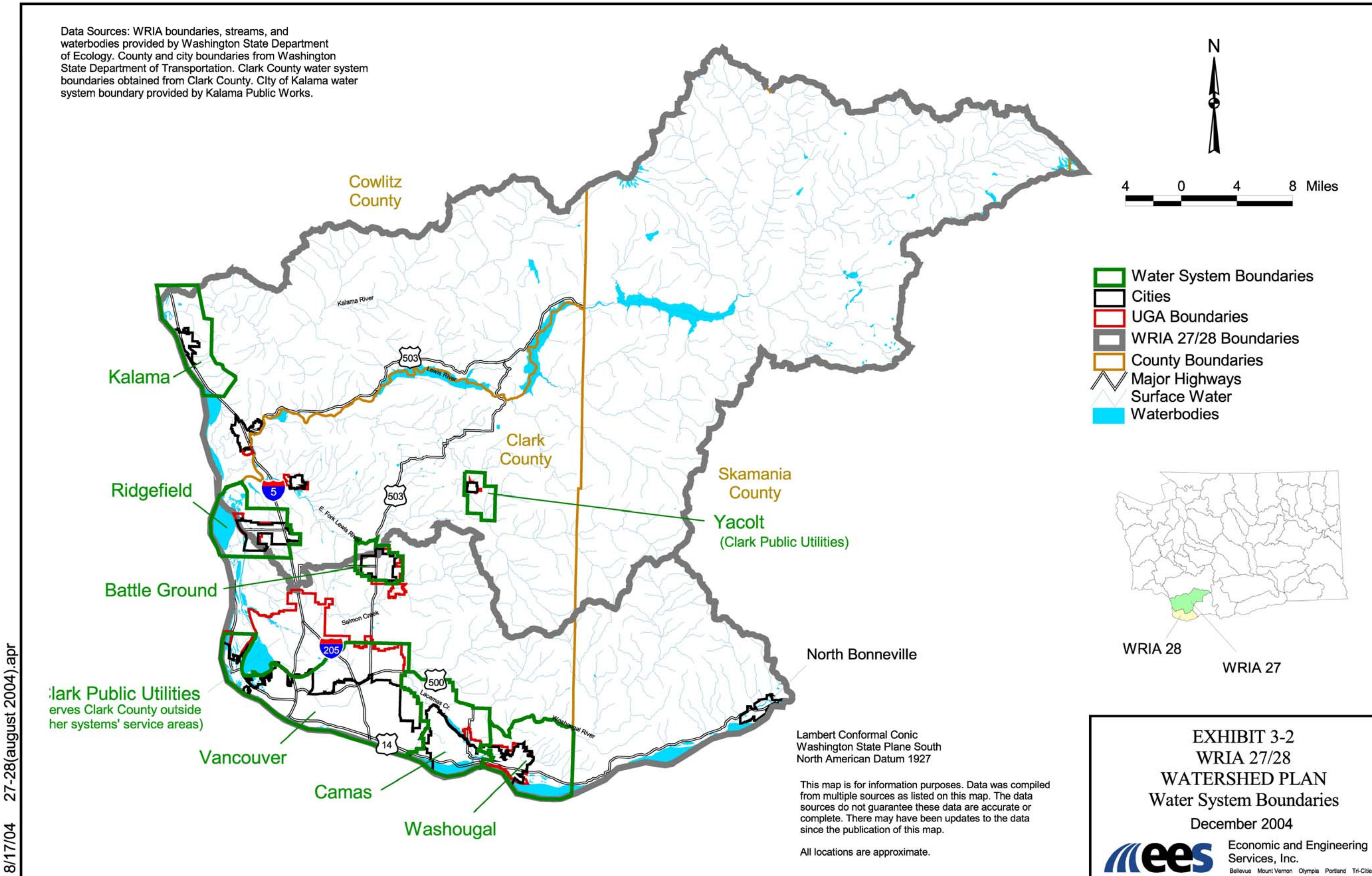
(18) City of Kalama Draft Water System Plan (November 2001) and personal communication with City staff.

Table 3-1 and Exhibit 3-1 also present the projected increase in water demands for various categories of municipal and domestic water use, including large and small public water systems, and domestic wells. The forecasts were obtained from purveyor water system plans and are depicted as average day demands (ADD) and maximum day demands (MDD), and are expressed in millions of gallons per day (mgd). Annual demands are expressed in the table in acre-feet. Only large communities, serving populations of at least approximately 2,000 people, are considered individually in Table 3-1. Other, smaller communities, such as North Bonneville, are included in the category “Community and Group B” water systems.

As shown on Table 3-1, average day municipal and domestic demands are projected to increase by 50 percent, from approximately 50 mgd in 2000 to 75 mgd in 2020. Of the total demand in these categories, approximately 90 percent is associated with the eight largest public water systems in WRIAs 27 and 28, as listed on the table. This is further illustrated by Exhibit 3-2, which depicts the service area boundaries for the purveyors. The exhibit shows that the majority of the areas where urban growth is expected are provided water by the large municipal purveyors. The increase in water demands over the next 20 years is therefore expected to primarily be borne by these purveyors. As such, development of water supplies to meet the needs of these water providers is a central focus of this chapter.

Exhibit 3-1
Population and Water Demand Projections




Data Sources: WRIA boundaries, streams, and waterbodies provided by Washington State Department of Ecology. County and city boundaries from Washington State Department of Transportation. Clark County water system boundaries obtained from Clark County. CIty of Kalama water system boundary provided by Kalama Public Works.
N
4 0 4 8 Miles
Cowlitz County
Clark County
Skamania County
Kalama River
Lewis River
E. Fork Lewis River
Salmon Creek
Lacamas Cr.
Washougal River
503
5
205
500
14
Kalama
Ridgefield
Battle Ground
Yacolt
(Clark Public Utilities)
Clark Public Utilities
serves Clark County outside
other systems' service areas)
Vancouver
Camas
Washougal
North Bonneville
Water System Boundaries
Cities
UGA Boundaries
WRIA 27/28 Boundaries
County Boundaries
Major Highways
Surface Water
Waterbodies
WRIA 28
WRIA 27
Lambert Conformal Conic
Washington State Plane South
North American Datum 1927
This map is for information purposes. Data was compiled from multiple sources as listed on this map. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this map.
All locations are approximate.
EXHIBIT 3-2
WRIA 27/28
WATERSHED PLAN
Water System Boundaries
December 2004
Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities
8/17/04 27-28(august 2004).apr

3.1.2 Relationship between Water Supply and Stream Flows

Water supply management has a significant relationship to management of stream flows. Where surface water is utilized as a source of supply, there is a direct reduction in stream flows downstream of diversions. A similar relationship may also exist between stream flows and ground water supplies, in some situations. Due to potential connectivity between ground water and surface water, pumping of wells can reduce baseflows in nearby streams. This is due to capture of ground water that otherwise would have discharged to surface water. These types of effects are complex and vary according to many factors, such as the nature of the local hydrogeology and topography. Additional efforts associated with this watershed plan have focused on evaluating surface/ground water interactions. These studies are summarized below:

- *Ground water/Surface-Water Relationships in the East Fork Lewis River Watershed* – This analysis assessed the hydraulic connection between the regional ground water system and the East Fork Lewis River and its tributaries. The effort also considered the potential impacts upon stream flow posed by planned municipal ground water withdrawals in the area. The results of this analysis have been summarized in a Technical Memorandum entitled *Ground water/Surface-Water Relationships in the East Fork Lewis River Watershed* (PGG, 2003a).

  The analysis concluded that ground water withdrawals do capture water from tributary streams in the East Fork Lewis River Subbasin. However, these effects are generally minor. Municipal well withdrawals were estimated to account for less than four percent of the river's baseflow. In total, stream flow capture by exempt well withdrawals throughout the watershed were estimated to account for less than one percent of the baseflow in the East Fork Lewis River in 2003.

- *Effect of Exempt Wells on Baseflow, Washougal River Watershed* – This analysis considered the impact that withdrawals by domestic wells have upon stream flows in the Lacamas Creek and Washougal River Subbasin. The results of the effort have been reported in a Technical Memorandum entitled *Effect of Exempt Wells on Baseflow – Washougal River Watershed* (PGG, 2003b).

  In general, this analysis concluded that exempt well withdrawals have a minimal impact upon stream flow levels. The percentage of stream capture, or baseflow reduction, by such wells in the driest time of year ranges from 0% to 3.5% of total baseflow, with the amount for the majority of evaluated stream tributaries being less than 0.5%. In some cases, baseflows are even increased when the effects of exempt wells and septic system return flows are considered in conjunction. This is due to return flows being greater than stream flow capture attributed to exempt well pumping.

It is recognized that the study of exempt wells was a case study focused upon specific geographic areas in the Washougal River Watershed. Results may not be directly applicable to other sub-basins due to the somewhat variable hydrology and geology in other sub-basins. However, the following observations are also relevant in assessing potential impacts of exempt wells:

- Population forecasts shown in Table 3-1 indicate that growth in the population served by domestic wells to year 2020 will be relatively modest. It is on the order of 12,000 new people, throughout WRIAs 27 and 28. This is 6.5% of the total projected population growth of over 185,000 new people.
- Existing rural zoning requirements limit the density of housing that would typically be served by individual domestic wells, spreading the impacts over large areas;
- Most houses with an individual well also have a septic system. Return flow from septic tank drainfields is substantial (e.g. on the order of 70% of water pumped). This return flow often will contribute to base flows in local streams.

Based on these observations, management efforts targeting domestic wells appear less critical than management measures for larger water users. Measures should be taken to ensure that large clusters of shallow wells are not located in proximity to small tributaries.

Because of the relationship between water supply and stream flow, the impacts of management actions upon water supplies and stream flows are considered together. Therefore, the water supply policy and management strategies set forth in this chapter have been developed according to the following two goals of the Planning Unit:

- Effectively and efficiently manage water to ensure availability, reliability and predictability for beneficial uses over the long term, considering ongoing changes in population, local economies, and water-use technology.
- Manage stream flows effectively to sustain aquatic biota, including fish populations in their various life stages.

This same approach is followed in Chapter 4 – Management of Stream Flows, where certain water supply management actions are identified which may be employed to reduce impacts to surface water.

3.2 General Techniques for Managing Water Resources

Over the course of the planning process, the Planning Unit reviewed a number of strategies for supporting future water supply needs in WRIAs 27 and 28. Detailed descriptions of these techniques and their applicability to WRIAs 27 and 28 are provided in Appendix I. A brief summary of these strategies is provided below.

3.2.1 New Water Supply Development

This strategy involves development of additional future supplies from either surface or ground water. In many parts of WRIAs 27 and 28, ground water is available. The development of additional surface water supplies to meet municipal demands has been explored by some public water systems. New surface water diversions are typically more costly than additional development of ground water. In addition, stream flows are highly variable seasonally and water may not be readily available in the dry summer months when communities use the most water. For these reasons, public water systems have typically focused on ground water for new supplies. The primary challenge for developing additional ground water sources is obtaining water rights due to potential impacts to surface waters and a backlog for processing applications.

In areas throughout WRIAs 27 and 28 where there is limited access to development of new ground water supplies, alternative supply strategies must be relied upon. The Planning Unit's water supply management policy for new and expanding municipal supplies, presented in Section 3.3.1, addresses this issue.

3.2.2 Water Conservation

Water conservation refers to the beneficial reduction of water use, loss, or waste. Conservation measures can be implemented within the municipal, industrial, and agricultural sectors.

In the municipal context, water conservation consists of a range of activities involving both water systems and their customers. Water systems must submit a water conservation plan to the Washington State Department of Health (DOH) outlining measures to be implemented, as a condition for approval of Water System Plans and issuance of new water right permits.

The importance of water conservation in the municipal sector has recently been reaffirmed with the passage of House Bill 1338 during the 2003 legislative session. Section 7 of this law authorizes DOH to establish water efficiency requirements, to be applied to all municipal water purveyors. By December 31, 2005, DOH must adopt rules that outline conservation planning requirements, develop water distribution system leakage standards, and establish minimum conservation performance reporting requirements.

In the industrial context, water conservation consists of a range of activities based on the size and type of industry. Because of the large volumes associated with these users, opportunities often exist to conserve significant quantities of water.

In the agricultural context, water conservation involves different technologies and approaches, in comparison with the municipal sector. Efficiency measures at the individual farm level would typically be implemented by the landowner and/or agricultural producer raising a crop or producing livestock. WRIAs 27 and 28 do not have irrigation districts or extensive canal systems.

Some water conservation measures have already been implemented within WRIAs 27 and 28. The major public water systems throughout the basin have conducted public outreach and education efforts. In addition, some systems have instituted fixture retrofits (showerheads and toilets) and implemented leak detection and repair programs. Water conservation has also been utilized in the industrial sector in WRIAs 27 and 28. Some process efficiencies have been implemented at industrial facilities within the basin;

however, additional opportunities exist due to the large volumes of water involved and the existence of various incentives such as reductions in overhead costs and energy consumption. In many cases, industrial process efficiencies may be coupled with water recycling efforts, as described in the next section.

3.2.3 Water Reclamation and Reuse

Water reclamation and reuse refers to the capture, treatment, and reuse of wastewater, typically for non-potable purposes. By using this as a source of water, the need for water from natural sources can be reduced.

Based on a review conducted during this planning process, municipal wastewater reuse is not an attractive water supply strategy for most communities in WRIAs 27 and 28 in the near future, in relation to other water supply alternatives. This is due primarily to the high costs of municipal wastewater reuse projects and the abundance of ground water supplies in the basin. There are exceptions, however. The City of Battle Ground is actively considering reuse opportunities.

Water reuse and recycling in the industrial sector is currently much more feasible than in the municipal sector for WRIAs 27 and 28, due to lower costs compared with municipal projects, fewer public concerns, and the need to manage wastewater discharges while complying with discharge permit limitations. Many water-intensive industries in the basin have already implemented water recycling processes.

Technical Memorandum No. 2 issued during the Planning Phase (EES, 2002b) discusses the water reclamation and reuse opportunities in WRIAs 27 and 28 in greater detail.

3.2.4 Voluntary Transfers of Water Rights

This strategy involves changing an existing water right to meet needs associated with a different use or a different location than originally defined in the water right. Transfers (also known as water right changes) do not increase the overall amount of water being used in a basin; rather, they modify where and how the water is used. Transfers typically take the form of voluntary leases or sales of water rights.

Transfers of industrial water rights to use for municipal purposes have potential in WRIAs 27 and 28, due to the existence of some substantial industrial water rights associated in some cases with the same sources of supply (e.g., aquifers) already used by municipal water purveyors. In a situation where an industrial water user scales back production, leaving a portion of its water right unused, that amount of water could be sold or leased to a public water system for municipal purposes. Such arrangements have already been explored by some industries and water purveyors in the basin.

3.2.5 Aquifer Storage and Recovery

In areas where water availability is limited on a seasonal basis, excess water can be injected into ground water aquifers during wet periods and then withdrawn during dry periods to aid in meeting water demands. This process, known as Aquifer Storage and Recovery (ASR), serves to optimize the use of existing water resources, especially in areas dependent primarily upon surface water supplies.

ASR is currently not an attractive water supply option in WRIAs 27 and 28. Some water purveyors have previously explored ASR and determined it not to be feasible or even necessary, due to the fact that existing ground water supplies are abundant and do not require augmentation to support further development. However, opportunities for ASR should be re-evaluated from time to time.

3.2.6 Surface Water Storage

Similar to ASR in its overall objective, surface water storage in impoundments and reservoirs is often used where surface water supplies are limited on a seasonable basis. During wet periods, when excessive flows are present, water is captured and retained for use later during drier periods.

Surface water storage is currently not an attractive water supply option in WRIAs 27 and 28. Due to the abundance of ground water supplies, water providers have little desire to transition to surface water to meet future needs. Surface water requires more expensive treatment than ground water, and construction of reservoirs can have significant environmental impacts that can be avoided by using ground water instead.

3.3 Water Supply Policy for WRIAs 27 and 28

The Planning Unit has developed proposed water supply policies to balance the objectives of water supply and stream flow protection:

Policy WSP-1:

Public and private water users throughout WRIAs 27 and 28 should have access to water resources to meet new or expanded needs for water supply consistent with adopted land use plans.

Policy WSP-2:

Water resource development to meet new or expanded needs should avoid or minimize effects on stream flows or aquatic habitat in stream reaches where flow conditions are an important factor for sustaining aquatic life, including fish populations in their various life stages.

The water supply policy was developed primarily with municipal water purveyors in mind, as they will provide water to the majority of the population growth and economic development anticipated to occur throughout the basin.

A strategy has been developed to guide the implementation of the water supply policy. As outlined below, the strategy addresses three issues: new or expanded municipal supplies (requiring new water rights); existing municipal supplies (not requiring new water rights); and regional water supply options.

Inherent in this strategy is the concept that ground water is preferred over surface water as a source of new water supplies. The Planning Unit recommends new or expanded surface water diversions be discouraged, except in limited cases where there is no feasible or cost-effective alternative. In those cases where additional water supplies are needed, ground water development is recommended. However, as discussed in Section 3.1.2, ground water has been shown to be in communication with surface water in some parts of the basin. This is especially true for withdrawals from shallow wells in proximity to tributary streams. Therefore, priority should be given to ground water supply alternatives for which surface water impacts are avoided.

3.3.1 New or Expanded Municipal Water Supplies

Each of the eight major municipal water providers listed in Table 3-1 will require new or expanded water supplies to meet the growth in demands over the coming 20 years. In most cases, the development of these additional supplies requires the purveyors to obtain new or increased water rights. The Department of Ecology (Ecology) has the responsibility for reviewing water right applications. Under its current process, Ecology issues water right permits only if the proposed use meets the following requirements, in accordance with RCW 90.03.290:

- Water will be put to beneficial use;
- There is no impairment to existing, or senior, rights;
- Water is available for appropriation;
- Issuance of the requested water right will not be detrimental to the public welfare.

In reviewing ground water permit applications, Ecology takes into account the potential for impacts upon surface waters. Ecology has denied ground water right requests in cases where connectivity has been demonstrated and where stream flow was determined to be too low to support existing uses and/or fish habitat.

Recommendation:

It is recommended the following procedure be followed for municipalities requesting new or expanded water rights.

1. Communities requesting additional ground water rights to serve growth must evaluate the relationship of their proposed water supply projects to stream flows. Where such an evaluation indicates that the new or expanded source of supply will not impact stream flows, the Planning Unit recommends that Ecology grant water rights sufficient to meet projected demands. Communities receiving new and additional water rights will be required to optimize the use of their new rights, through existing and future conservation requirements (see Section 3.2.2).
2. Where this evaluation indicates that development of the source of supply will impact the flow regime, the Planning Unit recommends that the municipal water supplier analyze alternative options for water supplies. In such cases, supply alternatives include use of a different (most likely a deeper) aquifer, purchase of water from a

neighboring community, development of a tidally-influenced source, or purchase of water from a regional water system (see Section 3.3.3).

> ***Recommendation:***
>
> The Planning Unit recommends that a map be developed during the implementation phase of the watershed planning process that would depict locations of deep aquifers suitable for water supply development. Such a map could be developed in partnership with the USGS, and will involve a study to identify aquifers that are not in hydraulic continuity with streams.

3. If the supply alternatives analysis indicates that no practicable alternative is available, the water right applicant may petition Ecology to utilize a 'reservation of water defined within state rule (see Section 4.4.1). The Planning Unit recommends that Ecology (in conjunction with Fish & Wildlife) evaluate requests for reservation use by reviewing the applicant's analysis of other alternatives <u>and</u> by evaluating the applicant's proposal in terms of off-setting and mitigating actions.

   - The Planning Unit recommends that Ecology develop clear guidance for mitigation. A starting point for such guidance may be found in an Ecology publication entitled "Mitigation Measures used in Water Right Permitting" dated April 2003.
   - The Planning Unit recommends that where an applicant applies for a water right under a reservation, they be required to mitigate the predicted stream flow depletion to the maximum extent practicable through flow-related actions. Practicable is meant to include both economic and logistic considerations.
   - No less than half of the predicted stream flow depletion (see Table H-2a) must be offset through the acquisition of active upstream water rights or other flow augmenting actions in the same subbasin upstream of the new proposed water right. The Planning Unit recognizes there may be occasional exceptions where offsetting one half of the predicted stream flow depletion fully or in part may be infeasible or cost-prohibitive. For example, the Kalama River and upper North Fork Lewis River subbasins have been identified by the Planning Unit as areas where offsetting actions may be infeasible, due to the lack of upstream water rights that could be acquired as a mitigation action. In these limited cases, acquisition of offsetting active water rights or flow augmentation actions shall be implemented to the extent feasible. Any remaining offset requirement shall be mitigated through other habitat actions designed to offset the effects of the stream flow depletion not being offset. In no case shall the amount of stream flow depletion from new water rights issued under this policy exceed the quantity shown in Table H-2a, under the column heading "Net Stream flow Depletion Allowance."
   - The Planning Unit recommends that Ecology consider other mitigating actions to address impacts that cannot be practicably off-set (no more than half) through

water-for-water actions. This includes actions such as the restoration of wetlands and side-channels that increase stream storage capacity;

- The Planning Unit recommends that Ecology consider habitat restoration actions other than the restoration of wetlands and side-channels using the following criteria:
  - habitat actions should focus upon projects that improve stream conditions impaired by flow (e.g., projects that improve width to depth relationships or improve landscape-level hydrologic processes, etc.);
  - habitat actions should address threats and limiting factors through priority actions identified in the Lower Columbia Salmon Recovery Plan;
  - habitat actions should be evaluated within the context of when the baseflow impacts will occur and the expected timeframe of habitat project benefits;
- The Planning Unit recommends that Ecology (and Fish & Wildlife) consider cost to the applicant in terms of other supply alternatives, water supply total project cost, and the cost of the off-setting and mitigating actions. These costs should be evaluated within the context of other fish recovery actions that may be needed to compensate for impairment to stream flow.
- The Planning Unit intends that domestic wells, including those serving multiple houses but not required to obtain a water right permit, be exempt from mitigation requirements.

Water Reservations

Recommendation:

In order to satisfy the goals associated with the establishment of closures and/or instream flows, and the goals associated with providing a secure source of water for future public water supply, it is recommended that in each basin a block of water be reserved for future public water supply that would not be subject to the closures and/or instream flows established by rules for WRIAs 27 and 28.

The amount of water, the entity, and the source(s) of the water to be reserved for public supply is recommended in Appendix H (Table H-2) and should be identified in the proposed rules to be adopted by the Department of Ecology for WRIAs 27 and 28. This is described further in Section 4.4.1 of this Watershed Management Plan.

3.3.2 Existing Municipal Water Supplies

Recommendation:

For cases in which *existing* municipal supplies (as contrasted with planned *future* supplies) have the potential to negatively impact flows in critical stream reaches, the Planning Unit recommends that selected communities voluntarily consider enhancing their conservation efforts and undertake a review of alternative sources of supply, similar to that described in Section 3.3.1. It is recommended that, where feasible, these water suppliers cease or limit the use of certain existing supplies and develop alternative sources of supply that are less likely to impact flows in critical stream reaches. It is also recommended that implementation of such alternatives be eligible for funding from regional, state, or federal funding programs (see Section 3.6). This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

Water suppliers in this situation should also consider availability of regional supplies (Section 3.3.3). It is important to note that existing municipal water rights are not subject to relinquishment if use of the rights ceases or is limited.

3.3.3 Regional Water Supply Options

WRIAs 27 and 28 residents are blessed by an opportunity that simply is not available in most regions of the Northwest—the presence of a significant source of water in the Pleistocene Alluvial Aquifer in the Vancouver Lake lowlands. While there are outstanding issues associated with the source development, these issues seem relatively minor compared to the benefit of having a water source of this magnitude located precisely in one of the fastest growing areas of the state. In real terms, this source can be substituted for new and current water supplies that impact stream flows in the East Fork Lewis and Salmon Creek. It could also service emerging needs as far east as the Washougal basin.

Clark Public Utilities (CPU) and the City of Vancouver (Vancouver) are both researching the feasibility of new ground water sources in the Pleistocene Alluvial aquifer in the Vancouver Lake area. Based upon preliminary evaluations, these supplies appear to be sufficient to meet both suppliers' long-term needs, as well as other needs in adjacent areas of WRIAs 27 and 28, without impacting stream flows.

One important issue that has been raised in regard to developing the ground water supply at Vancouver Lake is related to contaminated ground water present at the Port of Vancouver. Pumping at Vancouver Lake could potentially alter water table elevations at the Port site, and cause the existing plume of contaminated ground water to spread more widely than it would without the new pumping.

Recommendation:

CPU and the City of Vancouver anticipate working closely with the Port and environmental and health agencies to find a solution. Because of the regional importance of the ground water resource at Vancouver Lake, the Planning Unit recommends that all affected parties work together to create a solution that allows for development of this source of supply as quickly as possible.

CPU has a well-established transmission and distribution network throughout a significant portion of Clark County, including interties with some communities (e.g., Battle Ground, Ridgefield, and Vancouver). CPU is well poised to provide water to many users. CPU does not have a significant presence, however, in southeast Clark County near the Cities of Camas and Washougal. To provide service to this area would require the construction of five to ten miles of transmission mains and new pumping facilities. A more logical choice for a regional supply for that portion of WRIA 28 may be a wellfield located in that area. The Cities of Camas and Washougal are initiating efforts to develop wellfield supplies from the Pleistocene Alluvial Aquifer near the Steigerwald Wildlife Refuge. Test wells are planned for some time in 2005/2006. This area may be capable of meeting the long-term needs of both Camas and Washougal without reliance on a Vancouver Lake lowland source.

Both of these regional supply options are highly recommended for evaluation by some communities, as specifically discussed in Section 3.4. Ultimately, both source areas (Vancouver Lake and Camas/Washougal) could be intertied to provide redundancy and greater flexibility to meet emerging growth needs.

Recommendation:

The Planning Unit views the Columbia River and ground water in hydraulic continuity with the Columbia River as a major water resource to meet water supply needs. As new water supplies are needed, it is preferable they be withdrawn from the Columbia River, adjacent lowland reaches of tributaries subject to tidal effects, and/or associated ground waters, rather than from flow-limited reaches of streams tributary to the Columbia. This approach can meet regional supply needs, while protecting important aquatic habitat in the region.

The tidal reach of the mainstem Lewis River (i.e., the North Fork Lewis River below Woodland) is an example of a source described by the above recommendation.

3.3.4 New Developments and Industrial Suppliers

Recommendation:

In general, the Planning Unit recommends that new urban or suburban developments or industrial facilities that require new or expanded water supplies shall seek to obtain water from existing municipal or other water suppliers rather than developing separate sources of supply. (Note: this would not apply to agricultural uses). If an existing municipal supplier or other water supplier is not available, then the new development or industrial facility should explore water supply sources that are not in hydraulic continuity with surface water or explore the feasibility of developing tidal and/or Columbia River sources. If none of these options are available, Ecology may consider issuing water rights that entirely off-set the net impact to stream flow.

There are currently no large municipal water systems in Skamania County. Therefore the recommendation above has little applicability in Skamania County at this time. This could change in the future, if growth leads to creation of larger public water systems in Skamania County.

Options to provide financial incentives and/or technical assistance to large industries for water conservation and water reuse will be explored, where this can be linked directly to protection of stream flows.

3.3.5 Water Supply Considerations for Tidally-Influenced Stream Reaches

In considering the effects of water supplies on stream flow, it should be recognized that tidally influenced reaches of streams in WRIAs 27 and 28 are different from free-flowing reaches. Further information on tidally influenced reaches is presented in Section 2.4.3. In tidally influenced reaches, during the time of each day when water is backed up, the water level in the stream is controlled by the water level in the Columbia River. At these times, water withdrawals for water supply purposes do not have measurable effects on the depth of water levels in the stream, and therefore do not impact flow-related habitat conditions. During the time of each day when tides subside and the stream returns to a free-flowing condition, withdrawals may have effects similar to those in free-flowing reaches of a stream.

Therefore, in managing water supplies within tidally influenced stream reaches, the Planning Unit finds that:

Recommendation:

Surface water source limitations, such as stream closures administered by Ecology and low flow conditions on new water rights, should not apply to tidally-influenced stream reaches in WRIAs 27 and 28[1]. Specific locations of tidal reaches are identified in Appendix H.

3.4 Water Supply Strategies for Major Municipal Water Providers

This section summarizes key information and the recommended water supply strategies for the eight largest municipal water providers in WRIAs 27 and 28, as listed in Table 3-1. The water system profiles are presented according to the size of the communities served, from the largest to the smallest. Details regarding each water system are provided in Appendix J.

The water supply plans of each purveyor are subject to compliance with urban growth planning policies at county and municipal levels.

3.4.1 City of Vancouver

The City of Vancouver supplied water to a population of approximately 194,000 people in 2000, or roughly 60 percent of the total Clark County population. The City anticipates serving approximately 261,000 people in 2020, with an average day demand of 33.50 mgd.

The City's sources of supply are comprised of 41 wells located at 11 water stations throughout the City. These water stations are located in the Burnt Bridge Creek subbasin. Some water stations are in the drainage area of Burnt Bridge Creek itself, while others are located in other portions of the subbasin that drain to the Columbia River. Based on the City's understanding of local aquifer relationships, most of these water stations draw from aquifers that are not in direct hydraulic continuity with Burnt Bridge Creek.

The City may, from time to time, submit applications for new water rights, transfers, or changes to existing rights for the City's water stations. As described above, such rights apply primarily to sources located outside of the Burnt Bridge Creek drainage in areas not subject to restrictions of water rights issuance according to the policies and recommendations set forth in Section 4.

The City has identified as its primary supply option for meeting future needs the development of a wellfield to the west of Vancouver Lake, in the Columbia River Alluvium. Based upon studies that have shown this aquifer to be quite productive, it is envisioned that this source would be used to supply all demands associated with growth beyond approximately 2010, the time when reliable supplies are anticipated to be fully

[1] This approach has been used in instream flow regulations adopted by Ecology for other WRIAs. For example, the Chehalis Basin instream flow regulation, Chapter 173-522 WAC, states that the affected stream reach for streams that are tidally influenced is "from influence of mean high tide at low base flow levels to headwaters." In other words, the flow regulation does not apply in the tidally influenced reach.

utilized. This new supply would also provide an additional level of redundancy to the existing system, allowing the use of other sources to be reduced if warranted in the future. Future restrictions to water rights issuance (i.e., closures) are not intended to apply to the Vancouver Lake lowlands area (See Section 4.4.1).

Recommendation:

Development of Vancouver Lake Wellfield. The Planning Unit endorses the City's plan to develop a new wellfield near Vancouver Lake.

Permitting agencies should make every effort to facilitate the development of the Pleistocene Alluvial Aquifer and encourage its use over other sources.

3.4.2 Clark Public Utilities

Clark Public Utilities (CPU) supplied water to a population of approximately 77,000 people in 2000, or roughly 20 percent of the total Clark County population. CPU anticipates serving 113,355 people in 2020, with an average day demand of 14.19 mgd.

CPU's sources of supply consist of 33 ground water wells located throughout CPU's service area. CPU's average daily demand will likely exceed the utility's primary annual water rights by year 2006. Forecast maximum day demands are expected to exceed CPU's total instantaneous water rights by 2020. CPU's water supply strategy for the future involves the development of additional wells in the Pioneer area, adjacent to high-growth areas, and development of a regional wellfield immediately southeast of Vancouver Lake. Based upon studies that have shown this aquifer to be quite productive, the Vancouver Lake wellfield is envisioned to support the majority of CPU's future growth. After the Vancouver Lake lowland wellfield is operational, supply wells in the upland areas will continue to be used to meet peak demands and for emergency backup purposes, as long as mitigation requirements continue to be met.

In addition to focusing upon these new supplies, CPU has also directed substantial resources at the management of existing supplies. Acknowledging the need to manage the water resources of the Salmon Creek Basin, in which many of CPU's sources are located, the utility has entered into a joint agreement with Ecology and Clark County. As a part of this agreement, a Water Resource Plan was developed, outlining a management strategy for this area. CPU is committed to maintaining an effective management strategy for the Salmon Creek Basin.

Recommendations:

Pioneer Area Wells. The Planning Unit endorses the development of additional wells in the Pioneer area to serve as a public water supply. The supply is subject to off-setting and habitat mitigating measures outlined in Section 3.3.1.

Vancouver Lake Wellfield. The Planning Unit endorses the development of the Vancouver Lake wellfield. CPU should consider sale of water from this supply source to other purveyors throughout Clark County, for use in meeting future demands.

Permitting agencies should make every effort to facilitate the development of the Pleistocene Alluvial Aquifer and encourage its use over other sources.

Salmon Creek. The Planning Unit endorses CPU's current efforts regarding management of the Salmon Creek Basin.

3.4.3 City of Camas

The City of Camas supplied water to a population of approximately 12,500 people in Clark County in 2000. The City anticipates serving 30,859 people in 2020, with an average day demand of 8.51 mgd.

The City's sources of supply are comprised of nine ground water wells and two surface water sources. The two surface water sources are Jones and Boulder Creeks, which have been providing the City with water since the early 1900's. The City relies primarily upon its ground water supplies, with surface water accounting for about one-third of total production. Three emergency interties with the City of Washougal provide additional supply reliability for the City.

The City's average daily demand will likely exceed the City's primary annual water rights by year 2006. This situation may occur sooner, if industrial growth happens at a quicker pace than anticipated. Recognizing its need for additional water supply in the future, the City has identified various supply options, including maximizing the capacities of existing sources and water rights, development of new wells, joint supply development with the City of Washougal, and development of a non-potable Columbia River supply for industrial and irrigation uses.

Recommendations:

Perform a review of alternative sources of supply to replace surface water sources. Due to the impacts upon stream flows in Boulder and Jones Creeks of the City's surface water diversions, Camas should undertake a review of alternative sources of supply, similar to that discussed in Section 3.3.1. The City's existing plans for new ground water development near the Washougal River should be considered in this process, if the new wells are anticipated to not have negative impacts upon the river. If new water rights are secured by the City, the Jones and Boulder Creek sources should be retired, or used during periods of high flow only, as a condition of the new water right. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

Further evaluate feasibility of non-potable supply. The Planning Unit recommends that the City re-evaluate development of a non-potable Columbia River supply, considering the substantial amount of water used for industrial purposes in the City. The Planning Unit commits to aiding the City in identifying and obtaining funding sources for implementation of such a project, most likely through programs administered by Ecology and DOH (see Recommendation in Section 8.3). This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

Consider regional supply options with other public water systems. The Planning Unit recommends that the City evaluate regional supply options such as those discussed in Section 3.3.3. These include the development of a wellfield supply near the Steigerwald Wildlife Refuge or, if other opportunities prove infeasible, the potential purchase of water from Vancouver. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

Assist Georgia Pacific in conservation efforts. The Planning Unit recommends that the City provide technical assistance and financial support to Georgia Pacific in developing water conservation measures that would reduce dependency on surface water from Lacamas Creek and ground water from the lower Washougal River vicinity. Any ground water savings realized through conservation could be available to help meet the City's growth needs. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

3.4.4 City of Battle Ground

The City of Battle Ground supplied water to a population of approximately 9,000 people in Clark County in 2000. The City anticipates serving 29,000 people in 2020, with an average day demand of 3.48 mgd.

The City's sources of supply consist of 8 ground water wells. In addition to these well supplies, the City has three interties with Clark Public Utilities (CPU). These interties are used only in the following situations: 1) for assistance in meeting some peak demands, 2) while the City's wells are out of operation for maintenance, and 3) for emergency purposes.

The City's existing sources of supply and water rights are not adequate to accommodate the significant growth anticipated for its service area. The City has identified the development of additional wells as its primary strategy to meet future needs.

The City has implemented various conservation activities including an increasing block water rate structure and an advertisement campaign.

As part of the watershed planning effort, relationships between surface water and ground water in the East Fork Lewis River subbasin were reviewed (PGG 2003a). This review indicates that Battle Ground's wells in the Upper Troutdale and Sand and Gravel Aquifers likely capture baseflow from both the East Fork and Salmon Creek. Wastewater from the City is currently conveyed to a treatment plant near the mouth of Salmon Creek. However, the City is assessing the feasibility of constructing a new treatment plant that will treat wastewater to Class-A Reclaimed Water standards, and directly or indirectly discharge reclaimed water into Salmon Creek or other watercourses. To facilitate this, modification of existing Total Maximum Daily Loads (TMDLs) may be necessary. Provided water quality concerns are adequately addressed, flow augmentation could provide substantial benefits to Salmon Creek or other surface waters. The City has requested that consideration be given to granting mitigation credits for flow augmentation. Due to the importance of protecting and restoring stream flows in these subbasins, the Planning Unit offers the following recommendations for Battle Ground's water supplies.

Recommendations:

Enhance conservation. Battle Ground should enhance its current conservation efforts, with the goal of reducing the production required of existing wells. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

Perform a review of alternative sources of supply. Due to the potential for withdrawal from the City's existing wells to impact stream flows in the East Fork Lewis River and Salmon Creek, Battle Ground should undertake a review of alternative sources of supply, similar to that discussed in Section 3.3.1. The City's plans for a new well should also be subject to Section 3.3.1. Use of reclaimed water may also be of value. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

Purchase water from Clark Public Utilities. It is likely that new water supplies available to Battle Ground will have hydraulic continuity with the East Fork Lewis and Salmon Creek. Due to the regional significance of the East Fork Lewis to salmon recovery and foreseeable population growth, purchase of water from a CPU regional water source is critical. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

Stream Flow Augmentation. The Planning Unit endorses the City of Battle Ground's efforts to develop a new wastewater treatment plant and to augment stream flows with Class-A Reclaimed water, provided water quality in receiving waters is also maintained or improved. The Planning Unit also supports consideration of mitigation credits for stream flow augmentation. Mitigation credits should reflect net stream-flow benefits in relation to withdrawal impact areas. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

3.4.5 City of Washougal

The City of Washougal supplied water to a population of approximately 9,000 people in Clark County in 2000. The City anticipates serving 17,222 people in 2020, with an average day demand of 2.80 mgd.

The City receives its water supply from 5 wells that withdraw water from the shallow alluvial aquifer upon which the City is located.

Based on current demand projections, the City requires additional sources of supply to meet future needs. The City's current future supply strategy consists of maximizing the use of its existing wells and water rights, as well as installing a new large capacity well in the center of town.

Recommendations:

Development of new well. The City of Washougal should follow procedures outlined in Section 3.3.1 as it relates to the installation of a new well near the center of town.

Consider regional supply options with other public water systems. The Planning Unit recommends that the City consider use of regional sources. These include the development of a wellfield supply near the Steigerwald Wildlife Refuge or, if other opportunities prove infeasible, the potential purchase of water from Vancouver. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

3.4.6 City of Woodland

The City of Woodland supplied water to a population of approximately 4,000 people in Cowlitz and Clark Counties in 2000. The City anticipates serving 6,933 people in 2020, with an average day demand of 1.28 mgd.

The City's single source of supply is a Ranney Well collector that withdraws water adjacent to the Lewis River. Similar to the City of Kalama, the Ranney Well collector is shallow and considered to be in direct connection to surface water. However, the Ranney Well is at a low point in the Lewis River watershed and is directly under the influence of tidewater. Therefore, the impacts upon stream flow by City diversions are overshadowed by the larger effects of tidal influence.

Since 1999, the City has operated a filtration/disinfection water treatment plant that addresses Surface Water Treatment Rule (SWTR) requirements as well as reducing aesthetic problems associated with dissolved iron concentrations in the raw water supply.

The City's preferred plan to meet the water demands associated with future development is to expand its use of the Lewis River Ranney Well.

> ***Recommendation:***
>
> ***Increase Ranney Well withdrawals.*** The City of Woodland's Ranney Well is located within the tidal influence of the North Fork Lewis. The Planning Unit is not recommending protective measures in this reach. The Planning Unit supports expansion of the Ranney Well water supply.

3.4.7 City of Kalama

The City of Kalama supplied water to a population of approximately 3,000 people in 2000. These include residents of the City as well as some unincorporated lands in Cowlitz County adjacent to the City. The City anticipates serving 6,847 people in 2020, with an average day demand of 1.47 mgd.

The City's single source of supply is a Ranney Well collector that withdraws water adjacent to the Kalama River. Similar to the City of Woodland, the Ranney Well collector is shallow and considered to be in direct connection to surface water. However, the Ranney Well is near the downstream end of the Kalama River watershed and impacts upon stream flow by City diversions are relatively small in comparison with flows at this location. The diversion location is slightly upstream of the zone of tidal influence on the river.

A diatomaceous earth water filtration plant provides required water quality treatment. Based on current demand projections, additional supplies may be necessary by 2016. To meet this need, the City is planning to expand its treatment plant capacity by an additional 900 gpm. The City has applied for additional water rights of 1.72 cfs on an instantaneous basis. Average flow on the Kalama River is 314 cfs in August.

> ***Recommendation:***
>
> ***Increase Ranney Well withdrawals.*** The Planning Unit endorses the City's plans to increase water rights for withdrawal from its Ranney Well of up to an additional 1.92 cfs subject to provisions outlined in Section 3.3.1. The Planning Unit recognizes that the purchase of off-setting water rights is not feasible in the Kalama River, and the 1.92 cfs of additional water rights is not subject to this provision; however, habitat mitigation requirements should be implemented commensurate with flow reduction impacts consistent with Section 3.3.1.

3.4.8 City of Ridgefield

The City of Ridgefield supplied water to a population of approximately 2,000 people in Clark County in 2000. The City anticipates serving 15,000 people in 2020, with an average day demand of 3.70 mgd.

The City's water supply consists of 3 active wells and 2 standby wells located in Abrams Park, near Gee Creek. The City has also recently developed an intertie with Clark Public

Utilities on the east side of the City's system. In the near term, this intertie is intended only to support fire flow needs. However, wholesale purchases from CPU via the intertie are a supply option for the future.

The City will require additional sources of supply to meet future needs. The City's current future supply strategy consists of maximizing the use of its existing wells, as well as installing multiple new wells over the course of the next 12 years.

The City supports the work of the Gee Creek Restoration Committee, efforts of which are guided by the Washington State University (WSU) Cooperative Extension Watershed Stewards Program for the purposes of reducing negative impacts to Gee Creek (e.g., high flows and water quality concerns) due to stormwater runoff.

Recommendations:

Enhance conservation. Ridgefield should enhance its current conservation efforts, with the goal of reducing the production required of existing wells. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

Continued involvement with Gee Creek restoration. The Planning Unit recommends that the City coordinate with the Watershed Stewards Program to identify any actions it may take to aid in the Gee Creek restoration effort. If low flows are identified as an issue needing to be addressed, the City should undertake a review of alternative sources of supply, similar to that discussed in Section 3.3.1. The City's existing plans for new wells should be considered in this exercise, if the new wells are anticipated to have less of an effect upon stream flows than current sources. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

Consider wholesale water purchases from CPU. The Planning Unit recommends that the City consider purchasing water from CPU to aid in meeting future demands, utilizing the recently installed fire flow intertie.

3.5 Water Supply Strategies for Other Types of Water Users

3.5.1 Small Public Water Systems

State law defines a "public water system" as "any system providing water for human consumption through pipes or other constructed conveyances, excluding a system serving only one single-family residence and a system with four or fewer connections all of which serve residences on the same farm." Under this definition, even wells supplying only two houses are designated as public water systems.

The Washington State Department of Health (DOH) regulates public water systems under two main categories. Group A systems are those systems regulated under the federal Safe Drinking Water Act (SDWA). Group B systems are regulated under State law, but are not regulated under SDWA. Typically, county health districts are delegated the regulatory role for Group B systems, while the State DOH performs regulatory responsibilities for Group A systems. Group A and B categories are described further, below.

- Group A, Community water systems provide water to 15 or more service connections used by year-round residents for 180 days or more in each calendar year. Community water systems may serve cities, individual subdivisions, mobile home parks, and other types of communities.
- Group A, Non-community water systems provide water to the public, but not to residential communities. DOH regulates two sub-categories: "transient" and "non-transient." Examples include campgrounds, restaurants, motels, schools, day-care centers, and some businesses.
- Group B systems are systems that meet the definition of a public water system, but do not fall into one of the categories listed above. For example, these include systems serving smaller communities or subdivisions ranging from 2 to 14 residential service connections.

Table 3-2 summarizes the water systems in WRIAs 27 and 28.

Table 3-2
Summary of Water Systems

	Clark County	Cowlitz County	Skamania County	Total
WRIA 27				
Community Systems	545	59	N/A	604
Non-community Systems	31	14	N/A	45
WRIA 28				
Community Systems	852	N/A	45	897
Non-community Systems	31	N/A	18	49
Total	**1,459**	**73**	**63**	**1,595**

Of the 604 community systems listed in Table 3-2 for WRIA 27, 592 (98 percent) are Group B systems having less than 15 service connections. Of the 897 community systems in WRIA 28, 882 (98 percent) are group B systems.

In recent years, a trend throughout the State of Washington has been an increase in the number of Group B systems serving six or fewer households. This has been a technique used to allow water supply for new subdivisions, since water rights were not required under the "exempt well" provision of the State Ground Water Code (Chapter 90.44.050 RCW). In many cases a large subdivision would have a number of exempt wells to serve lots in sets of six. However, a recent decision by the Washington State Supreme Court indicated that use of exempt wells to provide water for subdivisions was contrary to State law. Given this situation, recent experience does not provide a good foundation for projecting future trends in Group B systems. Apart from Group B systems relying on exempt wells, recent practice has been to discourage formation of new public water systems, at least in Clark County.

Table 3-3 lists all existing Group A community public water systems in WRIAs 27 and 28, except for those considered to be major municipal water providers. Interviews with local planning departments and state agency staff suggests that little or no growth is anticipated in the number of small Group A community systems. Where new development requires public water supply, the trend in more urban areas has been to encourage connection to an existing water system. For example, in Clark County, new development can hook up to the water systems owned by either the incorporated cities or Clark Public Utilities. Growth projections related to these larger systems are described in Section 3.4. In more rural areas, such as Skamania County, water needs of new development will generally be met either by domestic wells or formation of small new public water systems serving local areas.

Table 3-3
Small[1] Group A Community Water Systems

Public Water System	No. of Connections
WRIA 27	
Yacolt (receives all water from CPU)	473
Larch Corrections Center	204
Woodland Mobile Home Park	78
Amboy (receives all water from CPU)	57
Willard National Fish Hatchery	15
WRIA 28	
North Bonneville, City Of	229
Vista Del Rio Mobile Home Park	208
Country Manor Mobile Home Park	160
Golden West Mobile Manor	145
Great Western Mobile Home Park	120
Acres Mobile Home Park	86
Oak Meadows Mobile Home Park	71
Skamania Landing Owners Assoc Inc	54
Green Mountain Mobile Ranch	53
Vanridge Mobil Park	41
Hillcrest Mobile Manor	33
Brookside	27
Parkside Airpark Owners Assn	27
Morning Meadows	25
Single Tree Acres	23
North Sunset Point Water Users Assn	19
Magna Vista Water Corp	18
Tukes Mountain Homeowners Assoc	18

(1) For purposes of this discussion, “small” public water systems are those with less than 500 service connections.
Note: There are additional Group A systems that are classified as “non-community,” such as campgrounds, churches, schools, small businesses, etc.

Table 3-1 displays population and water demand projections collectively for the small systems. As shown in Table 3-1, estimated demand associated with small systems is a relatively small proportion of total demand in the municipal and domestic sector in WRIAs 27 and 28. Based on the information discussed above, the analysis depicted in the table incorporates an assumption that population and demand served by small public water systems will remain constant to year 2020 (i.e., no growth).

> ***Recommendation:***
>
> In those cases where new supplies are required for small Group A systems, it is recommended that a review of alternative sources of supply be conducted (see Section 3.3.1), with an emphasis placed upon evaluating the purchase of water from an existing major water purveyor (see Section 3.3.3). If new sources are required and a reserved block of water is not available, then the net impact to surface flows should be off-set by acquiring existing upstream water rights.

3.5.2 Domestic Wells

Approximately 35,000 people in WRIAs 27 and 28 obtain their water supply from individual domestic wells. These wells are not part of any public water system, and are not regulated by DOH. In addition, under the State Ground Water Code, these wells are generally exempt from the requirement to obtain a water right (Chapter 90.44.050 RCW). For this reason, they are commonly known as "exempt wells" (note that some Group B systems may also have exempt wells – see Section 3.5.1).

Table 3-1 displays the amount of water use estimated to be associated with domestic wells. In 2000, approximately 3,800 acre-feet of water (or roughly seven percent of the total municipal and domestic demand in WRIAs 27 and 28) was withdrawn from such wells. Based upon growth rates for rural areas throughout WRIAs 27 and 28, the population relying upon domestic wells is expected to increase to 46,000 by 2020. The anticipated demand associated with this population in 2020 is approximately 5,100 acre-feet, or six percent of the total municipal and domestic demand forecast for 2020.

A separate study (PGG, 2003b) has been performed as a part of this watershed planning process to evaluate the effects of exempt well pumping upon baseflow (i.e., that component of stream flow comprised of ground water discharge) in WRIAs 27 and 28 (specifically, the Washougal River Subbasin). The study was aimed at characterizing the effects of household wells on base flows in the Washougal River and its tributary streams. This was accomplished by comparing the amount of stream capture by exempt wells to the amount of return flows from septic systems, resulting in a net stream capture (or reduction in baseflow).

The results from this study, which was focused upon the Lacamas Creek drainage in the Washougal River Subbasin, are summarized in Section 3.1.2. In general exempt wells were found to have a minimal impact upon baseflows. In some cases, baseflows in selected reaches are even increased as a result of rural development, due to pumping from a deeper aquifer coupled with septic system return flows. In light of this information, the Planning Unit does not recommend the metering of exempt wells.

Recommendation:

Based upon the results of the analysis described above, and considering the relatively small amount of water withdrawals comprised by this category of water use, the Planning Unit recommends that a reservation of water be identified in rule language that provides for domestic well use, even within closed basins. However, this is not intended to promote use of domestic wells in lands zoned for urban densities. In addition, this recommendation is intended for areas served by septic systems that return water to the shallow ground water locally. Where homes are not served by septic systems or where sewer service is extended to an area, extension of public water supply may be needed.

This issue is discussed in greater detail in Section 4.3.2, which includes a stream flow management policy aimed at anticipating and mitigating water balance implications of extending sewer services to developing areas.

It should be noted that Skamania County is primarily rural in character and does not have urban growth areas. Most water service is from wells. The only community with public sewer service is the City of North Bonneville.

An analysis of full build-out projections for undeveloped lots in rural Clark County in relation to proposed water reservations was conducted by Clark County (Rupley, 2006). Based on average daily consumption calculations, this analysis concludes that all watersheds except Salmon Creek have sufficient water reservations to accommodate build-out of existing rural lots. When peaking factors are considered, potential deficits exist in other watersheds as well. However, since Salmon Creek is a watershed undergoing substantial growth, it is anticipated that urban growth boundaries will be expanded within this area. As result, many existing undeveloped rural lots will become urban area lots, and will need to be supplied by major water purveyors. Consistent with the water supply strategies outlined in this plan, it is expected that development of regional water sources, transition of individual wells to community systems with urban growth boundary expansions, and activities such as flow augmentation will improve water availability in the future.

3.5.3 Self-supplied Industrial Water Users

Commercial and industrial facilities may receive water from a public water system, or may have their own, independent sources of supply. This section describes self-supplied users, since their demands are not captured in the discussion of other categories of water use and future needs.

Table 3-4 displays information on the largest of these self-supplied users. In general, these are industrial facilities, primarily in the vicinity of Vancouver, Camas, and Kalama. None of them are located in Skamania County.

Two users, Georgia Pacific and ALCOA, have water rights that are much larger than the rest. Georgia Pacific, located in Camas, has both surface and ground water rights. ALCOA, located in Vancouver, has ground water rights. ALCOA shut down operations in 2001, due to the western power crisis. At this time it is not known whether ALCOA will resume operations: this decision will depend on market conditions and other factors.

Projection of water usage by self-supplied industry in the future is highly uncertain. In general, a basic assumption is that existing industries will continue to use the same amount of water used now; and that new industries will be supplied by major public water systems, with their needs included in existing demand projections. However, these assumptions were modified to address specific cases where available information suggests different assumptions are warranted. In support of this watershed planning work, contact was made with economic development officials associated with the City of Vancouver and Clark County; and the Public Works Director for the City of Camas. In addition, facility staff or company officials associated with Georgia Pacific, Boise Cascade, and SEH America were also interviewed to identify potential changes in future water use.

Based on these interviews, the following specific information was obtained. Where this information suggests a modification of the general assumptions on industrial use, these modifications are incorporated in Table 3-4.

- Georgia-Pacific (Camas): Fully active production, making full use of current water rights from Lacamas Lake during winter and from the Lower Washougal wellfields and Camas Slough Columbia River during the summer. To the extent expansion is planned, it will occur within the framework of existing water rights, including efficiencies and equipment modifications.
- ALCOA (Vancouver): No production currently. Large water right unused. However, could restart if market changes.
- Chem-Trade Logistics (Kalama): Assume full usage of water right. No plans to expand.
- SEH America (Vancouver): Full use of water rights. They have applied for additional water rights, to essentially double water consumption. However, uncertainty in obtaining these water rights could be constraint in future growth. Currently a small portion of water used is supplied by the City. City water is not preferred due to presence of chlorine and fluoride. The facility is currently recycling and reusing process water to reduce sewer costs.

Table 3-4 Self-Supplied Commercial/Industrial Water Rights and Usage				
	Water Rights [1]		Annual Water Usage [2]	
Name of Company [3]	Qi (gpm)	Qa (afy)	Present (afy)	Future (afy)
Surface Water Right Holders-WRIAs 27 and 28				
Georgia-Pacific [4]	102,821	44,775	44,775	44,775
All Others	3,659	420	420	420
Ground Water Right Holders-WRIAs 27 and 28				
Georgia-Pacific [4]	31,800	50,380	50,380	50,380
ALCOA [7]	25,650	35,809	0	35,809
Port of Vancouver	6,600	10,575	10,575	10,575
SEH America [8]	2,000	3,227	3,227	6,454
Klineline Sand & Gravel [9]	2,000	3,200	0	0
Clark County PUD (use at generators)	1,750	2,800	2,800	2,800
Great Western Malting Co.	1,200	645	645	645
All Others	9,175	7,010	7,010	7,010
WRIAs 27 and 28 Total	**186,655**	**158,841**	**119,832**	**158,868**
Surface Water Right Holders-Columbia River Source				
Chem-Trade Logistics [5]	8,980	32	32	32
Noveon [6]	6,286	23	23	23
Port of Kalama	1,010	5,605	4	5,605

NOTES:
Qi = Authorized Instantaneous Withdrawal/Diversion
Qa = Authorized Annual Withdrawal/Diversion
gpm = gallons per minute
afy = acre-feet per year

(1) Water rights data obtained from Department of Ecology's Water Rights Application Tracking System (WRATS) database (May, 2002). Qi for surface water rights has been converted from cubic feet per second to gpm for comparative purposes.

(2) For general estimating purposes, annual water usage is assumed equal to the water right, unless alternative data were obtained during interviews with company staff. Future usage was assumed to equal present usage, unless otherwise noted.

(3) Only those water right holders with Qi greater than 1,000 gpm are listed individually.

(4) Water rights listed in WRATS under the names of Crown Zellerbach Corporation and Crown Willamette Paper. Surface water rights are for Lacamas Lake and Camas Slough.

(5) Water rights listed in WRATS under the name of Dow Chemical Company.

(6) Water rights listed in WRATS under the name of Kalama Chemical, Inc.

(7) ALCOA is currently not in production, but may start up again, depending upon market conditions. No portion of these rights has been relinquished, according to Ecology staff.

(8) SEH America has filed an application for an additional 2,000 gpm to meet future growth needs.

(9) Klineline Sand & Gravel went out of business in the mid-to-late 1970's, and this water right has not been exercised since that time. Although the right remains on the WRATS list, it should not be considered active.

A significant industrial employer not listed in Table 3-4 is Boise Cascade. Due to product changes, Boise Cascade's Vancouver facility is no longer a primary paper producer. As a secondary paper producer (coating, etc.), Boise Cascade is only using roughly 30 percent of its 27 acre plant. In 2000, Boise Cascade donated 15,000 gpm (24,000 afy) of ground water rights and 0.5 cfs (360 afy) of surface water rights to the City of Vancouver to support industry at the Port of Vancouver. These rights are essentially for Columbia River water.

Recommendations:

Conservation and reuse. The Planning Unit places an emphasis upon water conservation and reuse with respect to industries with large water demands. Ecology and DOH should develop technical assistance and funding opportunities focused specifically upon the needs of self-supplied industries, to aid in reducing current water demands.

Future water demands. Where feasible, industries requiring additional sources of supply in the future should connect to existing municipal water supplies. Where not feasible due to technical issues, logistics, or cost, then it is recommended that the industry evaluate alternative sources as described in Section 3.3.1.

Consider the feasibility of non-potable supply. The Planning Unit recommends that large, self-supplied industrial water users evaluate development of Columbia River non-potable supplies, similar to that considered by the City of Camas. The Planning Unit commits to aiding industries in identifying and obtaining funding sources for implementation of such a project, most likely through programs administered by Ecology and DOH (see Recommendation in Section 8.3).

3.5.4 Additional Economic Development in Clark County

Future industrial development in Clark County is currently under review in the context of the process to amend the County’s Comprehensive Land Use Plan, as considerable economic development is anticipated. While this development would most likely be supplied by the major public water systems such as Vancouver or CPU, it is considered here because it has not been specifically accounted for in current water system plans. For purposes of this discussion, a range of water demand estimates associated with Clark County’s current assumptions on economic development were created, using the following methodology:

1. Clark County staff estimate that an additional 84,000 jobs will be attracted to Clark County by 2023.
2. Existing commercial and industrial lands within Clark County UGAs can accommodate industries accounting for approximately 40,000-50,000 additional jobs. This commercial/industrial growth is generally accounted for in the water demand forecasts developed by major water purveyors.
3. Therefore, additional commercial/industrial lands are to be designated to accommodate approximately 34,000-44,000 additional jobs.
4. Additional water supply, not already planned for, will be needed to support this growth.
5. A "Low Estimate" of water demand assumes a demand of 20 gallons per day per employee (based on standard industry estimates[2]) required of 34,000 employees.
6. A "High Estimate" of water demand assumes a demand of 20 gallons per day per employee required of 44,000 employees, plus the addition of another high-tech industry such as SEH America, requiring an additional 2,880,000 gallons per day.

[2] Obtained from “Wastewater Engineering: Treatment, Disposal, and Reuse,” 3rd edition, Metcalf and Eddy, Inc.

Based on this approach, the additional need for water supply is estimated to range from 762 to 4,215 acre-feet per year (0.68 to 3.76 mgd). This represents approximately one to five percent of the total municipal and domestic water demand projected for Clark County in 2020. As this range demonstrates, the primary driver is not the number of jobs involved, but the character of industrial development. A major, water-intensive industry can require a large volume of water, in comparison with the number of jobs involved.

As noted previously, this additional economic development could be served by major public water systems. However, these water demands are not incorporated in current water system plans. It is also possible that some of this new demand could be self-supplied by individual industrial facilities, if they could obtain new water rights, or transfer existing water rights from another water user. The recommendations from Section 3.5.3 should be applied.

3.5.5 Agricultural Water Users

Water usage in the agricultural sector is not well documented. The most recent set of comprehensive statistics on cropping was produced in 1997 and recent trends render this information somewhat outdated. For purposes of this Watershed Plan, estimates of water usage are based upon application of a Crop Irrigation Demand (CIR) to estimated acreage of different crops. These values are shown in Table 4-5.

Table 3-5
Water Usage in the Agricultural Sector

	ADD (mgd)	MDD (mgd)	Annual (afy)
WRIA 27	3.5	7.1	3,962
WRIA 28	6.1	12.2	6,848

Source: GeoEngineers, 2001.

There has been considerable change in the use of agricultural lands in recent years, as rural development has altered the character of these lands. In Clark County, there is considerable conversion of land from large agricultural parcels, to smaller parcels (e.g., 2 – 20 acres). These parcels are typically used for rural residential purposes, and may or may not include agricultural activities such as livestock, berry production, or horticulture. The overall impact on total water use is unknown.

Interviews with farmers, conservation district staff, county staff, and Washington State Department of Agriculture staff have not yielded any clear trends in water resource needs or issues in this sector. There is some indication that some farmers have changed to more water-efficient irrigation practices (e.g., drip irrigation and pressurized systems) over the past decade, but this is not well documented. There are approximately 47 applications pending for new water rights for agricultural purposes. These applications total 154 afy in annual use requested. Processing of these applications will likely take several years, due to the overall backlog of water rights applications statewide.

There may be water supply issues affecting individual farmers in WRIAs 27 and 28. However, taken as a whole, the agricultural sector is not identified as an area where water supply issues represent a high priority for the WRIAs 27 and 28 Planning Unit.

Recommendations:

New surface water supplies. The Planning Unit does not endorse the use of surface water for meeting additional future agricultural water demand.

Conversion of water rights. The Planning Unit encourages agricultural water right holders to request changes of existing surface water rights to ground water rights not in hydraulic continuity with surface waters. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

New ground water supplies. The Planning Unit recommends that Ecology process water right requests pertaining to future agricultural ground water demand, subject to consistency with the Planning Unit's water supply policy (Section 3.3.1) and successful completion of Ecology's water right application review process.

Transfer of Agricultural Water Rights. Given the availability of existing water rights, the Planning Unit endorses the transfer of ground water rights from one user to another to meet future agricultural water demands. To promote the public interest, the Planning Unit encourages the Department of Ecology to expedite processing of agricultural ground water right transfers between agricultural water users.

3.5.6 Unauthorized Water Users

Aside from the legal, appropriated use of surface and ground waters, there is a potential for illegal diversions of surface water and withdrawals of ground water to occur. Where unauthorized uses are occurring involving either surface waters and/or ground waters in continuity with surface streams, enforcement actions against unauthorized uses can potentially help to improve low flows. Ecology would generally be the agency responsible for enforcement actions.

The quantity of unauthorized water used within the WRIAs 27 and 28 watersheds is not known. In the more populated areas, some unauthorized uses are thought to occur. This issue is also discussed in Section 4.4.6, with respect to stream flow management. A policy is stated in Section 4.4.6 that recommends periodic surveys by Ecology to identify unauthorized was uses on streams deemed critical to salmon recovery within WRIAs 27 and 28, followed by appropriate enforcement actions to eliminate these uses.

3.6 Implementation Considerations for Water Supply Management

Table 3-6 summarizes implementation considerations for the water supply recommendations discussed in Sections 3.4 and 3.5 above. Implementation issues may vary somewhat from those listed in the table, depending on the specific action and community involved. Where there are staffing impacts that would likely require hiring of at least ½ Full-Time Employee (FTE) by the implementing organization(s), they are called out in the funding column.

Table 3-6
Implementation Considerations for Water Supply Actions

Priority[1]	Activity	Implementers[3]	Financial/ Economic Costs[2]	Potential Funding Sources
Category: Water Supply				
High	Public Water Systems develop new or expanded supplies. Requires engineering studies; approval of water system plan; water rights processing; other permitting; SEPA compliance; construction; operations & maintenance. Standard procedures exist for all of these.	*Lead*: Public Water System *Others*: DOH, Ecology	High	*Main*: Water rates and hookup charges in affected service areas *Additional*: Grants or low-interest loans from existing state & federal programs
High	Planning studies to explore alternative sources of supply to replace an existing source (selected communities).	*Lead*: Public Water System	Low	*Main*: Water rates in affected service area
High	Replace an existing source of supply with a different source to reduce impacts on stream flow. Requires engineering studies; water rights processing; other permitting; inter-local agreements or contracts; construction; operations & maintenance.	*Lead*: Public Water System *Others*: DOH, Ecology, adjacent water system(s) to serve as wholesaler	Medium to High	*Main*: Leg. appropriation *Additional*: Water rates in affected service area
Medium	Develop map of region's aquifers with emphasis on surface water hydraulic continuity.	*Lead:* Ecology *Others:* Public water systems	Medium	*Main:* Grants, water purveyor revenues
Medium	Enhanced conservation exceeding state requirements in selected communities.	*Lead*: Public Water System *Others:* Ecology, Conservation Districts	Low to medium	*Main*: public water system *Additional*: Grants from DOH or Ecology
Medium	Industrial supplies: Expand conservation & reuse; develop non-potable sources; connect to municipal systems.	*Lead*: Private industry (large plants) *Others*: Ecology & DOH (technical assistance; water rights processing if applicable)	Low to High (Varies by facility)	*Main*: Private industry *Additional*: Leg. appropriations
Low	Consider the effects of individual domestic wells when modifying or adopting comprehensive plans, zoning designations, or other land use regulations.	*Lead*: Counties, cities	Low	*Main*: counties, cities general fund or permitting fees, grants
Low	Agricultural supplies: switch from surface to ground water. Discourage new uses of surface water (use ground water instead).	*Lead*: Landowner *Others*: Ecology, Conservation Districts	Low to medium	*Main*: Landowner *Additional*: Leg. appropriations
Low	Develop water-level monitoring program for aquifers	*Lead:* Water purveyors *Others:* USGS, counties	Medium	*Main:* Grants, water purveyor revenues

(1) Priority in context of all actions in Watershed Management Plan.
(2) Preliminary, generalized estimates of financial or economic cost to the community or water user involved. High: greater than $500,000; Medium: $50,000 to $500,000; Low: less than $50,000. Total cost, whether up-front or over a period of time up to ten years.
(3) "Lead" implementer would take responsibility for organizing efforts under this action, including pursuing funding sources listed in the far right column.
Abbreviations: SEPA = State Environmental Policy Act, DOH = Department of Health, Leg. = Legislative

Section 4
Management of Stream Flows

4.1 Introduction

Management of stream flows is a critical component of the watershed plan. Stream flows are an important determinant of habitat conditions for fish and other aquatic life in streams throughout the region. Stream flows can be altered substantially by human activity in the watershed. Water withdrawals for public and private supplies reduce stream flow, as water is either diverted from a stream or withdrawn from an aquifer that may be connected with a surface stream. Other activities affect flows by changing how water drains from lands within the watershed. These activities include forestry, land use and development practices and alterations to floodplains and associated wetlands.

As described in Section 1.3, the Planning Unit has established the following goal with regard to stream flow management:

- Manage stream flows effectively to sustain aquatic biota, including fish populations in their various life stages.

Section 4 of the Watershed Management Plan presents policies and recommendations on management of stream flows intended to address this goal. The policies and recommendations presented here complement those presented in Sections 3 and 7 of this Plan which address water supply and fish habitat, respectively.

Management of both low and high flows is addressed in this Plan. It is important to manage flows during dry periods of the year when stream flows drop to their lowest levels. This typically occurs during the late summer and early fall months. Adequate flows at this time are essential to provide habitat for fish and other aquatic life. High flows that occur from runoff in the winter and spring are important in moving sediment through a river system and creating and maintaining proper habitat conditions within the stream channel and floodplain. On the other hand, excessively high flood conditions can be damaging to fish habitat, as well as property and human safety.

At this time there are few stream gauges in WRIAs 27 and 28, and this hampers the ability to monitor flows and target management actions. Therefore, this section proposes resources be directed towards improving routine monitoring of flow conditions in priority streams.

The WRIAs 27 and 28 Planning Unit has attempted to take a comprehensive perspective on flow management issues. In general the discussion throughout Section 4 assumes that reduced flow rates during the dry season are harmful to fish and their habitat; and that increased peak flows (i.e. flood events) from human activity can also be harmful to fish and their habitat.

This section identifies a range of management actions to manage stream flow conditions at both the low and high ends of the flow spectrum. These actions can be divided into two general categories. Management of water supply is important for stream flow, where water sources deplete flows. Management of land use and related issues is important where changes to the watershed disrupt runoff and ground water recharge. This breakdown is summarized in Table 4-1.

Table 4-1
Management Techniques

Category	Technique	Affects Low Flow	Affects High Flows
Water Use	Restrict issuance of new water rights	✓	N/A
	Water conservation	✓	N/A
	Curtailment or changed operations in drought conditions	✓	N/A
	Source substitution	✓	N/A
	Transfers to State Trust water rights	✓	N/A
	Enforcement actions against unauthorized water uses	✓	N/A
Land Use	Forest practices	✓	✓
	Development practices and stormwater management	✓	✓
	Floodplain management	✓	✓
	Wetlands management	✓	✓

The first six techniques listed in Table 4-1 are related to water use. They pertain to activities of those who divert surface water or withdraw ground water for consumptive uses, such as for municipal, domestic, industrial, and agricultural purposes. The latter four techniques are related to land use activities.

4.1.1 Stream Flow and Water Supply

As noted above, development and use of water supplies affects stream flow. In particular, water withdrawals can exacerbate low flow conditions that occur in the late summer and early fall. At this time of year, when flows are naturally low, even a small reduction in stream flow from water withdrawals have significant impacts on aquatic habitat. Flow is obviously reduced when surface water is diverted directly from a stream. Flow may also be reduced when ground water is pumped, if the aquifer used is hydraulically connected to surface waters.

At the same time, the Planning Unit recognizes that water supply is essential for communities, citizens and businesses, and needs for water will increase as the region continues to grow and develop. Striking a balance between protecting flows and allowing for water supply has been a major aspect of this watershed planning process.

To achieve this balance, Section 4 of the Watershed Management Plan presents a number of policies. For new supplies to meet needs of a growing population, this Plan recommends increased emphasis on ground water supplies rather than surface water supplies. Where feasible, confined ground water aquifers that have minimal impact on stream flow in tributaries to the Columbia River should be developed rather than aquifers that are directly connected to these tributary streams.

The Watershed Planning Unit has reviewed the magnitude and locations of expected needs for new water supplies throughout WRIAs 27 and 28. In some cases, water can be withdrawn from areas that will not cause significant effects on stream flow or aquatic habitat. This is the case, for example, near the mouths of streams that are influenced by tidal effects and backwater from the Columbia River. In other cases, water can be purchased from a regional water system, such as delivery of water from Clark Public

Utilities and Vancouver to other communities within Clark County. Both CPU and Vancouver plan to develop a major new ground water source in the lowlands adjacent to the Columbia River. This source is not expected to impact flows in tributary streams in the region and can therefore provide a valuable alternative to other sources that may have more substantial impacts on stream flows locally.

It is recognized that even with these approaches in place, new development of water supplies will be needed for some communities where impacts to stream flow are unavoidable. The Planning Unit offers a proactive set of recommendations to address these situations. Communities should explore all reasonable alternatives prior to developing a new supply that will reduce late summer flows in tributary streams. Where alternatives are either infeasible or prohibitively expensive, other approaches such as water conservation and development of reclaimed water supplies[1] can help reduce needs for new supplies. The Planning Unit recommends a procedure whereby these alternative solutions must be explored in detail before Ecology considers issuing new water rights that would impact stream flows.

The Planning Unit also recommends a policy to prohibit issuance of new water rights that would reduce low flows, except under certain pre-defined circumstances. This policy can be accomplished under State law through what is known as a "closure" of streams to new allocations. In the Washougal, Kalama, and East Fork Lewis basins, there is sufficient modeling data to assist in the development of numeric instream flow data. These numerical flows have been integrated with the stream closures to allow flexibility in managing intra-basin transfers while providing additional legal basis for the closures.

The Planning Unit recognizes that a total closure of streams to all new water right applications would conflict with the goal of ensuring adequate water supplies are available for the region. Therefore the policy has conditions for:

- Domestic wells, served by septic systems;
- Specific communities that may not have access to alternative supplies. In these cases a pre-defined quantity of water will be "reserved" for possible allocation to that community. The reserved quantity will be defined in terms of the net effect on stream flow from development of new supply capacity.
- Other communities and industries that may need supplies in the future, but whose needs cannot be well-defined at this time. Again, a pre-defined quantity will be reserved to meet these needs.

The reserved supplies discussed above (except for domestic wells) can be tapped only if the community first demonstrates there is no other practicable alternative, commits to effective stewardship through conservation and/or production of reclaimed water; and commits to offsetting actions and mitigating actions that minimize the effects on stream flow or aquatic habitat. Actions will be evaluated within the context of other supply alternatives, water supply total project cost, and the cost of the off-setting and mitigating actions. These costs should be evaluated within the context of other fish recovery actions that may be needed to compensate for impairment to streamflow.

[1] Reclaimed water is highly treated wastewater that can be used for non-potable purposes such as irrigation of large landscapes and golf courses, industrial uses, and other uses permitted under State law.

This Plan also recommends acquisition of water rights from willing sellers for the State Trust. This program sets aside water specifically for stream flows and other purposes. In addition, this Plan calls for increased enforcement actions against unauthorized uses of water. Finally, the Plan recommends that major water users develop policies and procedures to reduce the impacts of withdrawals during drought conditions when streams are under unusual stress.

These policies, taken as a whole, are designed to protect stream flows from unnecessary depletion, while still allowing reasonable opportunities for water supply to meet the needs of a growing region. Further details are provided later in this section of the Watershed Management Plan.

4.1.2 Stream Flow and Land Use

Water withdrawals to meet water supply needs are not the only human activity influencing stream flow. Land use, development practices, forest practices, and modification of floodplains and wetlands all affect runoff within a watershed. Where these factors allow precipitation to run off more quickly, they concentrate peak flows, erosion and flood damage. In addition, some of these activities reduce natural storage in ground water, floodplains and riparian wetlands. Where natural storage is reduced, less water is retained to support base flows during the dry season.

Over 85 percent of the lands within WRIAs 27 and 28 are forested. In general, the Planning Unit anticipates that recent changes in forest management under the Forests and Fish Rules, DNR’s Habitat Conservation Plan, and the Northwest Forest Plan provide an adequate regulatory framework for forest practices. These programs offer a range of environmental benefits, and should generally improve water quality and move in the direction of a more natural flow regime in local streams and rivers. The Planning Unit does not offer new policies in this regard, but calls on State and federal government agencies to monitor the effectiveness of these programs and periodically report to the public on their results, including effects on stream flow and fish habitat.

The Planning Unit has recommended additional policies in the areas of stormwater management, extensions of sewer service to unsewered areas, floodplain protection and wetlands management. Specific project opportunities have been identified where possible. These policies and projects are described in greater detail later in Section 4.

Channel configuration is also important to aquatic habitat. On some streams, various factors have led to wider, shallower channels in some reaches. This generally magnifies problems related to low flow and reduces habitat quality. Alterations to channel configuration problems are beyond the scope of the stream flow discussion in Section 4 of this Plan. However, this issue is being addressed in the Lower Columbia Fish Recovery Board's Subbasin Plans which are under development (refer to Section 7).

Other activities can also disrupt shallow aquifer recharge, subsurface flow patterns, and discharge that support the stream flow regime. These activities were not evaluated in detail during the planning process and require additional evaluation as discussed later in this section.

4.1.3 Summary of Stream Flow Management Policies

This section summarizes the stream flow management policy statements discussed in the upcoming sections. For convenient reference, Table 4-2 lists each policy statement.

Table 4-2
Summary of Stream Flow Management Policies for WRIAs 27 and 28

No.	Technique	Policy
Policies on Flow Monitoring		
SFP-1	Flow monitoring	For purposes of improving stream flow management in the region, it is important that existing stream gauges be maintained over the long-term and that additional, permanent stream gauges be installed.
Policies on Water Supply as Related to Stream Flow		
SFP-2	Restrictions on issuance of new water rights	The Department of Ecology should adopt State Rules (WACs) under its Instream Resources Protection Program to restrict issuance of new water rights in WRIAs 27 and 28. In all affected streams reaches a closure should be established, but with certain exceptions as indicated below. Existing water rights shall not be affected by this policy. For each stream that flows into the Columbia River, the zone where water levels are substantially affected by tidal influence and backwater from the Columbia River shall not be closed to issuance of new water rights. The location of the lower most extent of the closure will be recommended by the Planning Unit prior to management plan adoption; The rules adopted shall not prevent issuance of water rights for selected purposes and conditions. These include: ▪ New uses for domestic wells, based on the amount of the water required to meet estimated needs. This quantity represents the net depletion of stream flow in each subbasin by all domestic wells installed after the effective date of the rule; ▪ New uses for small community systems and other beneficial uses, up to a predefined, limited “block” of water. These quantities represent the net depletion of stream flow in each subbasin for these categories of water use. Access to this block shall be granted only after consideration of items as listed for municipal systems, below. ▪ New uses for municipal water systems, based on the amount of water required to meet estimated needs. This quantity represents net depletion of stream flow in each subbasin. Access to this block should be granted only after consideration of practicable alternative supplies, demonstration of appropriate measures to ensure water-use efficiency, and consideration of measures that offset or mitigate the depletion of stream flow or provide other types of aquatic habitat benefits; ▪ Small, temporary uses of water for environmental restoration purposes not exceeding one year in duration. ▪ Non-consumptive uses such as fish propagation or hydropower. ▪ New uses limited to the high flow season, where the nature of the proposed use is such that water will not be taken in the low-flow season. However, this is not intended to allow withdrawals large enough to compromise habitat-forming processes of any stream. The Planning Unit recommends that minimum instream flows be adopted as an additional element of the State Rules in selected basins where sufficient data is available. The minimum instream flows will be used in processing applications for changes or transfers of existing water rights. However, the blocks of water reserved for domestic, municipal, and other beneficial uses (see above) shall not be subject to minimum instream flow conditions. The Planning Unit recommends the rule be evaluated after Plan adoption, as the need is identified through the Plan review process outlined in Chapter 8; and that revisions to the rule be considered if needed. Increases to water supply reservations may be considered if compatible with aquatic habitat protection objectives. In addition, water reservation quantities may be shifted among water use categories to better address actual needs. However, the total reservation quantity in each subbasin shall not be decreased. Consistent with Chapter 90.82.130 any process to revise the rule should use a form of negotiated rulemaking that uses the same processes that applied in WRIA 27/28 for developing this Watershed Management Plan. Rule review should consider a quantitative comparison between stream flows and population targets from the Salmon Recovery Plan developed by LCFRB. The Planning Unit does not intend for Ecology to defer processing of water rights, pending rule adoption.

Table 4-2 (cont)
Summary of Stream Flow Management Policies for WRIAs 27 and 28

No.	Technique	Policy
SFP-3	Water Conservation	Water conservation is part of a sound comprehensive water resources management program. In general, adherence to State requirements for municipal water conservation, as modified from time to time, will be sufficient for most communities within WRIAs 27 and 28. Conservation activities that exceed state requirements should be carried out in selected communities where water use has the potential to cause significant impairment of stream flow conditions. Based on the Planning Unit's assessment of watershed conditions, these communities include Battle Ground, Ridgefield, Yacolt, and Camas (see Sections on East Fork Lewis River and Washougal River for further discussion of these communities). This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State. Water conservation actions by farmers practicing irrigated agriculture may be warranted in selected locations, where there would be significant benefits to stream flows. The Conservation District in each County should provide technical assistance to farmers to identify water conservation opportunities and funding sources.
SFP-4	Short Term Drought Response	Where major surface water diversions or ground water withdrawals have a direct effect on stream flows on a time scale of weeks or less, the water user should consider adopting voluntary procedures to alter operations in the event of a State-declared drought emergency affecting WRIAs 27 and/or 28. The water user should adopt policies and procedures in advance, to allow for quickly altering operations to minimize or eliminate the depletion of stream flow to the extent feasible in the event such a drought occurs. This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State. For hydropower operations such as the Lewis River project, it is assumed that FERC license conditions fully address releases under low flow conditions, including drought conditions. Efforts should continue to identify small surface water users that could implement this type of management strategy to improve low flow conditions.
SFP-5	Source Substitution	Communities using water sources (surface or ground water) that significantly reduce base flows in any stream that provides important fish habitat within WRIAs 27 and 28 should consider alternative sources of supply that eliminate or minimize these effects. It is anticipated that this would require examination of cost, potential rate impacts, reliability considerations, and evaluation of other feasibility criteria. This is a Planning Unit recommendation for voluntary actions. Implementation should not be mandated by the State. In limited cases, this policy may apply to rural areas where residents rely on domestic wells (exempt wells). When modifying or adopting comprehensive plans, zoning designations, or other land use regulations, Clark and Cowlitz counties, cities, local governments, Ecology, and/or others as appropriate should assess this possibility through a water-balance analysis, in selected rural areas where extensive new development is expected to occur or where there is substantial existing development served by exempt wells. The intent is to explore solutions for small creeks where a large number of existing domestic wells may deplete stream flows. Under the right circumstances, if a different source could be used to replace individual wells, effects on stream flow could potentially be reduced or eliminated. Local community views should be included in this process.
SFP-6	Transfer of Water Rights to State Trust	Ecology should use its existing State Trust program, and funding provided by the State Legislature, to identify and acquire water rights from water users willing to sell or donate their water rights in WRIAs 27 and 28, where transfers to the State Trust would provide a significant benefit to fish habitat.

Table 4-2 (cont)
Summary of Stream Flow Management Policies for WRIAs 27 and 28

No.	Technique	Policy
SFP-7	Enforcement Against Unauthorized Uses	Ecology should conduct or support initial surveys in selected subbasins to determine whether unauthorized water uses are occurring on streams deemed critical to salmon recovery within WRIAs 27 and 28. If these surveys identify extensive unauthorized uses, they should be expanded to additional subbasins and carried out on a regular, periodic basis (e.g. once every five years). Where unauthorized uses are identified, Ecology should take enforcement actions to eliminate these uses. An alternative or additional approach would be the establishment of a watermaster that has regulatory authority to regulate illegal water diversions. Further development of this concept is recommended during the implementation phase.
SFP-8	Hydropower Operations	The Planning Unit relies on the FERC licensing process to provide protections for flow and other habitat factors associated with hydroelectric facilities on the North Fork Lewis River.
Policies on Land Use as Related to Stream Flow		
SFP-9	Forest Practices	The USFS, State DNR and private landowners should consider effects of forest management practices on stream flow and other fish habitat factors, in making forest management decisions. The Planning Unit anticipates that existing programs under the State's Forests and Fish regulations, DNR's Habitat Conservation Plan, and the federal government's Northwest Forest Plan will provide the regulatory framework needed in this regard. The State and federal governments should monitor the effectiveness of these programs and periodically provide public documentation of their effectiveness in protecting fish habitat in WRIAs 27 and 28.
SFP-10	Stormwater Management	Clark County, Cowlitz County, and the Cities of Vancouver, Camas, Washougal, and Battle Ground should continue to carry out their legally mandated responsibilities with regard to stormwater management. The remaining cities in all three counties should review their stormwater management ordinances to determine whether they are adequately protective of fish habitat in local streams that may be affected by future development. Skamania County should voluntarily consider developing such an ordinance. Where enhanced stormwater management needs are identified, revisions to local ordinances should be considered in light of the guidance and BMPs provided in Ecology's Manual. The focus should be on upgrading development practices and mitigation requirements in areas where stream flow and fish habitat may be compromised as development occurs. Costs, expected magnitude of benefits, and feasibility considerations should be included in this review.
SFP-11	Sewer Extensions	When modifying or adopting comprehensive plans, zoning designations, or other land use regulations, jurisdictions should consider the water balance implications of allowing extension of sewer service to communities formerly served by septic systems. The Planning Unit recognizes that provision of sewer service can provide substantial water quality benefits. However, where sewer service is extended to replace septic systems, and residents continue to rely on water wells, stream flows may be reduced. This effect should be anticipated and mitigated where applicable. This is particularly important in areas with relatively dense development near small streams.
SFP-12	Floodplain Management	Within authorities, local jurisdictions and state agencies with land management responsibilities should protect existing floodplains from modifications that would impair their hydrologic functions and habitat value. Within authorities, local jurisdictions and state agencies with land management responsibilities should identify floodplain restoration projects, subject to local input, cost-benefit analysis, and availability of funding. Where these factors are favorable, and where substantial benefits to flow or other habitat factors are identified, these projects should be pursued for implementation.

Table 4-2 (cont)
Summary of Stream Flow Management Policies for WRIAs 27 and 28

No.	Technique	Policy
SFP-13	Wetlands Management	In conjunction with the Planning Unit, Counties should explore funding opportunities for conducting a county-wide wetland assessment that includes evaluation of hydrological functions. Counties should also require evaluation of hydrological function as part of any site-specific wetland assessments conducted under their critical areas, wetland or other land uses ordinances. Their wetlands ordinances should be modified as needed to include hydrologic functions in the wetland protection hierarchy. Counties should review and consider strengthening mitigation ratios, for selected wetland areas that offer significant hydrologic functions or other fish habitat benefits.

Organization of this Section

The remainder of Section 4 lays out these policies and recommendations in greater detail. Section 4.2 describes the need for improved monitoring of flow conditions. Section 4.3 introduces the concept of “target flows.” This concept offers a “measuring stick” for progress on protecting and improving stream flow conditions. Section 4.4 presents the suite of management tools for minimizing the effects of water withdrawals on flow conditions. Section 4.5 describes additional management tools related land use. Section 4.6 identifies priorities among the eight subbasins of WRIAs 27 and 28 for applying the stream flow management techniques. Section 4.7 summarizes stream flow conditions and recommendations in each of the eight major subbasins in WRIAs 27 and 28. Finally, Section 4.8 discusses implementation considerations for the stream flow management program.

4.2 Flow Monitoring Needs

In order to manage flows, streams must be monitored consistently. For purposes of the flow management program developed in this Plan, flow monitoring is needed to:

- Provide basic data needed to assess current status and long-term trends in stream flow
- Provide basic data to determine how various components of the watershed contribute to flow (e.g. flow contributed by specific tributaries; gains and losses from ground water interactions, etc.)
- Assess how short-term or long-term changes in watershed conditions affect flows (e.g. land use, precipitation trends).
- Evaluate the effectiveness of specific management actions designed to improve the flow regime.
- While not the focus of this section, stream flow data is also very valuable in the context of water quality monitoring (see Section 5.4.2).

At this time, the only long-term, continuously-recording flow gauges in WRIAs 27 and 28 are in the Lewis River Basin. These are the USGS gauges on the East Fork Lewis River near Heisson; the North Fork Lewis River at Ariel; and two tributaries to the North Fork Lewis River upstream of the PacifiCorps hydroelectric facilities (Speelyai Creek and Muddy River). In addition, CPU monitors flow on Salmon Creek as part of its Salmon Creek water resources management program. Clark County has a number of additional gauges on various streams, but they have not been in place for long periods and could be discontinued depending on County funding priorities. Taken together, these gauges are clearly not adequate for effective monitoring and management of flow conditions in the many streams across WRIAs 27 and 28. Even in the Lewis River Basin, additional gauges would be needed to effectively track changes in flow due to development, water withdrawals and other factors in the more populated areas.

Therefore, the Planning Unit offers the following policy statement regarding flow monitoring.

> ***Policy SFP-1:***
>
> For purposes of improving stream flow management in the region, it is important that existing stream flow gauges be maintained over the long-term and that additional, permanent gauges be installed.

It is recognized that installation and operation of gauges requires funding, and it may be impossible to fund gauges in every location desired. The Planning Unit identified the following criteria for focusing funding resources on selected subbasins (for subbasin boundaries, see Exhibit 2-2 in Section 2):

- Presence of existing gauges that should be maintained permanently;
- Past record of discontinued stream gauges, which provide data that can be leveraged if new gauges are installed;
- Degree to which flow is impaired now, with potential harm to aquatic habitat;
- Size of subbasin and associated extent of habitat for aquatic life
- Priority of streams in LCFRB Recovery Plan;
- Expected future changes in land use or water withdrawals, that will cause impairment of flow;
- Extent of existing urbanization, and associated feasibility of protecting or enhancing flow (e.g. consider highly urbanized subbasins less feasible)

Based on these criteria, the Planning Unit recommends that subbasins within WRIAs 27 and 28 be prioritized as follows for installation and maintenance of permanent, continuously-recording stream gauges:

Table 4-3
Subbasin Priorities for Stream Gauge Installation and Maintenance

High Priority	Medium Priority	Lower Priority
North Fork Lewis River Subbasin	Kalama River Subbasin	Burnt Bridge Creek Subbasin
East Fork Lewis River Subbasin	Salmon Creek Subbasin	Columbia River Tributaries Subbasin (Eastern WRIA 28)
Washougal River Subbasin		

Consideration should also be given to whether existing weather stations for measuring precipitation and other weather variables are adequate to meet stream management needs.

The Planning Unit applied particular attention to the East Fork Lewis River and Washougal River subbasins during the planning process. This is because they were used as "pilot" subbasins to develop the overall program for stream flow management. More detailed recommendations on flow gauging in these two subbasins are provided in Sections 4.7.3 and 4.7.7, respectively.

Monitoring of the relationships between ground water and surface water base flows would also be valuable.

Recommendation:

The Planning Unit recommends a water-level monitoring program be developed for aquifers in the region. Details of this program will be developed during the implementation phase.

4.3 Target Flows

One way in which the effectiveness of stream flow management can be quantified and monitored is through the establishment of "target flows." As used in this watershed plan, the term "target flows" means a realistic flow regime that could be achieved in most years by following selected management techniques over a long period of time (e.g. 10 years or more). The "flow regime" is defined by a set of statistics that define both high flows and low flows, durations, and their frequency of occurrence over a period of years. These statistics are readily developed from flow records at stream-gauging sites. An appropriate flow regime for a specific stream can be determined by evaluating historical flow conditions, current and projected water uses, and fish habitat needs.

Target flows should not be confused with "minimum instream flows" used in allocating water rights. Traditionally, a minimum instream flow for a given stream has been a single, low flow rate listed for each season (or sometimes a single flow rate for the entire year). The sole purpose of minimum instream flows in State law has been to define restrictions on issuance of new water rights. The minimum instream flow approach has value for that particular purpose, but does not provide a practical framework for addressing other factors that affect stream flow, nor for managing conditions that exacerbate peak flows.

The intent in establishing target flows is that, once management actions have been taken, the target flows should be achievable under typical precipitation and runoff conditions. Available management techniques are discussed later in Section 4 of this Plan. If improvement in flow conditions is to be achieved, management techniques that have the potential to achieve the desired target flows must be applicable in the specific watershed.

This approach can serve as the basis for a practical and achievable management program addressing all of the human activities that influence stream flow. It aims for achievable flow levels, it accounts for both low and high ends of the flow regime, and it captures the natural variability of stream flows (both seasonally and over long periods of time).

As with any stream flow management program, flow data is needed to define the flow regime. This underscores the value of permanent stream gauges. Target flows should be established only in areas where significant flow data has been collected over a long period of time (or where acceptable simulated flow data has been generated).

Briefly, for the low-flow period of late summer and early fall, flow levels can be defined at the 90th percentile, 50th percentile (median), and 10th percentile. These represent flows that can be expected, on average, either 1 year out of ten; 5 years out of ten, or 9 years out of ten, respectively.

For example, on the East Fork Lewis River this range of flows at the Heisson Gauge for the month of August is from 51 cfs to 120 cfs. The median flow is 74 cfs. These values can be defined as the target range for low flows in August. The goal would be to manage the watershed and water withdrawals to prevent this range of flows from decreasing over a time period of several years to decades (e.g. the range falls to a quantity such as 40 to 190 cfs, and the median falls to 70 cfs). In addition, it would be desirable to undertake management actions that would increase this range of flows (e.g. the range rises to a quantity such as 55 to 230 cfs, and the median rises to 85 cfs).

A different type of target flow statistic can be defined for peak flows that typically occur in the winter months. For peak flows, the Planning Unit has identified the 2-year flood and the 10-year flood as appropriate statistics. The 2-year flood has a 50 percent chance of occurring in any single year. The 10 year flood has a 10 percent chance of occurring in any single year. An appropriate goal would be to manage the watershed such that the 2-year flood and the 10-year flood either remain at a constant level over time, or decrease.

In addition, it is important that the duration of the highest flows do not increase. Increased duration of flows above certain levels can be damaging to riparian and channel conditions and contribute to erosion and sedimentation.

Appendix F provides additional technical information on target flows, using the East Fork Lewis River and Washougal River as examples. Recommendations on target flows for these two rivers are presented in Sections 4.7.3 and 4.7.7, respectively. Target flows have not been developed for other streams in the region at this time, but could be developed in the future.

4.4 Water Supply Management Actions to Protect Stream Flow

As discussed in Section 4.1.1 water supply actions can affect stream flow. This is particularly true during the late summer and early fall, when stream flows are already low due to reduced precipitation. Diversions of stream flow for water supply directly reduce stream flow. Pumping ground water can also reduce stream flow in local streams, if the aquifer involved is interconnected with local surface waters. However, the effects of pumping are often diffuse and may be delayed by days, weeks or months.

It should be noted that all ground water is inter-connected with surface water somewhere. For the purposes of this Plan, the primary issue is whether pumping ground water will affect stream flow in streams other than the Columbia River. Furthermore, the primary issue is effects upstream of the stream reaches that are tidally influenced.

In WRIAs 27 and 28 some aquifers have a more pronounced effect on local stream flows than others. Pumping from a large regional aquifer such as the Sand and Gravel Aquifer may not produce measurable impacts in the streams that flow into the Columbia River from WRIAs 27 and 28[2].

This subsection describes management actions that can be used to minimize the effects of water supply development on stream flow in WRIAs 27 and 28. More complete descriptions of these actions are provided in Technical Memorandum No. 8: Strategies for Managing Flows in Two Pilot Subbasins (EES, 2003b). For each technique, the Planning Unit offers a policy statement intended to guide water resource management in WRIAs 27 and 28.

[2] Since the Columbia River itself is so large, pumping from a regional aquifer at the quantities existing or expected for local needs may have effects that are not measurable on the Columbia River either.

Section 3 of this Watershed Management Plan should be reviewed in conjunction with this Section 4.4. This is because the Planning Unit intends that as stream flows are protected or improved, provision also be made for adequate water supplies.

4.4.1 Stream Closures, Minimum Instream Flows, and Water Right Reservations

This management technique involves placing restrictions on issuance of new water rights by the Washington State Department of Ecology (Ecology). This approach is designed to protect stream flows from new appropriations of water. This can be accomplished with stream closures, adoption of minimum instream flows, or both. These restrictions affect only the issuance of new water rights; existing uses of water and other watershed factors that influence flow are not affected by this action. Furthermore, this approach is designed to manage only low flow conditions, not peak flows.

A stream “closure” means that Ecology will deny any future applications for water rights from that stream and all its tributaries. This includes applications for surface water rights, and applications for ground water rights that could affect flows in the stream.

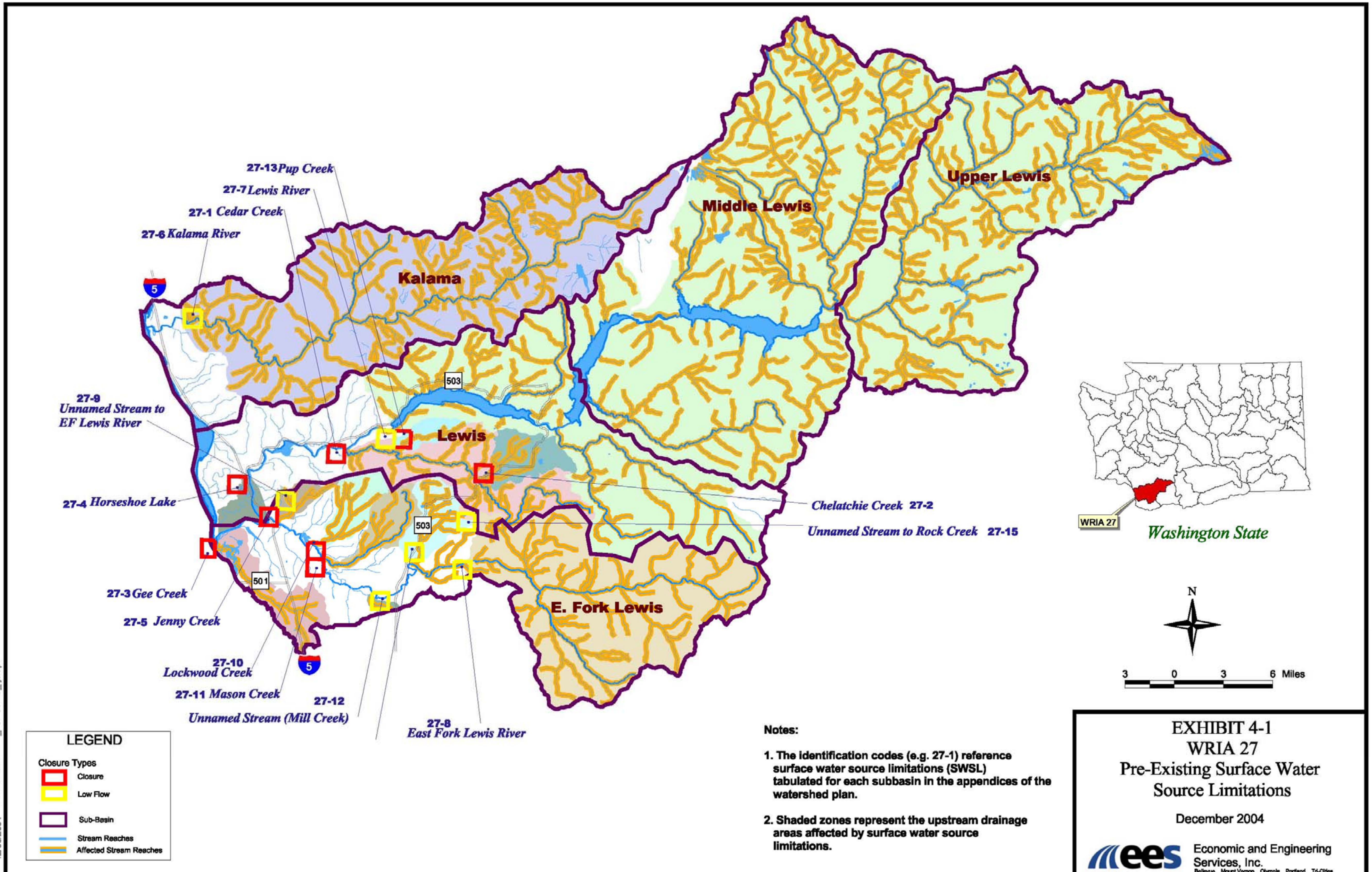
“Minimum instream flows” are different from closures. With minimum instream flows an applicant can receive a new water right. However, their use of the water right must cease whenever the flow in the stream falls below a certain level at a prescribed control point (this would typically occur during the summer months). As a practical matter, this requires monitoring of stream flow and issuance of notices or orders to these water right holders by Ecology when flows drop below the prescribed level.

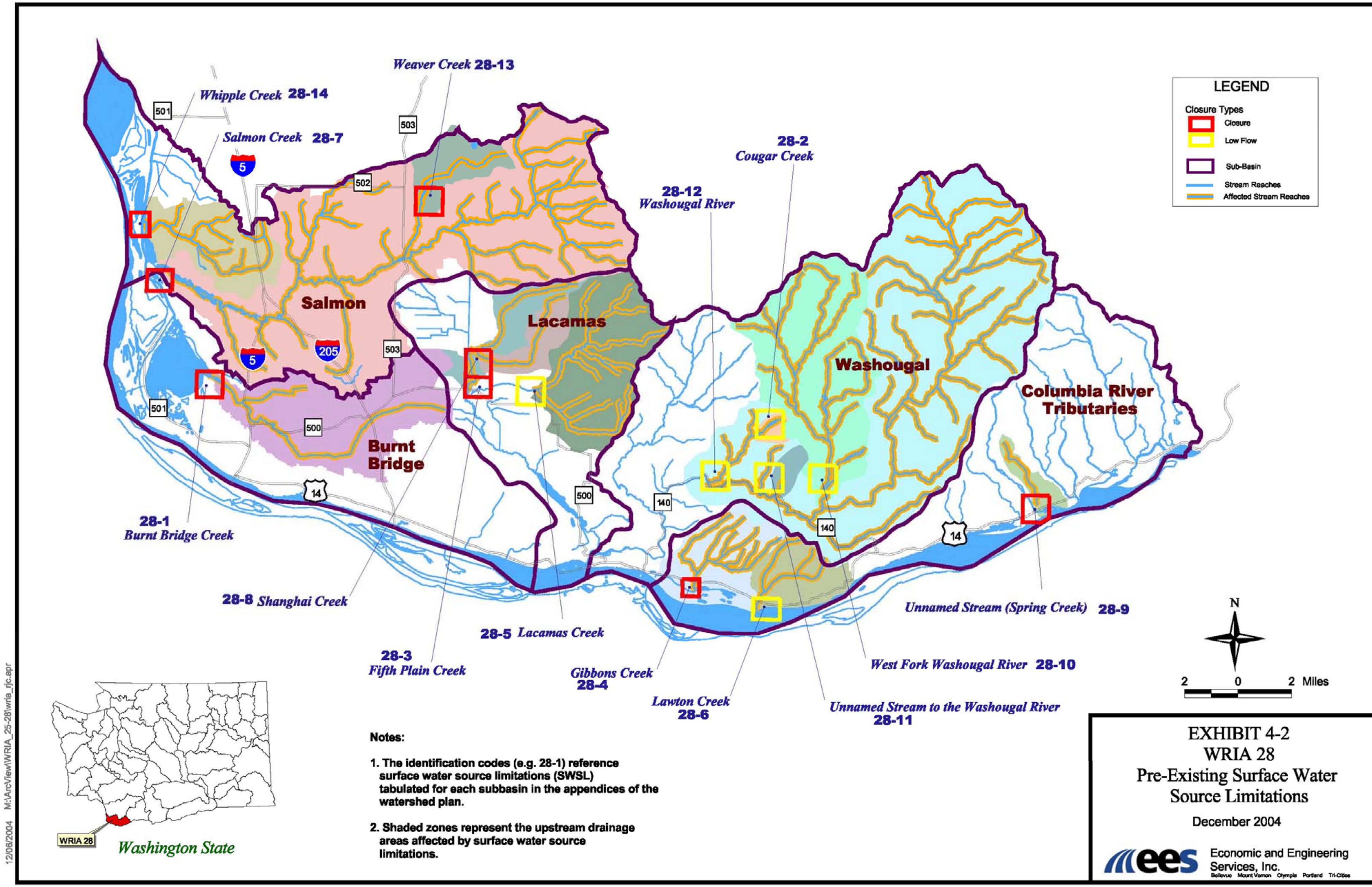
Some minimum instream flows and closures have been established by Ecology already through administrative actions in WRIAs 27 and 28. These administrative low flows and closures lists are referred to as Surface Water Source Limitations (SWSLs). Exhibits 4-1 and 4-2 present the locations of existing administrative low flows and closures from Ecology’s SWSL listings for WRIAs 27 and 28, respectively. Details regarding each SWSL are provided in Appendix G.

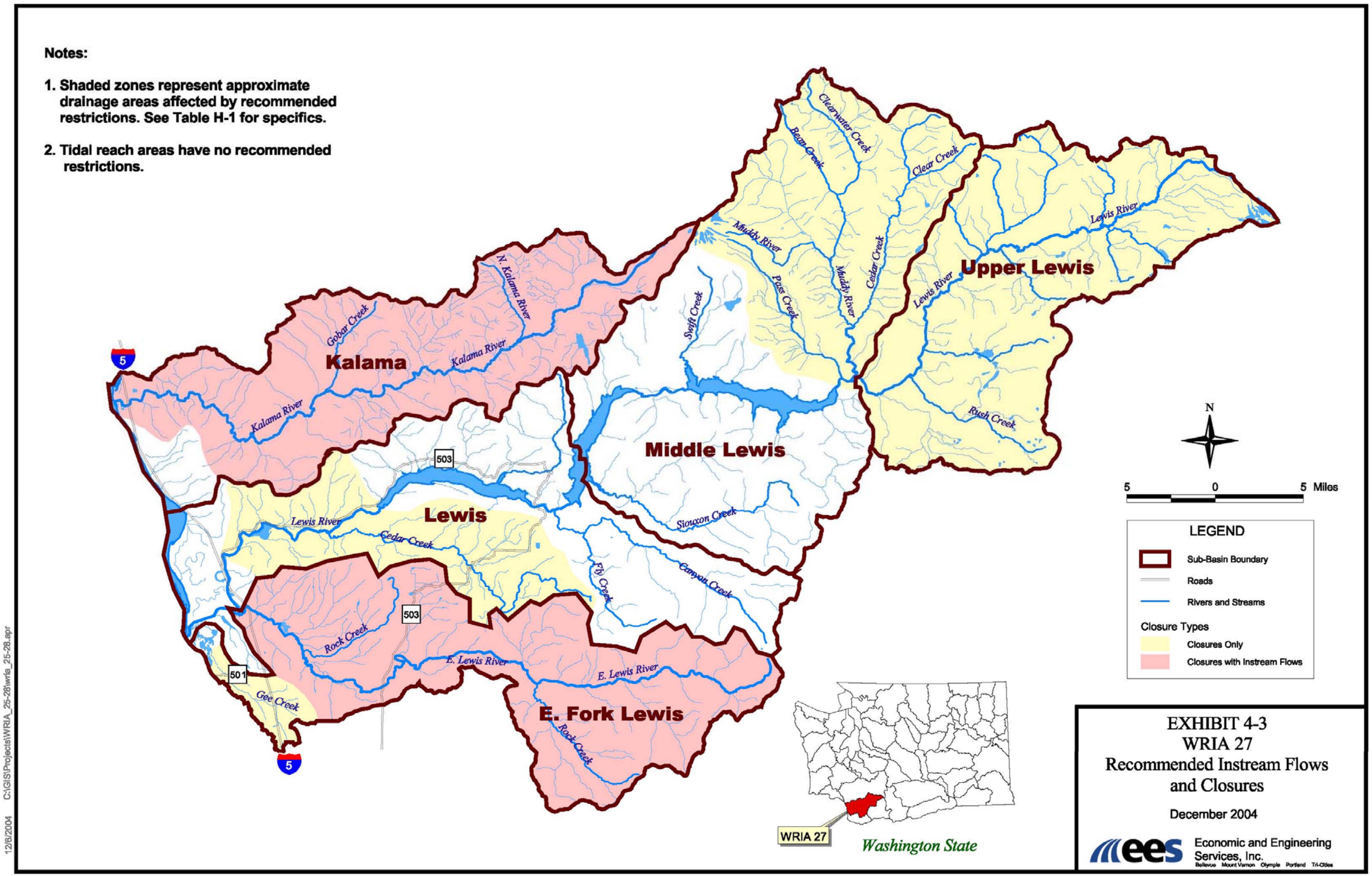
Table H-1 in Appendix H shows proposed restrictions on the issuance of new water rights in WRIAs 27 and 28. Table H-4 shows proposed instream flows for the Kalama River, East Fork Lewis River, and Washougal River. Table H-5 shows recommended instream flows based on toe-width data developed by Washington Department of Fish and Wildlife and Washington Department of Ecology. These recommended instream flows and closures are presented in Exhibits 4-3 and 4-4 for WRIAs 27 and 28, respectively.

Ecology also has the authority to pass a State Regulation (WAC) that would formalize minimum instream flows and closures. This is considered to offer stronger provisions that restrict issuance of new water rights or provide conditions on new water rights. This has been done in other WRIAs but not in WRIAs 27 and 28.

The Planning Unit views the additional protection for stream flow in an adopted State rule as desirable for achieving the objective of protecting stream flow. Therefore, this plan offers the following policy recommendation in this regard.


27-13 Pup Creek
27-7 Lewis River
27-1 Cedar Creek
27-6 Kalama River
Kalama
Middle Lewis
Upper Lewis
Lewis
E. Fork Lewis
27-9
Unnamed Stream to
EF Lewis River
27-4 Horseshoe Lake
27-3 Gee Creek
27-5 Jenny Creek
27-10
Lockwood Creek
27-11 Mason Creek
27-12
Unnamed Stream (Mill Creek)
27-8
East Fork Lewis River
Chelatchie Creek 27-2
Unnamed Stream to Rock Creek 27-15
503
501
5
WRIA 27
Washington State
N
3 0 3 6 Miles
LEGEND
Closure Types
Closure
Low Flow
Sub-Basin
Stream Reaches
Affected Stream Reaches
12/06/2004 M:\ArcView\WRIA_25-28\wria_rjc.apr
Notes:
1. The identification codes (e.g. 27-1) reference surface water source limitations (SWSL) tabulated for each subbasin in the appendices of the watershed plan.
2. Shaded zones represent the upstream drainage areas affected by surface water source limitations.
EXHIBIT 4-1
WRIA 27
Pre-Existing Surface Water
Source Limitations
December 2004
ees
Economic and Engineering
Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities


Weaver Creek 28-13
Whipple Creek 28-14
Salmon Creek 28-7
28-2
Cougar Creek
28-12
Washougal River
LEGEND
Closure Types
Closure
Low Flow
Sub-Basin
Stream Reaches
Affected Stream Reaches
Salmon
Lacamas
Washougal
Columbia River
Tributaries
Burnt
Bridge
28-1
Burnt Bridge Creek
28-8 Shanghai Creek
28-5 Lacamas Creek
28-3
Fifth Plain Creek
Gibbons Creek
28-4
Lawton Creek
28-6
Unnamed Stream to the Washougal River
28-11
West Fork Washougal River 28-10
Unnamed Stream (Spring Creek) 28-9
N
2 0 2 Miles
501
503
5
502
205
500
14
140
WRIA 28
Washington State
12/06/2004 M:\ArcView\WRIA_25-28\wria_rjc.apr
Notes:
1. The identification codes (e.g. 28-1) reference surface water source limitations (SWSL) tabulated for each subbasin in the appendices of the watershed plan.
2. Shaded zones represent the upstream drainage areas affected by surface water source limitations.
EXHIBIT 4-2
WRIA 28
Pre-Existing Surface Water
Source Limitations
December 2004
ees
Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities



Notes:
1. Shaded zones represent approximate drainage areas affected by recommended restrictions. See Table H-1 for specifics.
2. Tidal reach areas have no recommended restrictions.
Kalama
Lewis
Middle Lewis
Upper Lewis
E. Fork Lewis
Kalama River
N. Kalama River
Gobar Creek
Lewis River
Cedar Creek
Rock Creek
E. Lewis River
Gee Creek
Fly Creek
Canyon Creek
Siouxon Creek
Swift Creek
Muddy River
Pass Creek
Bean Creek
Clearwater Creek
Clear Creek
Cedar Creek
Rush Creek
503
501
5
N
5 0 5 Miles
LEGEND
Sub-Basin Boundary
Roads
Rivers and Streams
Closure Types
Closures Only
Closures with Instream Flows
WRIA 27
Washington State
EXHIBIT 4-3
WRIA 27
Recommended Instream Flows and Closures
December 2004
ees Economic and Engineering Services, Inc.
12/6/2004 C:\GIS\Projects\WRIA_25-28\wria_25-28.apr

12/6/2004 C:\GIS\Projects\WRIA_25-28\wria_25-28.apr

Notes:

1. Shaded zones represent approximate drainage areas affected by recommended restrictions. See Table H-1 for specifics.
2. Tidal reach areas have no recommended restrictions.

LEGEND

- Sub-Basin Boundary
- Roads
- Rivers and Streams

Closure Types

- Closures Only
- Closures with Instream Flows

EXHIBIT 4-4
WRIA 28
Recommended Instream Flows and Closures

December 2004

ees Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities

Policy SFP-2:

The Department of Ecology should adopt State Rules (WACs) under its Instream Resources Protection Program to restrict issuance of new water rights in WRIAs 27 and 28. In all affected streams reaches a closure should be established, but with certain exceptions as indicated below. Existing water rights shall not be affected by this policy.

For each stream that flows into the Columbia River, the zone where water levels are substantially affected by tidal influence and backwater from the Columbia River shall not be closed to issuance of new water rights. The location of the lower most extent of the closure is identified in this Plan.

The rules adopted shall not prevent issuance of water rights for selected purposes and conditions. These include:

- New uses for domestic wells, based on the amount of water required to meet estimated needs. This quantity represents the net depletion of stream flow in each subbasin by all domestic wells installed after the effective date of the rule;
- New uses for small community systems and other beneficial uses, up to a predefined, limited "block" of water. These quantities represent the net depletion of stream flow in each subbasin for these categories of water use. Access to this block shall be granted only after consideration of items as listed for municipal systems, below.
- New uses for municipal water systems, based on the amount of water required to meet estimated needs. This quantity represents net depletion of stream flow in each subbasin. Access to this block should be granted only after consideration of practicable alternative supplies, demonstration of appropriate measures to ensure water-use efficiency, and consideration of measures that offset and mitigate the depletion of stream flow or provide other types of aquatic habitat benefits;
- Small, temporary uses of water for environmental restoration purposes not exceeding one year in duration.
- Non-consumptive uses such as fish propagation or hydropower.
- New uses limited to the high flow season, where the nature of the proposed use is such that water will not be taken in the low-flow season. However, this is not intended to allow withdrawals large enough to compromise habitat-forming processes of any stream.

The Planning Unit recommends that minimum instream flows be adopted as an additional element of the State Rules in selected basins where sufficient data is available. The minimum instream flows will be used in processing applications for changes or transfers of existing water rights. However, the blocks of water reserved for domestic, municipal, and other beneficial uses (see above) shall not be subject to minimum instream flow conditions.

The Planning Unit recommends the rule be evaluated after Plan adoption, as the need is identified through the Plan review process outlined in Chapter 8; and that revisions to the rule be considered if needed. Increases to water supply reservations may be considered if compatible with aquatic habitat protection objectives. In addition, water reservation quantities may be shifted among water use categories to better address actual needs. However, the total reservation quantity in each subbasin shall be decreased. Consistent with Chapter 90.82.130 any process to revise the rule should use a form of negotiated rulemaking that uses the same processes that applied in WRIAs 27 and 28 for developing this Watershed Management Plan.

Rule review should consider a quantitative comparison between stream flows and population targets from the Salmon Recovery Plan developed by LCFRB.

The Planning Unit does not intend for Ecology to defer processing of water rights, pending rule adoption.

The Planning Unit discussed this policy extensively during the preparation of this Watershed Management Plan. Each of the items listed in the policy requires additional definition to ensure the Planning Unit's intent is met in final adoption of a state rule.

The provision for a "reservation" of water in a basin where issuance of water rights is restricted is particularly important. Communities and industries should explore a range of source options that do not affect surface waters. However, in cases where no reasonable and economical alternative is available, communities should still be able to meet their needs. The reservation offers a last resort after other possibilities have been exhausted.

A water right granted under a reservation shall have a priority date that is the same date as the rule was adopted.

If a water reservation is to be tapped, the water right applicant must further demonstrate responsible management of the resource, through off-setting actions, water conservation, or similar efforts. Actions should focus on those activities that can directly offset effects of pumping or diversions. For example, buying out and retiring upstream water rights can offset new withdrawals. As a second tier, mitigation may include other types of habitat restoration activities that do not directly offset flow impacts of expanded water supply. These actions should focus on restoration that optimizes habitat relative to instream flow.

These mitigation requirements do not apply to domestic well reservations.

It is important to clarify the relationship between reservations and domestic wells. Under current state law a person installing a domestic well to withdraw up to 5,000 gallons per day (including a well serving multiple residences) does not need to apply for a water right permit. The Watershed Management Plan makes no change to this exemption. However, through discussions with Ecology, the Planning Unit concluded that the ability of landowners to install domestic wells could be at risk under current law, in any area where a stream closure or minimum instream flow has been established. There are many such areas in WRIAs 27 and 28. The establishment of a water supply reservation for domestic wells in each subbasin is intended to protect the rights of landowners to install domestic wells, even in subbasins where stream closures and/or minimum instream flows have been established.

Table 4-4 provides a summary of the water right reservations developed for WRIAs 27 and 28, based on an analysis of water needs through 2020. The net stream flow depletion allowance depicted in the table reflects the mitigation element described above. As the need is identified through the plan review process outlined in Chapter 8, the water right restrictions and reservations should be evaluated to determine whether changes are needed to achieve the objectives of this Watershed Management Plan. For example, reservations may need to be increased as growth occurs beyond 2020 if such increases are compatible with objectives for aquatic habitat protection. If the rule adopted by Ecology is amended based on the rule and/or plan evaluation, the Planning Unit recommends the quantity of water reserved not be decreased.

Details regarding the development of the reservations are provided in Appendix H.

Table 4-4
Water Right Reservation Summary for WRIAs 27/28

Water User [1]	Net Stream Flow Depletion Allowance After Mitigation (cfs) [2]
***Kalama River Subbasin*[5]**	
Kalama	1.92
Small Systems and Domestic Wells	0.35
Subbasin Total	**2.26**
North Fork Lewis Subbasin	
Cowlitz County Portion	
Small Systems and Domestic Wells	0.26
Clark County Portion	
Small Systems and Domestic Wells	0.49
Skamania County Portion	
Domestic Wells	0.40
Small Systems	0.40
Commercial	0.21[6]
Subbasin Total	**1.76**
***East Fork Lewis Subbasin*[5]**	
Clark County Portion	
CPU, Battle Ground, and Ridgefield [4]	2.20
Small Systems and Domestic Wells	0.66
Skamania County Portion	
Small Systems and Domestic Wells	0.00
Subbasin Total	**2.85**
Salmon Creek Subbasin	
CPU, Battle Ground, and Ridgefield [4]	0.13
Small Systems and Domestic Wells	0.12
Subbasin Total	**0.24**
Burnt Bridge Creek Subbasin	
Vancouver	0.02
Small Systems and Domestic Wells	0.00
Subbasin Total	**0.02**
Lacamas Creek Subbasin	
Camas	0.50
CPU	0.30
Small Systems and Domestic Wells	0.36
Subbasin Total	**1.16**
***Washougal River Subbasin*[5]**	
Clark County Portion	
Washougal	0.00 [3]
Small Systems and Domestic Wells	0.36
Skamania County Portion	
Small Systems and Domestic Wells	0.74[7]
Subbasin Total	**1.10**
Columbia River Tributaries Subbasin	
Clark County Portion	
Small Systems and Domestic Wells	0.22
Skamania County Portion	
Small Systems and Domestic Wells	0.22
Subbasin Total	**0.44**

Notes:

[1] Categories of water users include:

Large Public Water Systems, which are listed individually.

Small Systems, which refers to Public Water Systems not listed individually and required to apply for a water rights permit.

Domestic Wells, including those serving multiple homes but exempt from the requirement to apply for a water right permit.

Other Beneficial Uses, such as self-supplied industrial uses.

[2] Calculated based upon an estimate of additional water rights needed to meet water demands through 2020. Incorporates the effects of offsetting and mitigation activities. The allowance applies only to mainstem flows; it is not intended to allow for extensive dewatering of smaller water bodies.

[3] Current water rights are sufficient to meet needs through year 2020. Therefore no reservation is established.

(4) Wells serving CPU, Battle Ground, and Ridgefield may draw partly from the East Fork Lewis River Subbasin and partly from the Salmon Creek Subbasin. Therefore, the stream flow depletion is split between these subbasins, based on information provided by CPU.

(5) In the lower reaches of this subbasin, there may be opportunity to increase reservation amounts, pending further study to refine understanding of flow impacts.

(6) Withdrawal impacts shall be limited to the mainstem North Fork Lewis River above Swift Reservoir only.

(7) During future plan review, the size of this reservation will be reconsidered in light of Skamania County's request for 1.15 cfs needed to accommodate approximately 3109 homes.

Some smaller streams and tributaries that drain directly to the Columbia River were not specifically analyzed in this watershed plan. These streams are not recommended for closure. Ecology will address these water bodies on a case-by-case basis in the future as applicants apply for new water rights. If, upon review, these streams are closed by administrative action, then it is recommended that a water right reservation should also be considered, to allow for domestic wells and potentially other uses. Such closures and recommendations would then be added to the formal rule at the next time the rule is updated.

While restricting issuance of new water rights serves to protect existing flows from further degradation, many of the other actions discussed below are techniques that can provide additional protection and can be used in some cases to enhance stream flows. Such increases in flow may be necessary to achieve healthy and harvestable levels of listed fish species. The actions in the land use category may also be used to reduce the frequency of high flow events and dampen their potentially devastating effects.

4.4.2 Water Conservation

By reducing the amount of water needed by water users, conservation can reduce diversions from surface waters, or pumping of ground water. In the case of surface water uses, this has a direct benefit for stream flows during the low flow periods. In the case of ground water uses, water conservation may improve low flows under certain conditions, but under other conditions may offer no benefits for stream flow. This is dependent on the degree of hydraulic continuity between the aquifer being pumped and the surface water of interest. Some aquifers have virtually no hydraulic continuity with surface streams that are flow limited, while others may have a high degree of continuity, as shown in studies performed by Pacific Ground water Group (PGG, 2003a).

Water conservation involves a range of activities, including both equipment and behavioral elements. Water conservation can be applied to municipal water users, industrial facilities that have their own water supplies, agricultural users, and potentially even individual household that have a single domestic well.

Because of the particular water sources that provide most of the water used in WRIAs 27 and 28, there are only limited opportunities to improve or protect stream flows with water conservation programs. Most water supplies for municipal and industrial purposes are drawn from ground water, and rely on aquifers that are not believed to be in continuity with local surface streams except in tidal reaches.

There are some exceptions, however, where surface water is used, or where municipal wells are located in close proximity to surface water bodies. In these cases, stream flow may be affected upstream of tidal reaches. These include the Cities of Battleground, Ridgefield, and Yacolt. Enhanced conservation efforts by these municipalities may provide some benefit to stream flows, due to the potential hydraulic connectivity between their wells and nearby streams. Even in these cases a greater benefit could be realized through source substitution, as discussed in the next section. For more information, see the subbasin-specific discussion in Section 4.7.

A significant component of growth in some areas within WRIAs 27 and 28 is expected to be rural in nature and will likely obtain water from domestic wells. Individual wells in rural areas typically have a negligible impact upon nearby streams, due to the small amount of water pumped compared to flows in nearby surface waters, and because much of the water pumped is returned via septic systems (PGG, 2003b). There are limited cases where relatively dense development relying on individual wells occurs in small tributary creek subbasins could have a larger effect on stream flows. All water users, including residents relying on exempt wells, are encouraged to use water efficiently. However, establishment of public programs to encourage water conservation by these residents would require development of new government programs and administrative delivery systems, since these water users are not served by any public water system. In those circumstances, the Planning Unit finds that source substitution would provide more substantial benefits than public programs to encourage water conservation. It should be noted, however, that source substitution is not a feasible or economical solution in rural areas without access to deep aquifers.

Water conservation in the agricultural sector was not studied in detail during the planning process. There may be opportunities for water conservation activity involving agricultural irrigation uses. However, there are no irrigation districts in WRIAs 27 and 28, where water use and management is conducted on a large scale. Furthermore, there is no sign of increases in this type of water use. Water conservation by farmers in a localized area may offer localized opportunities for stream flow protection or enhancement.

Based on this information, the Planning Unit adopts the following recommendation regarding conservation as a stream flow management technique in WRIAs 27 and 28:

Policy SFP-3:

Water conservation is part of a sound comprehensive water resources management program. In general, adherence to State requirements for municipal water conservation, as modified from time to time, will be sufficient for most communities within WRIAs 27 and 28.

Conservation activities that exceed state requirements should be carried out in selected communities where water use has the potential to cause significant impairment of stream flow conditions. Based on the Planning Unit's assessment of watershed conditions, these communities include Battle Ground, Ridgefield, Yacolt, and Camas (see Sections on East Fork Lewis River and Washougal River for further discussion of these communities). This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

> Water conservation actions by farmers practicing irrigated agriculture may be warranted in selected locations, where there would be significant benefits to stream flows. The Conservation District in each County should provide technical assistance to farmers to identify water conservation opportunities and funding sources.

4.4.3 Short-Term Operational Actions Responding to Drought Conditions

Short-term adjustments in water use or other activities can immediately improve flows during extreme conditions such as a severe drought. When the extreme conditions have passed, the action(s) can be discontinued.

An example of short-term actions that could be taken in response to extreme conditions is the short-term curtailment of water use by large water users that might have a direct impact on stream flows. This approach has been used in other areas in Washington State, such as in management of Tacoma's Green River supply related to its Second Supply Project. When flow levels drop to predetermined "trigger" levels, a water user may switch to an alternative supply, or curtail non-essential water uses in the community.

This approach is most effective in cases where a large water user relies directly on surface water supplies. This is because in this case, changes in water use have a direct and immediate effect on stream flow. However, there are few large water users that rely on surface water use in WRIAs 27 and 28. Because of this, investigation carried out during the course of the watershed planning effort (EES 2003b) identified only isolated opportunities for application of this technique to surface water users. It should be recognized that there may be smaller surface water users in several subbasins that could adopt this management strategy. These could offer some benefits, but would be more difficult to implement, compared with programs addressing a few, large water users.

The hydropower project operated by PacifiCorp on the North Fork of the Lewis River does have some ability to manage flows in response to drought conditions. The hydropower facility is a non-consumptive use of water. Releases from the Project's reservoirs are governed by the Project's FERC license conditions. For more information, see Sections 2.4.2 and 4.4.7.

The majority of water users in the WRIAs 27 and 28 subbasins obtain their water supply from ground water. While there are some major ground water users located in close proximity to some tributary streams, actions by these users having long-term impacts (e.g., conservation, source substitution, water right transfers to State trust) are viewed as more beneficial than short-term curtailment measures. Most larger ground water users rely on relatively deep wells. The effects upon stream flow of reducing or ceasing well pumping typically will be delayed by weeks or even months. Despite these limitations, there is at least one application of short-term responses for a major ground water user in the region (see Discussion of the Salmon Creek Management Plan in Section 4.8).

While this approach offers relatively few opportunities in WRIAs 27 and 28, it is still important as an element of the overall, comprehensive approach to managing stream flow. The Planning Unit adopts the following policy:

Policy Statement SFP-4:

Where major surface water diversions or ground water withdrawals have a direct effect on stream flows on a time scale of weeks or less, the water user should consider adopting voluntary procedures to alter operations in the event of a State-declared drought emergency affecting WRIAs 27 and/or 28. The water user should adopt policies and procedures in advance, to allow for quickly altering operations to minimize or eliminate the depletion of stream flow to the extent feasible in the event such a drought occurs. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

For hydropower operations such as the Lewis River project, it is assumed that FERC license conditions fully address releases under low flow conditions, including drought conditions.

Efforts should continue to identify small surface water users that could implement this type of management strategy to improve low flow conditions.

In general, the Planning Unit has identified only isolated water users that would be subject to this policy. A specific recommendation in this regard was developed for the City of Camas, and its surface water diversions on Boulder and Jones Creeks (see Section on Washougal River). Short-term responses to drought may also be applicable to the hydropower operation on the North Fork Lewis River. For more information on the hydropower facilities, see Sections 2.4.1 and 4.4.7.

4.4.4 Source Substitution

This technique involves substitution of water supplies from sources that have little or no impact on stream flows in critical areas, to replace water supply sources that have a high impact on flows in such streams. For example, in some cases a ground water source tapping a deep aquifer could be substituted for a surface water source or shallow ground water source that directly reduces flows in a stream. This potential opportunity has been identified by the Planning Unit, for the Cities of Battle Ground, Ridgefield, and Camas. See Sections on East Fork Lewis River and Washougal River for more information on these communities.

The Planning Unit commissioned a pilot review of data on domestic wells (exempt wells) in the Washougal River Basin. In this setting, where rural residences are relatively low-density, and where most houses have septic systems that return domestic water to the subsurface, well withdrawals have a relatively small effect on stream flow in the dry season. Based on this finding, management of exempt wells does not appear to be a high priority at the regional scale. However, there may be localized areas where due to density, availability of public sewer service, or other conditions, even domestic wells could cause problems for stream flow. The recommendation below also addresses this situation.

The Planning Unit adopts the following policy regarding source substitution as a stream flow management technique in WRIAs 27 and 28:

Policy SFP-5:

Communities using water sources (surface or ground water) that significantly reduce base flows in any stream that provides important fish habitat within WRIAs 27 and 28 should consider alternative sources of supply that eliminate or minimize these effects. It is anticipated that this would require examination of cost, potential rate impacts, reliability considerations, and evaluation of other feasibility criteria. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

In limited cases, this policy may apply to rural areas where residents rely on domestic wells (exempt wells). Clark and Cowlitz counties should assess this possibility through a water-balance analysis, in selected rural areas where extensive new development is expected to occur or where there is substantial existing development served by exempt wells. The intent is to explore solutions for small creeks where a large number of existing domestic wells may deplete stream flows. Under the right circumstances, if a different source could be used to replace individual wells, effects on stream flow could potentially be reduced or eliminated. Local community views should be included in this process.

4.4.5 Transfers of Water Rights to State Trust

Ecology has established a program under chapter 90.42 RCW in which water rights can be acquired from willing water rights holders and put into a trust water rights program. Trust water rights can either be held by the state or authorized for use by Ecology for instream flows, irrigation, municipal, or other beneficial uses. The trust water rights program is voluntary on the part of the existing water right holder. By reducing or eliminating selected diversions, the transfer of water rights to the trust program can increase stream flows.

This technique has limited applicability in the WRIAs 27 and 28 subbasins. As mentioned previously, the majority of surface water diversions (i.e., irrigation uses) are located in the lower portion of the subbasin where flow restoration, in general, is considered less beneficial to fish, as compared to flow protection and enhancement in the upper reaches of the subbasin. There may be local exceptions, however, where a transfer could offer a significant benefit. Such transfers may be made possible if funds were made available for the State to purchase the water rights. In addition, for the selected communities discussed above under the source-substitution technique, transfers of water rights to the State Trust could be performed for any water rights no longer needed. Therefore, the Planning Unit adopts the following policy:

> ***Policy SFP-6:***
>
> Ecology should use its existing State Trust program, and funding provided by the State Legislature, to identify and acquire water rights from water users willing to sell or donate their water rights in WRIAs 27 and 28, where transfers to the State Trust would provide a significant benefit to fish habitat.

Priorities for applying this policy to the various subbasins within WRIAs 27 and 28 are discussed in Section 4.6.

4.4.6 Enforcement Against Unauthorized Water Uses

Aside from the legal, appropriated use of surface and ground waters, there is a potential for illegal diversions of surface water and withdrawals of ground water to occur. Where unauthorized uses are occurring involving either surface waters and/or ground waters in continuity with surface streams, enforcement actions against unauthorized uses can potentially help to improve low flows. Ecology is the agency responsible for enforcement actions.

The quantity of unauthorized water used within the WRIAs 27 and 28 watersheds is not known. However, in the more populated areas, some unauthorized uses are expected to occur. Therefore, the Planning Unit adopts the following policy regarding enforcement against unauthorized water use as a stream flow management technique in WRIAs 27 and 28:

> ***Policy SFP-7:***
>
> Ecology should conduct or support initial surveys in selected subbasins to determine whether unauthorized water uses are occurring on streams deemed critical to salmon recovery within WRIAs 27 and 28. If these surveys identify extensive unauthorized uses, they should be expanded to additional subbasins and carried out on a regular, periodic basis (e.g. once every five years). Where unauthorized uses are identified, Ecology should take enforcement actions to eliminate these uses. An alternative or additional approach would be the establishment of a watermaster that has regulatory authority to regulate illegal water diversions. Further development of this concept is recommended during the implementation phase.

Priorities for applying this policy to the various subbasins within WRIAs 27 and 28 are discussed in Section 4.6.

4.4.7 Hydropower Operations

PacifiCorp owns three hydroelectric facilities on the Lewis River – Merwin, Yale, and Swift No. 1, and Cowlitz PUD owns the Swift No. 2 Hydroelectric project. All four hydro projects operate under licenses from the Federal Energy Regulatory Commission (FERC). The licensing process is extensive and includes assessment of stream flow and other environmental effects. The Planning Unit chose not to analyze these effects, to avoid redundancy with the recent re-licensing process.

Policy SFP-8:

The Planning Unit relies on the FERC licensing process to provide protections for flow and other habitat factors associated with hydroelectric facilities on the Lewis River.

4.5 Land Use Management Actions to Protect Stream Flow

4.5.1 Forest Practices

As discussed in Section 2.2, over 85 percent of the lands within WRIAs 27 and 28 are forested. These forested areas are typically found in the middle and upper reaches of the various subbasins. A majority of this forested land is owned and managed by the U.S. Forest Service (USFS) and Washington State Department of Natural Resources (DNR). Private companies also own and manage significant acreages in some areas.

Given the extent of forested lands, forest practices have substantial potential to affect the magnitude and timing of flows. The Planning Unit commissioned a hydrologic modeling study by PWR (2003) to evaluate the effects of land use and land cover on stream flows. Results from this study indicated that as clear-cut areas are replanted and where existing younger stands mature, the predominant effect is anticipated to be a reduction in peak flows and a reduction in low flows. Peak flows decrease due to delay of runoff as forest cover increases. Low flows decrease because of the net increase in evapotranspiration, which removes water from the watershed.

In areas where existing timber is harvested, effects will be the opposite, i.e. an increase in low flows and significant increase in peak flows.

Based on changes in the timber economy in recent years, harvest rates for southwest Washington over the next 50 years are expected to be lower, compared with rates of the past 50 years. At the same time, regeneration of formerly harvested forests is likely to continue. Moreover, the Forests and Fish Rules adopted by Washington State and incorporated in the Forest Practices Act will have a substantial impact on forest management practices. On federal lands, the Northwest Forest Plan has also altered trends on forest management practices. In general, the WRIAs 27 and 28 Planning Unit anticipates these changes will result in increased forest cover at the regional scale. Based on the results from the hydrologic modeling study, this can be expected to reduce both peak flows and low flows. Despite the expected reduction in low flows, these changes in forest practices are expected to improve habitat factors on the whole and improve prospects for recovery of salmon in the region. For example, they are expected to improve conditions with regard to stream temperature, large woody debris, and sediment loads.

The Forests and Fish Rules, DNR's Habitat Conservation Plan, and the Northwest Forest Plan address forest roads. In general, changes in road management practices on federal, state and private forest lands are expected to delay runoff in comparison with historic practices. This should generally reduce peak flows and attendant problems from sedimentation.

The Watershed Planning Unit has limited ability to influence forest practices. Local regulations are not allowed to conflict with the Forest Practices Act, which regulates private and State forest lands[3]. This limitation also includes watershed plans as described in RCW 90.82.120(3). Local jurisdictions do not have the authority to regulate federal lands such as national forests. Recognizing the jurisdiction over forest management rests with USFS, DNR and private landowners, the Planning Unit adopts the following policy relating to forest practices as a tool for stream flow management.

Policy SFP-9:

The USFS, State DNR and private landowners should consider effects of forest management practices on stream flow and other fish habitat factors, in making forest management decisions. The Planning Unit anticipates that existing programs under the State's Forests and Fish regulations, DNR's Habitat Conservation Plan, and the federal government's Northwest Forest Plan will provide the regulatory framework needed in this regard. The State and federal governments should monitor the effectiveness of these programs and periodically provide public documentation of their effectiveness in protecting fish habitat, including flow conditions, in WRIAs 27 and 28.

In addition, expected effects of changes in the watersheds' forested areas should be considered as part of the overall context for the target flows discussed in this Watershed Management Plan (see Section 4.3).

4.5.2 Development Practices and Stormwater Management

Land use and development practices, particularly those related to impervious surfaces and stormwater management, also impact stream flows. Conversion of lands from rural uses to suburban or urban uses typically alters watershed hydrology substantially. Based on the hydrologic study by PWR (2003) for the WRIAs 27 and 28 subbasins, small increases in effective impervious area (net including mitigation) can result in small but significant increases in peak flows and reductions in low flows. In general, when land uses pass a threshold of ten percent effective impervious surfaces, stream flow degradation can be expected to begin (PWR 2003). These effects have already occurred in the most urbanized portions of the region, such as the urban areas of the Burnt Bridge Creek and Salmon Creek Subbasins. In other areas where rural lands are expected to be converted to urban uses in the future, changes in hydrology can also be expected.

Over the very long term (e.g. 50 years), there may be extensive changes in land use as the region continues to grow and development spreads. This will have corresponding effects on stream flow, unless significant resources are devoted to mitigation practices. Most of the region's future development is likely to occur within the downstream portions of selected Subbasins, in areas where there is existing development and in proximity to major transportation corridors such as I-5. In areas near the Cities of Camas, Washougal, Vancouver, Battle Ground, Ridgefield, and Yacolt this has the potential to affect stream flow, as rural lands are converted to urban and suburban lands with more impervious surfaces. This would alter runoff characteristics in the areas affected.

[3] The Forest and Fish Rules are incorporated in the Forest Practices Act.

Because most new development in the region is expected to occur at the downstream end of the various subbasins, many stream reaches will not be affected in the middle and upper portions of these subbasins. The largest impacts can be expected in smaller creek drainages facing increased development. In addition, modifications to stream channels and adjacent floodplains often accompany development. Changes in stream hydrology due to development are also accompanied by degradation of water quality, in many cases. This will require continued attention as water quality cleanup plans (TMDLs) are put in place by Ecology (see Section 5).

City and County policies can mitigate effects of development by controlling development densities, specifying amounts of impervious surface area, establishing stream buffers, protecting floodplains and wetlands, and addressing storm water management. Ecology's recently updated Stormwater Management Manual for Western Washington (Manual) provides guidance to local jurisdictions regarding implementation of best management practices (BMPs) regarding stormwater management. City and county ordinances, rules, and permits are used to translate Ecology's guidance into requirements that have authority.

In the WRIAs 27 and 28 watersheds, Clark County is the only entity that will be subject to the Stormwater Manual requirements, as the county is subject to the provisions of a National Pollutant Discharge Elimination System (NPDES) Phase I permit. Neither Cowlitz County, Skamania County, nor any of the cities in either of the WRIAs are subject to the Phase I permit. However, Cowlitz County and the cities of Vancouver, Camas, Washougal, and Battle Ground are included in the tentative listing of Phase II communities that will be subject to the Stormwater Manual requirements in the near future.

Based on this information, the Planning Unit adopts the following policy regarding the use of stormwater management as a stream flow management technique in the WRIAs 27 and 28 watersheds:

Policy SFP-10:

Clark County, Cowlitz County, and the Cities of Vancouver, Camas, Washougal, and Battle Ground should continue to carry out their legally mandated responsibilities with regard to stormwater management. The remaining cities in all three counties should review their stormwater management ordinances to determine whether they are adequately protective of fish habitat in local streams that may be affected by future development. Skamania County should voluntarily consider developing such an ordinance. Where enhanced stormwater management needs are identified, revisions to local ordinances should be considered in light of the guidance and BMPs provided in Ecology's Manual. The focus should be on upgrading development practices and mitigation requirements in areas where stream flow and fish habitat may be compromised as development occurs. Costs, expected magnitude of benefits, and feasibility considerations should be included in this review.

Another development practice that potentially impacts stream flows is the use of exempt wells in rural areas. Of particular concern are dense clusters of individual shallow wells that are in close proximity to tributary or headwater streams. In this setting, well pumping may negatively impact flows due to hydraulic continuity. This effect is mitigated somewhat where household water use is returned to the shallow aquifer through a septic system.

Rural development relying upon deep exempt wells for water supply and septic systems for wastewater disposal may actually have the effect of increasing stream flows locally[4]. This can occur where water is withdrawn from a deeper aquifer that is not connected to the local stream, but water is returned to the shallow aquifer through a septic system. This effect would change if sewer service were provided to an area, thereby eliminating the septic return flows.

To address these issues, the Planning Unit adopts the following policy:

Policy SFP-11:

When modifying or adopting comprehensive plans, zoning designations, or other land use regulations, jurisdictions should consider the water balance implications of allowing extension of sewer service to developing areas. The Planning Unit recognizes that provision of sewer service can provide substantial water quality benefits. However, where sewer service is extended to replace septic systems, and residents continue to rely on water wells, stream flows may be reduced. This effect should be anticipated and mitigated where applicable. This is particularly important in areas with relatively dense development near small streams.

4.5.3 Floodplain Management

Floodplains provide storage for flood waters, thereby reducing peak flows and attendant damage during flood events. Water stored in a floodplain from a peak flow event drains back to the stream over a period of days or weeks. In addition to their hydrologic functions, floodplains offer important habitat functions. Benefits of floodplains practices for habitat purposes are discussed further in Section 7.

Since peak flow events in WRIAs 27 and 28 occur primarily in the winter and spring months, water stored in floodplains is usually not available in late summer and early fall to contribute to base flows. Therefore, the primary hydrologic benefits from floodplain management are expected to involve peak flows rather than low flows. In some floodplain areas, off-channel storage (in the form of wetlands, oxbows, and wall-based channels) is hydrologically connected to the river and likely provides some contribution to base flows.

The Planning Unit reviewed opportunities for using floodplain management actions as a tool for managing stream flow. Floodplain activities that can be regulated under local floodplain ordinances include controlling alteration of natural flood plains, controlling

[4] Source: *Effect of Exempt Wells on Baseflow – Washougal River Watershed* (Pacific Ground water Group, 2003a).

filling and grading within flood plains, controlling construction of flood barriers such as dikes, and restricting land uses that might increase erosion.

In addition to protecting existing floodplains, there may be opportunities to restore floodplain functions where floodplains have been altered or disconnected from the river channel. For example, existing dikes can be breached or removed to reconnect floodplains to the river channel. It should be recognized, however, that dikes were constructed to meet specific needs, and existing structures or land uses may depend on the presence of existing dikes for protection from floods. Plans to restore floodplains by modifying or removing dikes must address the effects on land use and the built environment.

The majority of floodplain areas within WRIAs 27 and 28 are located in the middle or lower reaches of the various subbasins. Therefore, hydrologic benefits of floodplain management actions would occur primarily in these areas.

The Planning Unit adopts the following policy regarding floodplain management as a stream flow management technique in the WRIAs 27 and 28 watershed:

Policy SFP-12:

Within authorities, local jurisdictions and state agencies with land-management responsibilities should protect existing floodplains from modifications that would impair their hydrologic functions and habitat value.

Within authorities, local jurisdictions and state agencies with land-management responsibilities should identify floodplain restoration projects, subject to local input, cost-benefit analysis, and availability of funding. Where these factors are favorable, and where substantial benefits to flow or other habitat factors are identified, these projects should be pursued for implementation.

Priorities for identifying and carrying out projects in the various subbasins within WRIAs 27 and 28 are discussed in Section 4.6.

More specific information is presented in the subbasin-specific sections that follow (see Section 4.7). Quantifying the possible flow benefits of modifications would require detailed analysis that has not been carried out at this time.

4.5.4 Wetlands Management

There are a variety of different wetland types in WRIAs 27 and 28, and different wetlands offer different benefits in terms of hydrology and habitat. The hydrologic functions of most wetlands in the subbasins have not been studied in detail.

In very simple terms, those wetlands that are associated with streams and floodplains can help to moderate peak flows. However, the amount of attenuation provided by restoration of a wetland is not always significant relative to the flow rates that occur. There could also be some limited benefit to low flow periods, since water from high flow events is stored and then released over a period of several weeks. Wetlands associated with streams and floodplains occur throughout the many subbasins in WRIAs 27 and 28. However, the most hydrologically significant wetlands are located along the main stem rivers, and especially in low-lying terrain near the mouths of these rivers.

Wetlands that occur in upland areas separate from streams and floodplains are less likely to offer stream flow benefits. In general, these wetlands form because they are on soils that do not infiltrate water readily. Because of this, the Planning Unit has not studied these upland wetlands in detail.

As with floodplain preservation and restoration, there are benefits to restoring and preserving wetlands for benefit of fish habitat in general, apart from their effects on flow rates.

County policies offer the best tools for wetland management in WRIAs 27 and 28. Wetland ordinances can be modified to include hydrologic functions in the protection hierarchy. Prohibitions on development can be enacted for wetlands with strong hydrologic functions. Where development will reduce or eliminate wetlands, mitigation ratios can be increased. Clark County's wetland ordinance generally provides greater wetland protection than ordinances in Cowlitz or Skamania Counties (EES 2003b). Clark County has also obtained grant funding to perform a county-wide wetland inventory.

The Planning Unit adopts the following policy regarding wetlands management as a steam flow management technique in WRIAs 27 and 28:

Policy SFP-13:

In conjunction with the Planning Unit, Counties should explore funding opportunities for conducting a county-wide wetland assessment that includes evaluation of hydrological functions. Counties should also require evaluation of hydrological function as part of any site-specific wetland assessments conducted under their critical areas, wetland or other land use ordinances. Their wetland ordinances should be modified as needed to include hydrologic functions in the wetland protection hierarchy.

Counties should review and consider strengthening mitigation ratios, for selected wetland areas that offer significant hydrologic functions or other fish habitat benefits.

4.5.5 Other Activities Affecting Shallow Aquifer Interactions

Other activities can also disrupt shallow aquifer recharge, subsurface flow patterns, and discharge that support the stream flow regime. These activities were not evaluated in detail during the planning process, and require additional evaluation.

Recommendation:

Evaluate the need to take additional actions to prevent disruption of shallow aquifer recharge, subsurface flow patterns, and aquifer discharge that support the stream flow regime in low flow periods.

4.6 Prioritization of Subbasins for Stream Flow Management Actions

In order to provide a strong implementation framework for the stream flow management program, it is important to lay out some priorities for applying the policies discussed in Sections 4.4 and 4.5. For the general policies that apply throughout the region, the Planning Unit has prioritized the various subbasins. Each policy discussed in Sections 4.4 and 4.5 should be targeted for action first in the highest priority subbasins; then in the medium priority subbasins, and finally in the lower priority subbasins.

Criteria for prioritizing subbasins include:

- Degree to which flow is impaired now, with potential harm to aquatic habitat;
- Priority of streams in LCFRB Recovery Plan;
- Expected future changes in land use or water withdrawals, that will cause impairment of flow;
- Extent of existing urbanization, and associated feasibility of protecting or enhancing flow (e.g. consider highly urbanized Burnt Bridge Creek less feasible)

Based on these criteria, the following priorities are recommended for implementation of stream flow management actions.

4.6.1 Highest Priority

- East Fork Lewis River (value for habitat; development in lower basin; relatively low flows in summer need protection)
- Washougal River (value for habitat; development in lower basin; relatively low flows in summer need protection)
- Lower end of Lacamas Creek (existing impairment and development pressure; importance as Chum habitat)
- North Fork Lewis (focus on Cedar Creek and other tributaries with habitat value and development activity)
- Hamilton Creek and Greenleaf Creek (value for habitat and low summer flows – both streams go dry in summer months)

4.6.2 Medium Priority

- Kalama River (little development pressure; forested areas covered by Washington State Forests and Fish Rules (F&F)); should be monitored for changes in these conditions that could change this ranking)
- Salmon Creek (not a high priority for salmon recovery; but has been a focus under CPU's Salmon Creek management plan.
- Gee Creek (in East Fork Lewis River Subbasin but not discussed in detail in existing material)

- Whipple Creek (classified in Salmon Cr. Subbasin, but not part of CPU's Salmon Creek management plan)

4.6.3 Lower Priority

- Burnt Bridge Creek (difficulty of restoration; emphasize stormwater management)

- Columbia Tributaries (smaller streams, less development pressure. However, should be monitored for changes in land use that could change this ranking.)

4.7 Stream Flow Conditions and Recommendations by Subbasin

This section applies the concepts and policies presented in previous sections to each of the eight subbasins defined for the watershed planning process. These subbasins are the Kalama River, North Fork Lewis River, East Fork Lewis River, Salmon Creek, Burnt Bridge Creek, Lacamas Creek, Washougal River, and Columbia River Tributaries Subbasins.

4.7.1 Kalama River

Subbasin Characteristics Relevant to Stream Flow

The Kalama River Subbasin has a drainage area of approximately 224 square miles and enters the Columbia River. The population center within the subbasin consists of the community of Kalama. As such, the major municipal and industrial water uses are located at the downstream end of the Kalama River, in the City of Kalama and Port of Kalama. Most of the subbasin's future development and water demands are likely to occur in this area as well. The City of Kalama has submitted an application for increased withdrawals from its Ranney well on the Kalama River. The Ranney well is located a short distance upstream of the zone of tidal influence.

Approximately 96% of the watershed is in commercial forestry and owned by private companies. Much of the watershed was logged resulting in construction of a road network, removal of large woody debris, and impacts to riparian zones. Furthermore, most of the historic floodplain has been diked and disconnected from the river to protect highway and industrial developments. Although the Kalama River historically had minimal floodplains, construction of Interstate 5 cut off the lower floodplains and the Port of Kalama completed the channelization of the river. While there may be some opportunities to reconnect the river channel to its floodplain, modification of major infrastructure features may not be feasible or economical.

The gradient of the Kalama River along the lower 8 miles is flat to moderate and the tidal influence extends up to about river mile 2.8. At river mile 10 the lower Kalama Falls blocks most anadromous fish, while at river mile 35 an impassable falls blocks all fish migration. In fact, many of the tributaries to the Kalama have steep gradients and only their lower portions are accessible to anadromous fish (Wade, 2000).

Appendix G contains a description and map of existing surface water source limitations (SWSLs). There is one administrative low flow currently in place in this subbasin, restricting issuance of new water rights.

An initial analysis has been made regarding comparison of the existing administrative low flow with the priority reaches identified as part of LCFRB's salmon recovery planning effort. The entire Kalama River mainstem upstream of the tidal reach affected by Columbia River flows has been identified as Tier 1 or Tier 2 priority reaches.

An IFIM study was conducted by the Department of Ecology and WDFW in 1999.

Based on the Conservation Commission's Limiting Factor Analysis (LFA), the Kalama River Subbasin has high road densities that have caused increased stream channel networking leading to potential peak flow concerns. Besides potential low flow problems in the mainstem, the LFA has indicated that many tributaries may have low flow concerns because of sediment accumulation near the mouths of the tributaries. These tributaries include Langdon Creek, North Fork Kalama, and Jacks and Wolf Creeks (Wade, 2000).

Stream Flow Management Recommendations for the Kalama River Subbasin

Policy SFP-2 (see Section 4.4.1) should be applied to strengthen restrictions on issuance of new water rights in the subbasin. As part of this policy, a reservation of water should be established for municipal and industrial uses in and around the City of Kalama. For details of the application of this policy to the Kalama River Subbasin, see Appendix H.

The City of Kalama is subject to state requirements regarding water conservation. The Port of Kalama may also be subject to these requirements. Water conservation by the City and Port beyond State requirements would not be likely to provide significant benefits for stream flows. Even with projected growth, these users have relatively small water needs, in comparison with flows on the Kalama River. In addition, the location of water intakes near the lower end of the subbasin limits the extent of impacts on the river in terms of river miles. (EES 2003b).

Conservation for the City of Kalama, however, could potentially be appropriate as one element of a mitigation package associated with new water rights as discussed in Appendix H.

The stream flow management policies presented in Section 4.4 and 4.5 should be applied to the Kalama River Subbasin. Based on the features and characteristics of the Kalama River subbasin, as described above, no additional, subbasin-specific stream flow management recommendations are identified for this subbasin at this time.

This discussion is directed only at protecting or enhancing stream flows. Other sections of this plan address water supply and habitat issues.

4.7.2 North Fork Lewis River

Subbasin Characteristics Relevant to Stream Flow

The North Fork Lewis River (North Fork) Subbasin has a drainage area of approximately 848 square miles and enters the Columbia River near the City of Woodland. The North Fork Subbasin is comprised of the Upper Lewis, Middle Lewis, and Lewis watersheds, as shown on Exhibit 2-2.

Unlike other areas in WRIAs 27 and 28, the North Fork Lewis River has dams and reservoirs that control flows. Merwin Dam blocks fish passage to 80% of the historic anadramous habitat (Wade, 2000). The dams are operated by PacifiCorp as the Lewis River Hydroelectric Project, and the operation of the project is regulated by a Federal Energy Regulatory Commission (FERC) license. Operational practices are described in Section 2.4.1 of this Watershed Management Plan. Flows on the North Fork are largely determined by these operational practices.

Population densities are generally low within the subbasin with the population center consisting of the community of Woodland. Thus, the major municipal and industrial water uses are also located at the downstream end of the Lewis River. Most of the subbasin's future development and water demands are likely to occur in this area as well. Scattered residential developments occur in the middle portions of the subbasin, while large portions of the subbasin are managed as commercial forest and are undeveloped except for logging roads. There is minimal water use in the headwater areas upstream of the PacifiCorp hydroelectric project.

The City of Woodland's withdrawals do not appear to significantly impact flows in the Lewis River. Even with projected growth, withdrawals are relatively small, in comparison with flows on the North Fork Lewis River. In addition, the location of the City's water intake near the lower end of the subbasin limits the extent of impacts on the river in terms of river miles. The reach of the Lewis River where the Ranney Well is located is in the zone of tidal influence. The City has submitted an application for additional withdrawals from its Ranney well on the Lewis River (see Section 3.4.6).

Appendix G contains a description and map of existing surface water source limitations (SWSLs). There five administrative low flows or closures currently in place in this subbasin, restricting issuance of new water rights.

The lower North Fork flows through a wide flat valley which is mostly under cultivation and protected from flooding by dikes. The lower 7 miles are almost completely diked, while river miles 7 to 15 have been rip-rapped to protect residential and road development. The lower 11 miles are also tidally influenced.

Above river mile 15 the river is confined within a canyon. Above the dams floodplains that may have existed along the middle and upper reaches of the mainstem or the lower reaches of the tributaries have been inundated, in part, by reservoirs. The LFA indicated that riparian conditions are poor in most areas in the subbasin; however, South Fork Chelatchie Creek has numerous natural open areas of wetlands and prairies.

The reach of the Lewis River and several tributaries upstream of the three reservoirs have been identified as Tier 1 or Tier 2 priority reaches in LCFRB's recovery plan. Creeks in the North Fork Lewis River subbasin also provide important fish habitat. For example, Cedar Creek is an important tributary in this regard.

The U.S. Forest Service conducted a peak flow analysis for various subbasins in the Upper Lewis River basin and found that Pine Creek has a high potential for increased peak flows. The toe-width instream flow study conducted by Caldwell (1999) indicated that spot flow measurements in Cougar Creek were near optimal in the fall of 1998. However, other studies do indicate some flow limiting conditions in several other creeks in the subbasin including Cedar, Ole, Rain, Dog, and Panamaker Creeks (Wade, 2000).

Stream Flow Management Recommendations for North Fork Lewis River

The primary human-controlled factor affecting stream flows in this subbasin is the hydroelectric project. The Planning Unit notes that operation of the hydroelectric project is subject to the conditions of PacifiCorp's FERC license. The licensing process is extensive and includes assessment of environmental effects of the project's operation. Therefore, the Planning Unit has not undertaken a separate review of flow management considerations for the hydroelectric project. Instead, in accordance with Policy SFP-8 the Planning Unit relies on the FERC licensing process to provide protections for flow and other habitat factors.

Policy SFP-2 (see Section 4.4.1) should be applied to strengthen restrictions on issuance of new water rights in the subbasin. As part of this policy, it will be important to determine whether the City of Woodland falls inside or outside of the area closed to new applications for surface water rights. This will depend on the exact location of the zone of tidal influence defined for this subbasin. If Woodland's water intake is determined to be in the closed area of the subbasin, a reservation of water will need to be established in accordance with Policy SFP-2.

The City of Woodland is subject to state requirements regarding water conservation. Water conservation by the City beyond State requirements would not be likely to provide significant benefits for stream flows, compared with the magnitude of stream flows and tidal fluctuations on the North Fork Lewis River (EES 2003b). There may be further opportunities for water conservation efforts along populated tributaries with important habitat, such as Cedar Creek.

The stream flow management policies presented in Section 4.4 and 4.5 apply to the North Fork Lewis River Subbasin. Based on the features and characteristics of the North Fork Lewis River subbasin, as described above, no additional, subbasin-specific stream flow management recommendations are identified for this subbasin. However, populated tributaries such as Cedar Creek should be flagged for particular attention in applying the stream flow management policies.

This discussion is directed only at protecting or enhancing stream flows. Other sections of this plan address water supply and habitat issues.

4.7.3 East Fork Lewis River

The East Fork Lewis River subbasin is one of two pilot subbasins that were selected for detailed study as part of the Watershed Planning process to explore the applicability of various stream flow management approaches. This section summarizes results of that study. For more detailed information, see the full Technical Memorandum on stream flow management strategies (EES, 2003b).

Subbasin Characteristics Relevant to Stream Flow

The East Fork Lewis River (East Fork) Subbasin has a drainage area of approximately 236 square miles and enters the Lewis River Subbasin, just west of Interstate Highway 5 approximately three miles south of the City of Woodland. For purposes of this Plan the East Fork Subbasin is considered to include the drainage to the Lewis River from the south side of the Lewis River downstream of Interstate 5, including the Gee Creek watershed.

Population centers within the subbasin include the communities of Ridgefield, LaCenter, and Yacolt, as well as the northern edge of Battle Ground. Forestry and farming are the primary land use even in the lower portions of the subbasin, while most of the upper portions of the subbasin are large private and public forest lands. Most of the subbasin's future development is likely to occur within the lower portion of the subbasin, in areas where there is existing development and in proximity to the I-5 transportation corridor.

Large portions of the upper subbasin repeatedly burned in the first half of the 20th century. These events have caused significant impacts on hydrology, and riparian and instream habitats (Wade, 2000).

The headwaters of the East Fork generally flow through steep terrain and narrow valleys. Tributaries in this area are also steep. Lucia Falls at river mile 21 blocks migration of all anadromous species except for steelhead and some coho. Downstream from river mile 17 and especially below river mile 11, the valley floor widens into a well-defined floodplain. The lowest six miles of the river has minimal slope and is tidally influenced.

Wetlands and open water also cover large portions of this floodplain area. However, the Limiting Factors Analysis (LFA) states that over 50% of the off-channel habitat and wetlands in the floodplain areas have been disconnected from the river as a result of diking, ditching, and draining to protect agricultural, residential and mining activities (Wade, 2000). Field survey work conducted by Pacific Water Resources confirms these findings (PWR, 2003). Floodplain maps from the detailed flood study for the lower part of the East Fork Lewis River show significant areas of floodplains.

Portions of the East Fork floodplain have been disturbed by gravel mining operations. There are many small ponds and diked areas that were created by these operations. Removal of these dikes to restore the floodplain to a more natural condition in the reach between Lewisville Park and about River mile 6 could provide habitat benefits.

Other floodplain areas that have been impacted as referenced in the LFA include locations at La Center Bottoms (RM 3.3 to 4.5), along the lower end of Lockwood Creek, dikes along the Ridgefield Pits, dikes along the Dean Creek near RM 7.2, and other areas up to approximately river mile 12.

Riparian conditions have been heavily impacted by grazing, farming and development along the lower river (Wade, 2000). Bank stability is a concern along certain reaches in the lower 14 miles of the East Fork Lewis River.

Road density is considered high in the subbasin according to the LFA and a study by the U.S. Forest Service found that increases in peak flows is a concern in the upper East Fork (Wade, 2000). The LFA also identified low flows as an issue in the mainstem as well as several tributaries based on instream flow studies conducted in the subbasin (see following section).

Review of stream gauging data for the Heisson Gauge conducted during the watershed planning process did not indicate any trends of either decreasing or increasing flows for the time period 1930 to 2000 (Barber 2002).

Ecology conducted an instream flow study on the East Fork using the Instream Flow Incremental Methodology (IFIM), with the field work being performed during the summer and fall of 1998. An Open File Technical Report titled *East Fork Lewis River Fish Habitat Analysis Using the Instream Flow Incremental Methodology and the Toe-Width Method for WRIA 27* was published by Ecology in June 1999 as Publication # 99-151.

The IFIM study on the East Fork was done for one site located in the vicinity of Daybreak County Park, near RM 10.8, with eight transects used within 500 feet upstream of this location. Stream flow measurements were made in May (high flow), July (medium flow), and September (low flow), 1998, with measured flows of 282, 97, and 34 cfs, respectively. The report did not make specific recommendations for instream flow management. Optimum flow levels identified in the IFIM study are documented in the report cited above, as well as the Technical Memorandum prepared on stream flow management for this Watershed Planning process (EES 2003b).

Stream Flow Management Recommendations for East Fork Lewis River

A set of general policies applicable to stream flow management throughout WRIAs 27 and 28 is presented in Sections 4.4 and 4.5. Table 4-5 identifies additional recommendations specific to the East Fork Lewis River Subbasin.

These recommendations are focused on protecting or enhancing stream flows alone. Other recommendations included in this plan address water supply and habitat issues.

Table 4-5
Stream Flow Management Recommendations
East Fork Lewis River Subbasin

Management Technique	Relevant Basin Characteristics	Recommendation
Restrictions on Issuance of New Water Rights	Water rights issuance is already restricted in the subbasin. There are nine existing administrative closures and low flows in the subbasin (see Appendix G).	Apply Policy SFP-2. This will modify the existing set of restrictions on issuance of new water rights in the subbasin. For more information, see Appendix H.
Water Conservation	City of Battle Ground – The City's wells are located just outside of the East Fork Lewis River subbasin boundary. An analysis by Pacific Ground water Group (PGG, 2003) indicated that three of the City's wells likely capture flow from both Salmon Creek and the East Fork Lewis River. City of Ridgefield – The City's wells are in close proximity to Gee Creek, which is located within the subbasin, though it is not a tributary to the East Fork Lewis River. City of Yacolt – The City's wells are in close proximity to Yacolt Creek, a tributary to the East Fork Lewis River.	The Cities of Battle Ground, Ridgefield, and Yacolt should enhance their existing water conservation programs to protect stream flows. This may be unnecessary, however, if source substitution is pursued instead (see below). This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Curtailment	Majority of water users in the East Fork Subbasin obtain their water supply from ground water Surface water use is minimal, with most occurring near the confluence of the East Fork with the Mainstem Lewis River.	Apply Policy SFP-4 regarding drought response.
Source Substitution	Water is already being imported from outside the subbasin by CPU to meet a portion of the existing and future needs of customers connected to its main water supply system. CPU has existing emergency interties with the Cities of Battle Ground and Ridgefield.	The Cities of Battle Ground and Ridgefield should consider wholesale purchases of water from CPU to eliminate water-supply impacts on stream flow. This is preferred over water conservation, because of greater benefits to flow. It is anticipated that this would require examination of cost, potential rate impacts, reliability considerations, and other feasibility criteria. (Note: This recommendation is also stated in Section 3.4.) This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

Table 4-5 (cont)
Stream Flow Management Recommendations
East Fork Lewis River Subbasin

Management Technique	Relevant Basin Characteristics	Recommendation
Transfer of Water Rights to State Trust	Battle Ground, Ridgefield, Yacolt have significant ground water withdrawals located in close proximity to tributary streams and to the East Fork	If source substitution is pursued as recommended above, and if water rights are no longer needed for primary or backup supply, Battle Ground, Ridgefield and Yacolt should consider transferring water rights to the State Trust. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Enforcement Action Against Unauthorized Uses	There is little information available on unauthorized uses.	Apply Policy SFP-7.
Forest Practices	Nearly 80 percent of the East Fork Subbasin is forested Two percent of forest lands are not managed for harvest (e.g., parks) Forty-three percent of forest lands are federally owned and managed, 36 percent are state owned, and 19 percent are privately owned.	Apply Policy SFP-9.
Development Practices and Stormwater Management	Most of the subbasin's future development is likely to occur within the lower portion of the subbasin, in areas where there is existing development and in proximity to transportation corridors such as I-5.	Apply Policies SFP-10 and SPF-11.
Floodplain Management	It may be possible to remove more of the dike located in the wetland area at the confluence with Brezee Creek. Previous restoration work hydraulically reconnected the river to the wetland via small culverts. It may be possible to remove dikes present in the reach between Lewisville Park and approximately River Mile (RM) 6. These dikes, as well as small ponds, were created related to gravel mining activities. Other impacted floodplain areas include locations at La Center Bottoms (RM 3.3 to 4.5), along the lower end of Lockwood Creek, dikes along the Ridgefield Pits, dikes along the Dean Creek near RM 7.2, and other areas up to approximately river mile 12.	Apply Policy SFP-12. Consider restoration opportunities noted at left, or others identified in the future, subject to local input, cost-benefit analysis, and availability of funding. If these factors are favorable, pursue implementation.
Wetlands Management	Most wetlands are located near the mouth of the East Fork and along the main stem East Fork downstream of river mile 12. Wetland areas are associated with some of the floodplain areas listed above.	Apply Policy SFP-13. Also consider restoration opportunities for wetlands associated with floodplain projects discussed above.

Proposed Target Flows and Management Points for East Fork Lewis River Subbasin

The concept of target flows was described in Section 4.3. As used in this plan, target flows represent a realistic flow regime that can be achieved in most years by following selected management techniques over a long period of time. A flow regime consists of a range of flows that vary seasonally based on precipitation and runoff.

Two management points are recommended for application of target flows in the East Fork Lewis River. One management point is the location of the existing USGS stream gage near Heisson, at approximately River Mile 20. This location was chosen because of the available data from this stream gage, which has been in continuous operation since 1930. It is recommended an additional management point be developed for the main stem of the East Fork in the vicinity of the Daybreak Bridge, at approximately River Mile 10. This location was selected for several reasons including:

- An additional point is needed downstream in the basin because the Heisson gage location is upstream of most of the water use in the East Fork Sub-basin
- The Daybreak site is upstream of the tidal and flood flow influence from the Columbia River, which extends up to approximately River Mile 7.5
- Modeling work was done by PWR, so simulated stream flow data and statistics are available at this site
- An IFIM study was done in 1999 in this vicinity

Lower Range of Target Flows

For applying target flows at the low end of the flow spectrum (i.e. in dry months of the year), the Planning Unit makes following recommendation.

Recommendation:

For the main stem of the East Fork Lewis River, it is recommended that the available flow statistics for the 90%, 50%, and 10% exceedance levels serve as a basis for the target flow regime applying to the low-flow months. The suite of flow-management techniques discussed for the East Fork Lewis River watershed should be designed with the goal of protecting these flows from degradation; and if possible improving these flows. At this time, the Heisson Gauge is the only management point with adequate data to apply this recommendation. A proposed new gauging site at Daybreak Bridge should also be used as a management point, once a sufficient record has been developed at that site.

Table 4-6 displays available data for the East Fork Lewis River management point at Heisson.

Table 4-6
East Fork Lewis River near Heisson (RM 20)
Average Monthly Percent Exeedance Flows[1] (cfs)

Month	90%	50%	10%
January	495	1,402	2,325
February	691	1,229	2,099
March	653	1,061	1,597
April	543	902	1,296
May	311	557	840
June	163	311	570
July [2]	**80**	**133**	**205**
August [2]	**51**	**74**	**120**
September [2]	**51**	**79**	**198**
October [2]	**70**	**261**	**775**
November	296	1,012	1,886
December	704	1,445	2,371

(1) Based on data from USGS Gage No. 14222500 near Heisson ~River Mile 20.2 with a drainage area of 125 sq. mi. Values are the percent exceedance of monthly average flows.
(2) Low flow months are highlighted for application of target flow approach.

The 90% exceedance values are the flow levels that address the lowest flow conditions. On average, flows are higher than this level nine years out of ten. The 50% flow is the median flow for each month and can be expected to occur approximately five years out of ten. The 10% flow is a higher flow that occurs on average only one year out of ten.

The objective of protecting and improving the flow regime includes the full range of flows from 10% to 90%. This is because, in addition to protecting fish and other aquatic life from very low flows, it is important that more abundant flow conditions be available to support habitat in as many years as possible.

Flow statistics for the Daybreak Bridge have been simulated based on drainage area and land use characteristics (PWR 2003) and are included in Appendix F. The simulated flows may overstate actual flows, since diversions, ground water pumping and exchanges between surface and ground water below the Heisson gage are not accounted for. Therefore, as noted in the recommendation above, the target flow regime at the Daybreak Bridge site should be based on actual data from the proposed stream gauge at that location. Simulated flows for many other sites in WRIAs 27 and 28 are contained in PWR's full report.

As discussed above, an IFIM study was conducted for a reach of the East Fork in the vicinity of the Daybreak Bridge. In general, for the low flow months (e.g. July – October), flows simulated at the Daybreak Site (PWR 2003) are well below the "optimal" levels defined in the IFIM study for various life stages of salmonid fish (Chinook, steelhead and Coho were covered in the IFIM study). This is expected, since the target flow regime is based on actual hydrologic conditions, and the IFIM methodology is not. The IFIM study acknowledged that normal streamflow may not achieve optimum levels.

Another factor should be considered at such time as a target flow regime is defined for Daybreak. Unpublished analysis of data performed for Friends of the East Fork from 2000 to 2003 indicate that the East Fork Lewis River from the Heisson gage downstream to various locations, such as the Daybreak Bridge area, is a "losing reach", at least during periods when flow is less than 200 cfs (Dyrland, 2003). This means that flows are actually lower at downstream locations than the flows at the Heisson gage. This information may need further verification since it seems to contradict data collected in the 1970s and 1980s by USGS. This anomaly was not factored into the modeling work done by PWR, since subsurface conditions and surface water-ground water interactions were not explicitly modeled.

Higher Range of Target Flows

A different set of statistics can be defined as the target for peak flow conditions. The purpose of defining this end of the target flow regime is to manage changes in land use and related conditions that could exacerbate damaging floods.

Recommendation:

For the main stem of the East Fork Lewis River, it is recommended that the 2-year and 10-year flood events be used as metrics for high flow events. The suite of flow-management techniques discussed for the East Fork Lewis River watershed should be designed such that these flow statistics do not increase over time, and if possible are reduced over time. In addition, the duration of the highest flows should not increase. At this time, the Heisson Gauge is the only management point with adequate data to apply this recommendation. A proposed new gauging site at Daybreak Bridge should also be used as a management point, once a sufficient record has been developed at that site.

Table 4-7 shows the flood statistics in cubic feet per second (cfs) for the Heisson Gauge.

Table 4-7
Flood Statistics for East Fork Lewis River

Site	2-year	10-year	100-year
Heisson gage	7,756	12,530	18,001

The 2-year flood event has a 50 percent chance of occurring in any given year. The 10-year flood event has a 10 percent chance. The 10-year flood can be viewed as a "surrogate" metric, for reducing potential damages from the 100-year flood. The 100-year flood is more difficult to estimate with high confidence.

Based on the modeling work done by PWR, the 10-year and 2-year flood events have increased from pre-settlement conditions to the present time. This increase is approximately two to four percent. By recommending that the high end of the target flow range be maintained at the present day flows, this would halt the current trend of increasing flows for the 100-year, 10-year and 2-year flood events.

Data on duration of peak flow events is not reported as part of standard flood statistics. Therefore, a baseline for duration is not presented at this time. In order to fully implement the recommendation above, data on duration of peak flow events should be compiled for past and future flow events.

Gauging Sites for the East Fork Lewis River Subbasin

Policy SFP-1 (see Section 4.2) highlights the importance of maintaining existing stream gauges and installing new stream gauges to provide stream flow management data. There is only one stream gauge in the East Fork Subbasin, on the East Fork near Heisson. This gauge is located at River Mile 20.2 and just south of the community of Yacolt. Historically, this has always been the only stream gauge in the subbasin. This gauge has been in continuous operation since September 1929 for both daily flow and annual peak flow, and has a drainage area of 125 square miles. The total drainage area of the East Fork Subbasin is approximately 236 square miles, so this gauging station only provides flow measurements for approximately one half of the subbasin. This is the least developed portion of the subbasin.

Recommendation:
It is recommended that the existing stream gauge at Heisson (RM 20.2) be maintained, and that one or more additional gauges be installed in the East Fork Lewis River Basin, to provide for more effective implementation of the flow management strategy and monitoring of results.

It is important that the existing stream gauge at Heisson be maintained, to continue providing long-term data on flows in this subbasin. In addition, if funding can be obtained it may be desirable to install additional gauges to enhance capabilities for monitoring and managing stream flow. The top priority would be a second gauge at the Daybreak site discussed above. The technical memorandum on stream flow management (EES 2003b) lists further sites in the East Fork Subbasin where additional gauges would be useful, in the event funding becomes available for this purpose in the future.

4.7.4 Salmon Creek

Subbasin Characteristics Relevant to Stream Flow

The Salmon Creek Subbasin has a drainage area of approximately 118 square miles and enters the Columbia River north of Vancouver Lake. Population centers within the subbasin consist of the rapidly growing City of Battle Ground, and developed areas north of the City of Vancouver city limits. Clark Public Utilities has wells within the Salmon Creek Subbasin.

Based on the Planning Unit's breakdown of subbasins within WRIAs 27 and 28, there are also separate creeks that flow into the Columbia within this subbasin (e.g. Whipple Creek).

Primary land use in the upper portion of the subbasin is timber production interspersed with smaller rural development, while the lower portion is a primarily urban landscape. Many of the tributaries in Salmon Creek subbasin are flat with meandering channels in the lower reaches of the subbasin. Agriculture and open space land uses cover most of the Columbia River lowlands to the west of Lake River. Most of the floodplain habitat along the Lake River lowlands have been altered by development and agriculture (Wade, 2000).

Much of the diking, stream adjacent roads, and railroads have disconnected floodplains in the lowlands including along Whipple Creek and just below I-5. The LFA identified some floodplain restoration potential between 179th and 206th streets (Wade, 2000). The LFA also identified numerous wetlands along Curtin Creek where some private mitigation efforts have been occurring south of the railroad. The Army Corps of Engineers is also investigating projects to enhance various wetlands and riparian habitat in the lower Salmon Creek floodplain.

Appendix G contains a description and map of existing surface water source limitations (SWSLs). There are currently three administrative low flows and closures in place in this subbasin, restricting issuance of new water rights.

Existing Salmon Creek Management Plan

A management plan has already been developed to address stream flow in the Salmon Creek Subbasin. The need for a management plan resulted from concerns regarding the effect of water withdrawals on fish habitat. The subbasin has been under administrative closure for further water rights since 1949. In 1992, a Memorandum of Understanding (MOU) was signed by Ecology, Clark County, and CPU to develop a ground water and surface water management plan. The plan was created to guide Ecology in its water allocation decisions to protect minimum instream flows and enhance instream values. The Salmon Creek Basin Water Resources Management Plan (CPU, 1996) focused on water supply and demand in the subbasin. In 2002, a document titled Salmon Creek Watershed Assessment (PGG, 2002) expanded on the work of the 1996 document to assess the status of five key fish habitat components and made recommendations to protect them. The five key habitat components are water; sediment; temperature; large woody debris; and nutrients, toxic contaminants and bacteria.

The MOU attempts to maintain a flow rate of 12 cfs in Salmon Creek at the Northcutt gauging station (PGG, 2002). It was anticipated that the goal would only be met 90 percent of the time, unless management changes were enacted. The recommendations in the Watershed Assessment were designed to meet the 12 cfs goal 100 percent of the time.

Recommendations from the Salmon Creek Watershed Assessment related to instream flows attempt to moderate flow regimes by maintaining flows during the low flow period and by reducing peak flows. The recommendations focus primarily on land use and surface water use, since these were identified as the largest contributors to flow problems. For example, modeling showed that surface water diversions can decrease the mean annual 7-day low flow by 20-35 percent (PGG, 2002). Modeling of land use showed an increase of 40 percent of total storm runoff since predevelopment (PGG, 2002). Surface water use recommendations focus on converting surface water rights to ground water and reducing unauthorized diversions. Land use recommendations highlight improving stormwater management to increase ground water recharge and to control routing of water to streams.

Key stream flow management recommendations from the Watershed Assessment include:

- Control stormwater runoff by reducing impervious surfaces.
- Control stormwater by adding stormwater detention for existing land use.
- Convert active surface water rights to ground water from aquifers not connected to Salmon Creek.
- Locate new domestic wells in aquifers not connected to Salmon Creek.
- Locate new municipal wells outside of the subbasin, preferably on the Columbia River floodplain.
- Survey periodically for unauthorized surface water diversions.
- Verify active water rights with a simple reporting system. (This measure was implemented during the drought in 2001.)
- Establish a monitoring program for stream diversion and ground water withdrawals for the largest 50 percent of water rights and claims.
- Plant trees to restore ground water recharge and baseflow[5].

CPU has implemented a strategy similar to the short-term operational response approach described in Section 4.4.3 of this Watershed Management Plan. Certain short-term operational changes are made when flows in Salmon Creek reach a certain level. The focus of the strategy is the reduction in pumping of CPU wells that are in close proximity to the stream. These actions are implemented with the goal of maintaining the 12 cfs flow rate in Salmon Creek at the Northcutt gauging station.

Stream Flow Management Recommendations for Salmon Creek

The WRIAs 27 and 28 Watershed Planning Unit did not undertake a separate review of conditions in Salmon Creek, given that a management plan has already been developed.

Recommendation:

The Planning Unit recommends that parties (i.e., Ecology, Clark County, and Clark Public Utilities) to the 1992 Salmon Creek MOU continue to implement the management plan. In addition, the parties to the MOU are encouraged to review the policies discussed in Sections 4.5 and 4.6 to assess whether additional stream flow management strategies are warranted in the Salmon Creek Subbasin.

Policy SFP-2 should be applied to strengthen restrictions on issuance of new water rights in the subbasin. However, application of this policy is not intended to disrupt the

[5] It should be noted that this item from the PGG report is not consistent with PWR's findings that increased forest cover results in lower flows due to evapotranspiration.

management program described above. Special considerations may be needed in applying Policy SFP-2 in the Salmon Creek Subbasin, so that the management plan is not disrupted.

In addition to Salmon Creek, Policy SFP-2 should also be applied to Whipple Creek and other named or unnamed tributaries to the Columbia River that lie within this subbasin.

4.7.5 Burnt Bridge Creek

Subbasin Characteristics Relevant to Stream Flow

The Burnt Bridge Creek Subbasin has a drainage area of approximately 79 square miles. The subbasin includes the Burnt Bridge Creek drainage, the Vancouver Lake area, and the Columbia Slope area. The subbasin is heavily urbanized and contains the City of Vancouver, the largest city within WRIAs 27 and 28. Vancouver's 11 water stations supplying ground water are located in this Subbasin, although only 5 are located in the actual drainage of Burnt Bridge Creek. The westerly portion of the City of Camas is also located within this subbasin. Rural residential development is the dominant land use along the upper reaches of this subbasin.

The upper portion of the Burnt Bridge Creek subbasin was once a series of interconnected wetlands that flowed westerly to Vancouver Lake, which is located in the lower western portion of Burnt Bridge Creek subbasin. For most of its length, the Creek flows in a deep, narrow, man-made ditch, and portions of the rest of the stream have been partially channelized (Wade, 2000). A dredging project in Vancouver Lake created a flushing channel that connected the Lake to the Columbia River. Industrial development occurs along the Columbia River from the flushing channel to Vancouver. Approximately 12 miles of dikes along the Columbia River protect the Vancouver Lake lowlands from flooding. Most of the floodplain habitat within the Vancouver Lake lowlands has been altered by this development and agriculture.

Appendix G contains a description and map of existing surface water source limitations (SWSLs). There is currently one administrative closure in place in this subbasin, restricting issuance of new water rights.

Stream Flow Management Recommendations for Burnt Bridge Creek

Due to the heavily urbanized nature of the Burnt Bridge Creek Subbasin, the Planning Unit has decided not to focus stream flow protection or restoration efforts in this area. As development has already greatly impacted the creek, and growth pressures will continue to increase, it would be very difficult to restore significant fish habitat in this area. Thus stream flow management techniques have not been reviewed in detail for this subbasin.

This does not mean that Burnt Bridge Creek should be ignored. Stormwater management is particularly important in this subbasin, due to the highly urbanized land use. Local jurisdictions should apply sound stormwater management practices. See Policy SFP-10 in this regard.

Policy SFP-2 should be applied to strengthen restrictions on issuance of new water rights in the subbasin. For details of the application of this policy to the Burnt Bridge Creek Subbasin, see Appendix H.

4.7.6 Lacamas Creek

Subbasin Characteristics Relevant to Stream Flow

The Lacamas Creek Subbasin has a drainage area of approximately 65 square miles. The only population center within the subbasin consists of the eastern portion of the City of Camas. However, the majority of Camas' sources of water supply are located in the Washougal River subbasin with the exception of source (Well 9) rather than the Lacamas Creek drainage. Urban and rural residential development covers a substantial portion of the lowland areas. This is also where most of the subbasin's future development is likely to occur. There is some agriculture in the Columbia River floodplain.

The Georgia-Pacific paper mill in Camas has a large water right for Lacamas Lake, as well as ground water rights and rights for water from the Columbia River. Diversions from Lacamas Lake have a significant impact on flows in the lower reach of Lacamas Creek, which provides important habitat for Chum.

Alterations to Lacamas Creek occurred because of a diversion tunnel connecting Lacamas Lake to the Columbia River. In addition, the dam around Round Lake has altered the natural hydrology of Lacamas Creek, and effectively limits fish passage (Wade, 2000). There are no minimum or maximum flow limitations placed on the operation of the dam.

Appendix G contains a description and map of existing surface water source limitations (SWSLs). There are currently three administrative closure and low flows in place in this subbasin, restricting issuance of new water rights.

Over 40% of the land cover in the Lacamas subbasin is in non-forest category, which includes all areas without mature forest cover (urban, agriculture, rangelands, cleared areas, and scrub cover). The LFA has identified the Lacamas Creek Subbasin as hydrologically impaired with potential for peak flow concerns (Wade, 2000). Public parks protect most of the Lower Lacamas Creek upstream of 3rd Ave. from development impacts (a reach of approximately one mile). The LFA identified potential to improve floodplain and side-channel habitat along this protected corridor. Other than some limited areas, there appears to be little opportunity to significantly increase flood storage volumes through floodplain restoration or enhancement.

Stream Flow Management Recommendations for Lacamas Creek Subbasin

Policy SFP-2 should be applied to strengthen restrictions on issuance of new water rights in the subbasin. For details of the application of this policy to the Lacamas Creek Subbasin, see Appendix H.

The Planning Unit did not conduct detailed analysis of opportunities within this Subbasin, but additional work is warranted to identify and implement stream flow management actions. Because of the importance of the lower reach of Lacamas Creek in supporting Chum recovery objectives, it would be valuable to protect and restore flows in the Lacamas Creek drainage. This includes addressing land use and water use issues in the developing area throughout the Lacamas Creek Subbasin, as well as exploring opportunities to reduce impacts of the Georgia-Pacific water usage on the lower reach of the creek. Therefore, application of the stream flow management policies described in Sections 4.4 and 4.5 is a high priority. In addition the following specific recommendation is made:

Recommendation:

Identify and carry out actions to reduce the impact of Georgia-Pacific's water use on Lacamas Creek. These actions may include a combination of source-substitution; water conservation; and/or water reclamation and reuse within the paper mill. The State of Washington should offer technical assistance for this purpose. In addition, the State of Washington should identify funding mechanisms that could, in part, contribute to reduction of water usage at the mill. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

This discussion is directed only at protecting or enhancing stream flows. Section 5 of this plan addresses habitat issues.

4.7.7 Washougal River

Like the East Fork Lewis River Subbasin the Washougal River Subbasin was selected as a "pilot" subbasin to explore the applicability of stream flow management approaches. This Section presents results and recommendations for the Washougal River Subbasin. For more detailed information, see the full Technical Memorandum on stream flow management strategies (EES, 2003b).

Subbasin Characteristics Relevant to Stream Flow

The Washougal River Subbasin has a drainage area of approximately 148 square miles. The main stem of the Washougal flows in a southerly direction within the western portion of Skamania County and then in a westerly direction through the easterly portion of Clark County to its confluence with the Columbia River, near river mile 120, between the cities of Washougal and Camas. The lower four miles of the river are in the Columbia River Valley, and the next 11 miles upstream are located in a narrow, shallow valley. Further upstream the Washougal is in a narrow, deep canyon extending into the Yacolt Burn Area described below.

Population centers within the subbasin include the cities of Washougal and Camas, both located in Clark County. There is some residential development along the Washougal River Road, which follows the Washougal River upstream from Washougal. Some agricultural development occurs in the lower reaches of the watershed. In addition, there is a large tributary, the Little Washougal River that has rural development and agricultural activity.

Eighty-one percent of the Washougal River Subbasin is forested. Of these lands, ten percent are federally owned and managed, 50 percent are state-owned, and 26 percent are privately owned. The remaining 14 percent are not managed for harvest (e.g. parks).

The Yacolt Burn in the early part of the 20th Century deforested large tracts of land in the upper reaches. The burn along with splash damming and logging has left many portions especially along the lower part of the mainstem channel scoured to bedrock and has disconnected side channels and floodplains (Wade, 2000). Large portions of the Washougal from the mouth to the Little Washougal at river mile 5.6 have been diked and rip-rapped. From the Little Washougal to Salmon Falls (RM 14.5) the channel is generally a single-thread system in bedrock with some areas lined with riprap. The upper reaches flow through a deep narrow canyon with minimal floodplain development (Wade, 2000). The Little Washougal and West Fork Washougal have many of the same characteristics.

Based on road densities and hydrologic maturity, the upper Washougal was determined not to have potential peak flow concerns in the LFA (Wade, 2000). However, the Little Washougal and West Fork Washougal were determined to have peak flow concerns. Over 40% of the land cover in these areas is in non-forest category, which includes all areas without mature forest cover (urban, agriculture, rangelands, cleared areas, and scrub cover).

The LFA has identified a potential to restore forested wetlands at School House Creek above river mile 13 and to restore floodplain connectivity at Slough Creek at river mile 14. In addition, the LFA concluded that many areas have the potential for riparian restoration. Riparian habitat conditions generally improve in the mainstem Washougal and most of its tributaries toward the upper reaches.

Ecology conducted an instream flow study on the Washougal River using the Instream Flow Incremental Methodology (IFIM), with the field work being performed during the summer of 1998. An Open File Technical Report titled *Washougal River Fish Habitat Analysis Using the Instream Flow Incremental Methodology and the Toe-Width Method for WRIAs 25, 26, 28, and 29* was published by Ecology in June 1999 as Publication # 99-153.

The IFIM study on the Washougal River was done for one site located in the vicinity of Hathaway Park in Washougal, near RM 3.5, with eight transects upstream of RM 3.5, within a 650 foot reach of the river. Stream flow measurements were made in May, June, July, and September, 1998, with measured flows of 440, 255, 153, and 77 cubic feet per second (cfs). The report did not make specific recommendations for instream flow management. Optimum flow levels identified in the IFIM study are documented in the above referenced report, as well as the Technical Memorandum prepared on stream flow management for this Watershed Planning Process (EES 2003b).

Stream Flow Management Recommendations for Washougal River Subbasin

A set of general policies applicable to stream flow management throughout WRIAs 27 and 28 is presented in Sections 4.4 and 4.5. ***Table 4-8 identifies additional recommendations specific to the Washougal River Subbasin.***

These recommendations are focused on protecting or enhancing stream flows alone. Other recommendations included in this plan address water supply and habitat issues.

Proposed Target Flows and Management Points for Washougal River Subbasin

The target flow concept was described in Section 4.3. As used in this plan, target flows represent a realistic flow regime that can be achieved in most years by following selected management techniques over a long period of time. A flow regime consists of a range of flows that vary seasonally based on runoff and precipitation.

Two management points are recommended for application of target flows in the Washougal River Subbasin. One management point is on the main stem of the Washougal River at the location of the former USGS stream gage near Washougal, at River Mile 9.2. This location was chosen primarily because of the available data from this former stream gage, which was in continuous operation from 1945-1981 and has the longest period of record in this sub-basin. An additional management point is recommended for the Little Washougal River near the confluence with the Washougal River. This location was selected for several reasons including:

- A USGS gage was in continuous operation at the location from 1951-1956, so there is a brief historical period of record for this tributary stream
- Clark County currently operates a gauge on the Little Washougal River
- Modeling work was done by PWR, so simulated stream flow data and statistics are available
- There are some significant water diversions near the headwaters of this stream, so there is a potential for increasing the low flows if these diversions are either reduced or moved to other locations

Gauges would need to be re-established at these locations in order to apply the target flow approach.

Table 4-8
Stream Flow Management Recommendations
Washougal River Subbasin

Management Technique	Relevant Basin Characteristics	Recommendation
Water Supply Recommendations Related to Stream Flow		
Restrictions on Issuance of New Water Rights	Water rights issuance is already restricted in the subbasin. There are four existing administrative closures and low flows in the subbasin (see Appendix G).	Apply Policy SFP-2. This will modify the existing set of restrictions on issuance of new water rights in the subbasin. For more information, see Appendix H.
Water Conservation	Most major municipal and industrial water uses are located at the downstream end of the Washougal River, in the Cities of Washougal and Camas. There is a notable exception: the City of Camas' surface water diversions on Boulder and Jones Creeks, tributaries to the Little Washougal River located in the western portion of the subbasin. These diversions account for approximately one third of the City's total annual production. There is some agricultural activity, and there may be opportunities for conservation by individual landowners.	The City of Camas should enhance its existing conservation program to reduce water diversions from Jones and Boulder Creeks. However, if source substitution is pursued instead, this may be unnecessary. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Curtailment	City of Camas has surface water diversions on Boulder and Jones Creeks, in addition to other supplies. Most other large water users in the Washougal River Subbasin obtain their water supply from ground water. Surface water use is minimal, with most occurring near the confluence of the Columbia River. Some surface and ground water uses associated with agricultural areas in the Little Washougal River drainage.	The City of Camas should develop a curtailment plan to reduce diversions from Jones and Boulder Creeks in the event of a state-declared drought emergency. (This approach would not be needed, if an alternative source is developed to replace these diversions – see above.) This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.

Table 4-8 (cont.)
Stream Flow Management Recommendations
Washougal River Subbasin

Management Technique	Relevant Basin Characteristics	Recommendation
Source Substitution	Alternative sources of supply for the City of Camas' surface water diversion include installation of new wells, the purchase of water from the City of Vancouver and the development of a non-potable Columbia River supply (for irrigation and industrial uses). The benefit relative to management of stream flows is that diversions from Boulder and Jones Creek could potentially be eliminated (or reserved solely for emergency backup supply).	The City of Camas should consider alternative sources of supply to reduce or cease use of surface water diversions on Boulder and Jones Creeks. Such alternatives include installation of new wells, purchases from City of Vancouver and development of non-potable source of supply. It is anticipated that this would require examination of cost, potential rate impacts, reliability considerations, and evaluation of other feasibility criteria. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Transfer of Water Rights to State Trust	See discussion regarding Camas' use of Jones and Boulder Creeks, above.	If the City of Camas reduces or eliminates diversions from Jones and Boulder Creeks, and if these water rights are no longer needed for primary or backup supply, they could potentially be transferred to the State Trust. This is a Planning Unit recommendation for voluntary action. Implementation should not be mandated by the State.
Enforcement Action Against Unauthorized Uses	There is little information available on unauthorized uses.	Apply Policy SFP-7.
Land Use Recommendations Related to Stream Flow		
Forest Practices	Eighty-one percent of the Washougal River Subbasin is forested. Of these lands, 14 percent are not harvested (e.g., parks, etc). Ten percent of the forested lands are federally owned and managed, 50 percent are state owned, and 26 percent are privately owned.	Apply Policy SFP-9.
Development Practices and Stormwater Management	Most of the subbasin's future development is likely to occur within the lower portion of the subbasin, in areas where there is existing development (i.e., near the Cities of Camas and Washougal).	Apply policies SFP-10 and SFP-11.
Floodplain Management	Much of the lower Washougal River from the mouth to the Little Washougal at RM 5.6 has been diked and rip-rapped. It appears there are opportunities for floodplain restoration or enhancement on the mainstem Washougal River, along the lower reaches of the Little Washougal, School House Creek, and Slough Creek. The LFA concluded that many areas have the potential for riparian restoration.	Apply Policy SFP-12. In addition, consider restoration opportunities listed here, or others identified in the future, subject to local input, cost-benefit analysis, and availability of funding. If these factors are favorable, pursue implementation.
Wetlands Management	Wetlands are located throughout the Washougal River Subbasin. Most are located near the mouth of the Washougal and along the main stem Washougal River.	Apply Policy SFP-13. Also consider restoration opportunities for wetlands associated with floodplain projects discussed above.

Lower Range of Target Flows

For applying target flows at the low end of the flow spectrum (i.e., in dry months of the year), the Planning Unit makes following recommendation.

> ***Recommendation:***
>
> For the main stem of the Washougal River and for the Little Washougal River, it is recommended that the available flow statistics for the 90%, 50%, and 10% exceedance levels serve as a basis for the target flow regime applying to the low-flow months. However, these flow statistics should be updated through installation of new stream gauges at the former gauging sites. The suite of flow-management techniques discussed for the Washougal River watershed should be designed with the goal of protecting these flows from degradation; and if possible improving these flows.

Table 4-9 displays available data for the Washougal River management point. It should be noted that this data is outdated, since the gauge ceased operation in 1981.

Table 4-9
Washougal River near Washougal (RM 9.2)
Average Monthly Percent Exceedance Flows[1] (cfs)

Month	90%	50%	10%
January	466	1501	2931
February	806	1547	2304
March	771	1242	2032
April	700	1042	1429
May	321	629	846
June	172	290	502
July [2]	**100**	**144**	**264**
August [2]	**67**	**91**	**153**
September[2]	**67**	**127**	**251**
October [2]	**97**	**446**	**1133**
November	684	1181	2439
December	902	1714	2793

(1) Flows near City of Washougal at USGS Gage No. 14143500 ~ River Mile 9.2 with a drainage area of 107 sq. mi. Values are the percent exceedance of monthly average flows from the period 1945 - 1981.

(2) Low flow months are highlighted for application of target flow approach.

The 90% exceedance values are the flow levels that address the lowest flow conditions. On average, flows are higher than this level nine years out of ten. The 50% flow is the median flow for each month and can be expected to occur approximately five years out of ten. The 10% flow is a higher flow that occurs on average only one year out of ten.

The objective of protecting and improving the flow regime includes the full range of flows from 10% to 90%. This is because, in addition to protecting fish and other aquatic life from very low flows, it is important that more abundant flow conditions be available to support habitat in as many years as possible.

As discussed above, an IFIM study was conducted for a reach of the Washougal in the vicinity of Hathaway Park. In general, for the low flow months (e.g. July – October), flows at the closest Washougal River gauge location shown in Table 4-9 are well below the "optimum" flows determined by IFIM for various life stages of salmonid fish (Chinook, steelhead and Coho were covered in the IFIM study). This is expected, since the target flow regime is based on actual hydrologic conditions, and the IFIM methodology is not. The IFIM study acknowledged that normal streamflow may not achieve optimal levels.

Flow statistics for the second proposed management point on the Little Washougal River have been simulated based on drainage area and land use characteristics (PWR 2003) and are included in Appendix F. The simulated flows may overstate actual flows, since diversions, ground water pumping and exchanges between surface and ground water are not accounted for. Therefore, as noted in the recommendation above, the target flow regime at the Little Washougal River site should be based on actual data from the proposed stream gauge at that location. Simulated flows for many other sites in WRIAs 27 and 28 are contained in PWR's full report.

Higher Range of Target Flows

A different set of statistics can be defined as the target for peak flow conditions. The purpose of defining this end of the target flow regime is to manage changes in land use and related conditions that could exacerbate damaging floods.

Recommendation:

For the main stem of the Washougal River, and the Little Washougal River, it is recommended that the 2-year and 10-year flood events be used as metrics for high flow events. However, these flow statistics should be updated through installation of new stream gauges at the former gauging sites. The suite of flow-management techniques discussed for the Washougal River Subbasin should be designed such that these flow statistics do not increase over time, and if possible are reduced over time. In addition, the duration of the highest flows should not increase.

Table 4-10 shows the flood statistics in cubic feet per second (cfs) for the Washougal River Gauge.

Table 4-10
Modeled Flood Statistics for the Washougal River

Site	100-year	10-year	2-year
Washougal Gauge	21,629	12,749	9,446

The 2-year flood event has a 50 percent chance of occurring in any given year. The 10-year flood event has a 10 percent chance. The 10-year flood can be viewed as a "surrogate" metric, for reducing potential damages from the 100-year flood. The 100-year flood is more difficult to estimate with high confidence.

Based on the modeling work done by PWR, the 100-year, 10-year, and 2-year flood events at each of the two recommended management points in the Washougal Sub-basin have had significant flow increases from pre-settlement conditions to the present time. Model results indicate that flows at the control point of the former gage location on the main stem have increased by nearly 350 cfs or nearly 4% for the 2-year flood event. The 10-year event has increased by 300 cfs or 2.4%, while the 100-year event has increased by 440 cfs or 2.1%. By recommending that the high end of the target flow range be maintained at the present day flows, this would halt the current trend of increasing flows for the 100-year, 10-year and 2-year flood events.

Duration of peak flow events is also important. Statistics on duration of flows should be compiled as discussed in the section on target flows for the East Fork Lewis River (Section 4.8.3).

Gauging Sites for the Washougal River Subbasin

Policy SFP-1 (see Section 4-2) highlights the importance of maintaining existing stream gauges and installing new gauges to provide data for managing stream flow. There is currently only one stream gauge in the Washougal River Subbasin. This is a gauge operated by Clark County located on the Little Washougal River, about ½ mile upstream from its confluence with the Washougal's mainstem. In the past there was a USGS stream gauge located on the Washougal River, at RM 9.2, about three miles upstream of the mouth of the Little Washougal River. This gauge had a period of record from 1945-1981 for daily average flow and 1945-1996 for annual peak flow. A second gauge was located on the Little Washougal River about 1 mile upstream from its confluence with the Washougal River mainstem, with a period of record from 1951-1955 for daily flow and 1951-1968 for annual peak flow. In addition, there was a gauge on Canyon Creek, which flows into the Washougal River just upstream of the mouth of the West Fork Washougal River.

Recommendation:

It is recommended that the former stream gauge on the Washougal River (RM 9.2) be replaced and the Clark County gauge on the Little Washougal River be maintained as a permanent installation recording continuous flow data, to provide for more effective implementation of the flow management strategy and monitoring of results.

If funding can be obtained it may be desirable to install additional gauges to enhance capabilities for monitoring and managing stream flow. The Technical Memorandum on stream flow management (EES 2003b) lists further sites in the Washougal River subbasin where additional gauges would be useful, in the event funding becomes available for this purpose in the future.

4.7.8 Columbia River Tributaries in Eastern WRIA 28

Subbasin Characteristics Relevant to Stream Flow

The Columbia River Tributaries Subbasin has a drainage area of approximately 85 square miles and is comprised of a series of relatively small creeks (Gibbons Creek, Duncan Creek, etc). There is no extensive development or major water uses within this subbasin. The City of North Bonneville is a designated Urban Area of the National Scenic Area, where future growth may occur. There are scattered small communities along Highway 14, but these do not have large public water systems. There are some agricultural areas in the southern portions of the subbasin. Future development in the subbasin will likely occur along Highway 14, but the population of this Subbasin is anticipated to remain small due in large part to the location of the subbasin within the Columbia River Gorge National Scenic Area. Because of the National Scenic Area status, and due to the physical constraints of the gorge itself, future development is expected to be quite limited in this area. Because of limited development and lack of major water uses, opportunities for water conservation, water rights transfers and enforcement against unauthorized uses are limited. Some limited opportunities may exist, such as irrigators located near tributary streams.

Appendix G contains a description and map of existing surface water source limitations (SWSLs). There are currently three administrative low flows and closures in place in the subbasin, restricting issuance of new water rights.

Small patches of land in the subbasin are in federal ownership under the Gifford Pinchot National Forest. Because most of the subbasin is within the Columbia River Gorge, there are only a small amount of low gradient reaches. The gradients quickly become too steep for fish to migrate. The construction of railroad and roads (i.e. State Route 14) has created alterations to the lower reaches and pinches off some of the streams. In addition, the operation of Bonneville Dam has altered the natural flow regime in the subbasin (Wade, 2000). According to the LFA, the entire subbasin is considered to be likely impaired hydrologically with respect to peak flows because of immature forest cover. However, the LFA indicated that low flows are the more significant issue in the subbasin, specifically in Woodward, Hamilton, Hardy, and Duncan Creeks (Wade, 2000).

There is a limited amount of low gradient floodplains in this subbasin. Besides the steep nature of tributaries, SR 14, railroads and development have reduced or eliminated many floodplains in the subbasin including Gibbon’s Creek, Campen Creek, and Lawton Creek floodplains. In addition, riparian zones are generally in poor condition in the lower portion of the subbasin according to the LFA. Low flow and habitat limitations could be improved by restoring natural channel processes and sediment transport affected by Highway 14 and the railroad. However, the Planning Unit has not explored these opportunities in detail.

Steigerwald Lake National Wildlife Refuge (SWR) was constructed to mitigate for a powerhouse at Bonneville Dam. It includes a diversion structure, elevated fish passage channel and fish ladder at Gibbon’s Creek to allow unrestricted fish passage through Steigerwald Refuge. While the channel alleviated most fish passage problems, most of the lower mile of the Creek has been disconnected from the historic floodplain (Wade, 2000). The Columbia Land Trust owns land just upstream of SR 14 near Gibbon's Creek where there is potential to restore habitat function along this channelized stream.

Stream Flow Management Recommendations for Columbia River Tributaries

Policy SFP-2 should be applied to strengthen restrictions on issuance of new water rights in the subbasin. For details of the application of this policy to this subbasin, see Appendix H.

The remaining stream flow management policies presented in Sections 4.4 and 4.5 should also be applied to this subbasin. The Planning Unit did not examine this subbasin in detail. Therefore other subbasin-specific recommendations are not made at this time.

This discussion is directed only at protecting or enhancing stream flows. Other sections of this plan address water supply and habitat issues.

4.8 Implementation Considerations for Stream Flow Management

Table 4-11 summarizes implementation considerations for the stream flow management recommendations discussed throughout Section 4. Implementation issues may vary somewhat from those listed in the table, depending on the specific action, and community involved. Where there are staffing impacts that would likely require hiring of at least ½ FTE by the implementing organization(s), they are called out in the funding column. Actions that relate to water conservation and substitution of water sources were presented in Section 3.6 and are not repeated here.

Table 4-11
Implementation Considerations for Stream Flow Management Actions

Priority[1]	Activity	Implementers[3] [4]	Financial/ Economic Costs[2]	Funding Sources
Category: Stream Flow Management				
High	Maintain existing stream gauges. Install new gauges at selected locations. Select exact sites; permit and construct gauges; O&M; data management.	*Lead*: Ecology *Others*: USGS, LCFRB, Counties	Medium	*Main*: Leg. appropriations (Ecology budget); Congr. appropriations (USGS budget); *Additional*: Counties; Public Water Systems
High	Adopt State Rule restricting issuance of new water rights in accordance with Policy SFP-2 as described in this Plan.	*Lead*: Ecology *Others*: LCFRB	Low	*Main*: Ecology (staff time) *Additional*: LCFRB (staff time)
High	Selected actions involving water supply. See Section 3.6.	*See Section 3.6*	*See Section 3.6*	*See Section 3.6*
High	Establish target flow monitoring and management program	*Lead*: LCFRB and Planning Unit or successor organization *Others*: Ecology, DFW		*Main*: Phase 4 implementation funds *Additional*: TBD
High	Initial surveys in selected subbasins to identify unauthorized uses and take enforcement actions. Follow-up in other basins if warranted.	*Lead*: Ecology *Others*: N/A	Low to medium	*Main*: Leg. appropriations (Ecology budget & staffing) *Additional*: N/A
High	Consider and address effects of forest practices on stream flow. Monitor effectiveness of F&F Rules and NW Forest Plan. Report to public periodically.	*Lead*: DNR, USFS *Others*: Private forest landowners	Low to medium	*Main*: Leg. appropriations (DNR budget); Congr. appropriations (USFS budget), Timber producers *Additional*: N/A
High	Within authorities, protect floodplains from modifications that would impair hydrologic functions or habitat.	*Lead*: Counties, cities, State agencies with land management responsibilities *Others*: DFW	Low	*Main*: County permitting fees or general fund revenues, grants *Additional*: State agency budgets
Medium	Review effects of stormwater discharges on stream flow and habitat. Where needed to protect key habitat, implement programs that exceed minimum requirements.	*Lead*: Counties, Cities *Others*: Ecology	Low to Medium	*Main*: County, City general funds; Stormwater assessment and fees, grants *Additional*: N/A
Medium	Purchase or lease of water rights from willing sellers, for State Trust program.	*Lead*: Ecology *Others*: N/A	Low to medium	*Main*: Leg. appropriations (Ecology budget) *Additional*: N/A
Medium	Within authorities, identify floodplain restoration projects and implement where feasible.	*Lead*: Cities, State agencies with land management responsibilities, Conservation Districts, Non-Profits *Others*: DFW, Ecology, Counties	Medium to High	*Main*: State or federal grants; Leg. appropriations *Additional*: N/A

Table 4-11 (cont.)
Implementation Considerations for Stream Flow Management Actions

Priority(1)	Activity	Implementers(3) (4)	Financial/ Economic Costs(2)	Funding Sources
Medium	Large water users and hydropower facilities: short-term drought response curtailment programs, to protect stream flows.	*Lead*: Selected public water systems; hydropower operators *Others*: N/A	Low to medium	*Main*: Large water users and hydropower facilities *Additional*: N/A
Medium	Evaluate the need to take additional actions addressing shallow aquifer interactions.	*Lead:* Planning Unit or successor organization *Others:* N/A	Low	*Main:* Phase 4 implementation funds *Additional*: TBD
Medium	Develop clear guidance for mitigation.	*Lead:* Ecology *Others:* N/A	Low	*Main:* Leg appropriations (Ecology budget) *Additional:* N/A
Medium	Wetlands inventories and ordinances: assess and protect hydrologic functions, consider strengthening mitigation ratios.	*Lead*: Counties and Planning Unit *Others*: N/A	Medium	*Main*: County development fees or general fund revenues (note staffing impact), grants *Additional*: N/A
Low	When modifying or adopting comprehensive plans, zoning designations, or other land use regulations, consider the water balance implications of allowing extension of sewer service to communities formerly served by septic systems.	*Lead*: Counties, Cities *Others*: Sewer agencies if different from Counties, Cities.	Low	*Main*: Counties, Cities general funds, permitting fees, grants *Additional*: N/A
Low	Water conservation by farmers practicing irrigated agriculture. Technical assistance by Conservation District in each county.	*Lead*: Agricultural producer *Others*: Conservation Districts	Medium	*Main*: Agricultural producer *Additional*: Leg. Appropriations (Cons. Commission & CD budgets).
Low	Source substitution for selected areas served by domestic wells: relatively higher densities and likelihood of stream impacts; dependent on feasibility and cost.	*Lead*: Counties *Others*: Public water systems, landowners	Medium to high	*Main*: Assessments on affected properties (local improvement districts), grants *Additional*: Federal and State salmon recovery funding; Leg. appropriations

(1) Priority in context of all actions in Watershed Management Plan.

(2) Preliminary, generalized estimates of financial or economic costs to the affected community, implementing organization or water user. High: greater than $500,000; Medium: $50,000 to $500,000; Low: less than $50,000. Total cost, whether up-front or over a period of time up to ten years.

(3) "Lead" implementer would take responsibility for organizing efforts under this action, including pursuing funding sources listed in the far right column.

(4) Lead and support roles will vary depending on jurisdiction and geographical area.

Abbreviations: CD = Conservation District, N/A = Not Applicable, USGS = U.S. Geological Survey, Leg. = Legislative

Section 5
Management of Surface Water Quality

The WRIAs 27 and 28 Planning Unit has identified protection and improvement of surface water quality as an important objective linked to the Watershed Management Plan. At the same time, the Planning Unit recognizes that programs already exist to protect and improve water quality, and it is not desirable to duplicate these programs. These include locally based water quality assessment efforts, such as Clark County's coordinated water quality monitoring program to ascertain the surface and ground water quality conditions under State stormwater pollution control requirements. In addition, the primary vehicle for achieving compliance with State criteria for surface water quality is the Washington State Department of Ecology's (Ecology) Total Maximum Daily Load (TMDL) program, also known as Water Cleanup Plans. In an effort to ensure that all waters of the State meet or exceed designated water quality standards, Ecology is engaged in a long-term process to develop water cleanup plans by assessing sources of water quality impairment and developing measures to reduce pollutant loading.

Policy SWQ-1

The Washington State Department of Ecology's program to set Total Maximum Daily Loads (TMDLs) for water bodies that do not meet state water quality standards is the primary vehicle for addressing surface water quality at the regional scale.

The Planning Unit determined that it would be valuable to provide guidance to Ecology in terms of prioritizing activities with regard to water cleanup plans. Local input at the watershed scale can help ensure that limited water quality funding is allocated in an effective and efficient manner. This section summarizes activities undertaken by the Planning Unit in regards to developing this guidance. Ecology's current list of polluted waterbodies is provided, followed by a discussion of pollutant sources in each subbasin. A proposed framework for prioritizing cleanup plans is then described, including Ecology's current listing methodology and recommendations generated by the Planning Unit for TMDL prioritization. Also included in the section is a discussion of water quality monitoring efforts, both existing and proposed future activities.

More detail regarding the Planning Unit's efforts regarding surface water quality management is provided in Technical Memorandum No. 7 (Task 4).

5.1 303(d) Listed Waterbody Segments

As required by section 303(d) of the federal Clean Water Act (CWA), every two years each state must identify its polluted waterbody segments and submit a list of these water quality limited estuaries, lakes, and streams to the U.S. Environmental Protection Agency (USEPA). To qualify for the list, it must be determined through water quality monitoring that the waterbody segment does not meet state surface water quality standards and that water quality is not expected to improve within the next four years. The standards are the criteria to ensure that water may be beneficially used for multiple purposes such as fishing, swimming, drinking, and fish habitat.

At the time this Watershed Management Plan was developed, Ecology's 1998 303(d) list served as the State's official list of impaired water bodies. Development of the "2002/2004" list was underway, and a draft of this new list is included as Appendix E of this plan. However, the 1998 list was used to develop recommendations. Once finalized the 2002/2004 list should be revisited during the implementation phase of the Watershed Management Plan.

Washington State is required by the USEPA to set priorities for establishing TMDLs, or cleanup plans for these impaired waterbody segments. A cleanup plan, designed to restore the beneficial use of the impaired waters, consists of an analysis of how much pollution a waterbody segment can receive, recommendations for controlling point source and nonpoint source pollution, and a monitoring plan to ensure the effectiveness of cleanup actions.

In general, monitored waterbody segments in Washington State are those segments with a history of pollution problems. According to Ecology, the 1998 303(d) list Statewide includes a total of 643 segments out of 1,099 for which data are available. These impaired segments compose only about two percent of all the waters in Washington. This indicates that the 303(d) list is a useful yet incomplete inventory of stream segments in violation of water quality standards.

Table 5-1 is an inventory of 25 waterbody segments in WRIAs 27 and 28 that are impaired for one or more water quality parameters and on the 1998 303(d) list of impaired segments.

Only the North Fork Lewis River and Washougal River subbasins[1] do not contain waterbody segments that are officially listed as impaired. Temperature and fecal coliform are the most common parameters in violation of standards within the planning area, with 15 and 14 impaired waterbody segments, respectively. Twelve segments are listed for violations of dissolved oxygen standards, while eight are listed for violations of pH.

Table 5-1 should not be considered an exhaustive inventory of all segments in the study area with water quality impairments, but only those that met criteria established by Ecology and were then approved by USEPA. Agencies have limited resources to monitor water quality conditions; therefore, water quality data are not available for many waterbody segments in the planning area. The data that are available are often based on permit requirements and specific agency monitoring objectives. Also, parameters and numbers of stations are subject to these limitations, and not presently designed to give the best assessment of water quality conditions in all waterbody segments.

[1] For this analysis, the Lacamas Creek watershed is considered a separate subbasin.

Table 5-1
1998 303(d) List[1] of Impaired Waterbody Segments in WRIAs 27 and 28

Listed Waterbody Segment	Parameter(s)[2] in Violation of Water Quality Standards	Waterbody Identification Number
Kalama River Subbasin		
Hatchery (Fallert) Creek	Temp	FX65ID
Kalama River	Temp	QB311V
East Fork Lewis River Subbasin		
East Fork Lewis River	Temp, FC	EI60MF
Lockwood Creek	FC	YD45JI
McCormick Creek	Temp, FC	GF76XA
Rock Creek (lower)	FC	MI81KO
Rock Creek (upper)	FC	XD64JB
Yacolt Creek	FC	KS71ST
Burnt Bridge Creek Subbasin		
Burnt Bridge Creek	DO, Temp, pH, FC	GB90VP
Salmon Creek Subbasin		
Cougar Canyon Creek	DO	RU61ZG
Curtin Creek	FC	XU25TT
Lake River	Temp, FC, Sediment Bioassay	IQ64OU
Mill Creek	FC	IQ96OD
Salmon Creek[3]	Temp, FC, Turbidity	FP99QE
Weaver (Woodin) Creek[3, 5]	FC	HO68MC
Lacamas Creek Subbasin		
China Ditch	DO, Temp	QY97TT
China Lateral	DO, Temp	RP10YQ
Cowpie Creek	DO	KE32SQ
Dwyer Creek	DO, pH	YQ90IX
Fifth Plain Creek	DO, Temp, pH, FC	QO04UK
Lacamas Creek	DO, Temp, pH, FC	YQ90IX
Matney Creek	DO, Temp, pH	JY73PR
Mill Ditch	DO, Temp, pH	YI74SA
Shanghai Creek	DO, Temp, pH	IA24XE
Columbia River Tributaries Subbasin		
Gibbons Creek[4]	FC	ZT56LK

(1) From the 1998 303(d) List; Department of Ecology, State of Washington.
(2) Parameter Abbreviations: Temp (Temperature); FC (Fecal Coliform); DO (Dissolved Oxygen).
(3) TMDL was written to address fecal coliform and turbidity on Salmon Creek and fecal coliform on Weaver Creek.
(4) A TMDL was written to address fecal coliform for Gibbons Creek in 1996.
(5) USEPA approved a TMDL for biological oxygen demand and ammonia TMDL for Weaver Creek in 1993.

5.2 Current and Future Sources of Pollutant Loading in WRIAs 27 and 28

Water quality degradation in the planning area is attributable to typical sources of dispersed point and nonpoint pollution loading. A variety of land uses and permitted water pollution sources contribute a range of pollutant loading throughout the subbasins. Most of the waterbody segments in violation of water quality standards are located in the lower regions of the subbasins. With the exception of the Columbia River Tributaries subbasin, urban, agriculture, commercial, and industrial land uses dominate these areas. National Pollutant Discharge Elimination System (NPDES) permitted point-source discharges from a range of sources[2] are mostly concentrated in the lower areas of the subbasins. Nevertheless, water quality impairments are also found to a lesser extent in the middle and upper areas in the Salmon Creek, Lacamas Creek, and East Fork Lewis River subbasins.

As human population grows in the planning area, the spatial coverage of commercial and residential development will also increase, likely reducing the spatial coverage of forest and agriculture land uses. Even with stringent best management practices (BMPs) to limit pollutant loading from land use development, it is reasonable to anticipate increased pollutant loading and additional listings of water quality impaired segments from population growth.

The Department of Ecology regulates discharges of pollutants to waters of the State, under the Clean Water Act. Permit holders in WRIAs 27 and 28 are listed in Table 5-2. The Planning Unit did not review these discharges, nor develop strategies for management of point source discharges, because they are covered under existing law and regulatory programs.

[2] Fish hatcheries; industries and utilities; urban stormwater and waste water treatment plant outfalls; dairies; and gravel and timber handling operations.

Table 5-2
National Pollutant Discharge Elimination System (NPDES) Permits in WRIAs 27 and 28

Permit ID[1]	Facility Name	Category Type	Type of Permit	County
WA0040029D	Allweather Wood Treaters	Industrial	Minor	Clark
WA0000264C	Boise Cascade Vancouver	Industrial	Major	Clark
WA0040932B	Clark Cnty Pud Lower River Rd	Industrial	Minor	Clark
WA0000299B	Evergreen Aluminum LLC	Industrial	Major	Clark
WA0040711C	Exterior Wood Inc	Industrial	Minor	Clark
WA0000256B	Fort James Camas LLC	Industrial	Major	Clark
WA0000019C	Great Western Malting	Industrial	Minor	Clark
WA0040991A	Pacific Coast Shredding	Industrial	Minor	Clark
WA0041025A	Port of Ridgefield, Lake River	Industrial	Minor	Clark
WA0039527B	Saint-Gobain Crystals & Detectors	Industrial	Minor	Clark
WA0039616D	Seh America	Industrial	Minor	Clark
WA0000418C	Support Terminal Services	Industrial	Minor	Clark
WA0038776B	Tidewater Vessel Repair	Industrial	Minor	Clark
WA0040967C	Time Oil Co	Industrial	Minor	Clark
WA0039918C	Vancouver Ice & Fuel Oil	Industrial	Minor	Clark
WA0041980A	Wafertech LLC	Industrial	Minor	Clark
WA0020249B	Camas STP	Municipal	Minor	Clark
WA0023230C	Lacenter Sewage Treatment Plant	Municipal	Minor	Clark
WA0038687C	Larch Correction Center	Municipal	Minor	Clark
WA0024368C	Marine Park Water Reclamation Facility	Municipal	Major	Clark
WA0037184A	Paradise Pt State Park	Municipal	Minor	Clark
WA0023272C	Ridgefield STP	Municipal	Minor	Clark
WA0023639C	Salmon Creek STP	Municipal	Major	Clark
WA0024350C	Vancouver West STP	Municipal	Major	Clark
WA0037427B	Washougal STP	Municipal	Minor	Clark
WA0000353c	Chemtrade Performance Chemicals LLC	Industrial	Minor	Cowlitz
WA0039721c	Columbia River Carbonates	Industrial	Minor	Cowlitz
WA0000281c	Noveon Kalama, Inc	Industrial	Major	Cowlitz
WA0040851b	Steelscape Inc	Industrial	Major	Cowlitz
WA0020320c	Kalama STP	Municipal	Minor	Cowlitz
WA0040843c	Port of Kalama	Municipal	Minor	Cowlitz
WA0020401b	Woodland STP	Municipal	Minor	Cowlitz
WA0023388c	North Bonneville STP	Municipal	Minor	Skamania

Source: provided by Ecology staff.
STP = Sewage Treatment Plant
[1]Does not include stormwater permits.

The following sub-sections describe present water quality conditions in the planning area's subbasins. Much of this information is summarized from the Level I Technical Assessment (GeoEngineers, Inc., 2001).

5.2.1 Kalama River Subbasin

Over 97 percent of the Kalama River subbasin is forested, with the balance in agricultural and other developed uses that are concentrated closer to its confluence with the Columbia River. Other than regulated point sources of pollution loading concentrated near the mouth of the river, most pollution loading in the subbasin is attributable to nonpoint sources resulting from forest management practices and residential development. Minor land use changes are anticipated in this subbasin; therefore, future sources of pollution loading will likely predominate from timber management, stormwater runoff from roads, and other diffuse nonpoint sources of pollution. The Level I Technical Assessment concluded that:

> "…In general water quality of the river system is in good condition and improving, as the lands that were logged in the 1970s and 1980s have been reforested and the road maintenance practices have improved… The lower reaches of the Kalama River is {sic} at some risk {of water quality degradation} due to conversion of land from forest to rural suburban use."

5.2.2 North Fork Lewis River Subbasin

Like the Kalama watershed, forest cover dominates the land use in the North Fork Lewis subbasin, with the U.S. Forest Service managing 61 percent of the watershed. Minimal human development or land use changes are anticipated in the middle and upper regions of the subbasin. Although the watershed is not presently listed as water quality impaired, temperature standards in the middle and lower reaches of the watershed are occasionally exceeded. For example, temperature data collected under the FERC re-licensing of Swift Power Plant No. 2 at the Swift dam indicates violation of standards. In general, water quality is improving in the subbasin after an extensive period of logging and road building; however, increased development pressure in the lower reaches of the watershed has the potential to degrade water quality and necessitates enforcement and enactment of proper water pollution controls. According to the Level 1 Technical Assessment:

> "These impacts may be in the form of increased sediment from land clearing and road building, loss of riparian habitat for shading and fecal coliform from on-site septic systems that are not properly installed or maintained."

5.2.3 East Fork Lewis Subbasin

Land uses are respectively more varied in the East Fork Lewis subbasin than the Kalama or North Fork Lewis. Agricultural and residential land uses are prevalent throughout the lower half of the watershed, while the upper half of the watershed is largely forested. Water quality impaired segments, listed for violations of fecal coliform and temperature, are distributed throughout the su-basin, and not restricted to the more developed lower watershed. Significant conversion of agricultural and forested land uses to residential development is anticipated throughout the lower watershed, especially near the cities of LaCenter, Ridgefield, Battle Ground, and Yacolt. According to the Level 1 Technical Assessment, these land use changes have the potential to increase pollution loading in the form of stormwater and sediment run-off.

5.2.4 Gee Creek and Whipple Creek

Gee Creek and Whipple Creek are small tributaries that drain directly into Lake River. They are located immediately south of the East Fork Lewis subbasin. Agricultural and residential land uses prevail in these watersheds; however, Gee and Whipple Creeks are not listed as water quality impaired. Because of their proximity to the City of Vancouver, additional nonpoint source loading from future residential development should be anticipated in these watersheds.

5.2.5 Salmon Creek Subbasin

The Salmon Creek subbasin is located entirely within Clark County. Located in one of the fastest developing watersheds in the State, degraded water quality in Salmon Creek and its tributaries reflect the impacts of a diversity of land uses in the subbasin. Residential, commercial, industrial, and agricultural land uses dominate the lower subbasin, with forested land uses restricted mostly to the upper reaches of the watershed. Agricultural land uses are rapidly converting to rural-residential and urban uses throughout the watershed. Water quality limited streams are concentrated in the lower half of the subbasin and are listed for fecal coliform, dissolved oxygen, turbidity, and temperature violations. The region in the subbasin near the City of Vancouver is highly urbanized, where pollution loading from stormwater runoff and sedimentation are likely sources of impairment. Aside from existing pollution loading from agricultural land use, the Level I Technical Assessment found that increased development pressure in the watershed holds the potential to further degrade water quality:

> "These impacts may come from land clearing and road building, loss of riparian habitat, and fecal coliform from on-site septic systems that are not properly installed or maintained."

With nonpoint pollution sources suspected of impairing water quality in the Salmon Creek subbasin, in 1995 Ecology developed a cleanup plan (TMDL) for violations of fecal coliform and turbidity standards. The cleanup plan addressed potential impairments of beneficial uses on four tributary segments[(3)] and the Salmon Creek mainstem. The cleanup plan established load allocations for fecal coliform and turbidity; related allocations and reduction targets to land use; and, proposed a pollution reduction strategy and monitoring program to evaluate effectiveness. It also found that de-vegetation of upland forests and grasslands, construction activities, destruction of wetlands, poor agricultural practices, failing septic systems, and alteration of stream channels and riparian zones were factors contributing to the degradation of beneficial uses. Finally, the analysis noted that water diversions in the subbasin could result in further decreases in summer flows, with potentially deleterious effects on water quality.

[(3)] Cougar Canyon Creek; Mill Creek; Curtin Creek; and Woodin (a.k.a. Weaver) Creek.

5.2.6 Burnt Bridge Creek Subbasin

The lower half of the Burnt Bridge Creek subbasin is predominantly an urban watershed consisting of residential, urban, and commercial land uses. The upper half of the subbasin is urban except for areas in the flood plain. The watershed has some of the poorest water quality in the study area and is listed for violations of fecal coliform, dissolved oxygen, pH, and temperature. Violations of these parameters are common in highly urbanized watersheds with significant stormwater runoff.

In response to water quality impairment in Burnt Bridge Creek, the City of Vancouver and Clark County Public Works are implementing a program to maintain and construct storm water facilities and swales to manage stormwater volume and reduce pollutant loading to the creek. Also, under the Burnt Bridge Creek Regional Wetland and Trail Project, the City of Vancouver is working to improve the water quality, flood plain detention, and wildlife habitat in the subbasin. Further, the City of Vancouver will sign a stormwater phase II permit with Ecology, which will increase actions to control stormwater pollution in the subbasin. In sum, the Level I Technical Assessment concluded:

> "Land use and its associated impacts are the primary source of water quality degradation in the Burnt Bridge Creek watershed… Sedimentation, loss of shading, decreased riparian habitat, leaking on-site septic systems and stormwater runoff may decrease water quality in the watershed…"

5.2.7 Lacamas and Washougal River Subbasins

The greater Washougal River watershed consists of the Lacamas Creek and Washougal River subbasins. First, the middle and lower regions of the Lacamas Creek subbasin consist of agricultural, commercial, residential, industrial, and urban land uses, while the upper watershed is mostly forested. Middle reaches on Lacamas Creek are impaired for fecal coliform, dissolved oxygen, pH, and temperature. Lacamas Creek however is not accessible to migratory fish. There is a natural waterfall located less than a mile upstream of the confluence with the Washougal River that blocks all upstream passage of anadromous fish. Future residential development in the watershed is expected to have negative affects on water quality, including increased sedimentation and other loadings of contaminants delivered by stormwater run-off.

Clark County has recently performed water quality monitoring in the Lacamas Lake area, as documented in the report *Lacamas Lake Restoration Program: WY2000 and WY2001 Water Quality Monitoring* (March 2002). This document summarizes the restoration program that ended in 2001. This restoration program pursued agricultural BMPs to reduce nitrogen and phosphorus inputs to Lacamas Lake, an ambient water quality monitoring program, and public education efforts.

East of the Lacamas Creek subbasin, the Washougal River subbasin is mostly forested, with urban, industrial, and residential land uses concentrated near the mouth of the river around the City of Washougal. Future residential development is anticipated in the lower region of the watershed. Water quality in the Washougal River and its tributaries is generally good; the Washougal River mainstem and its tributaries are not listed as water quality impaired. However, according to the Level I Technical Assessment:

> "Agricultural land uses within the watershed pose a significant risk to overall water quality."

Clark County collected temperature data for the Washougal River and its major tributaries, the West Fork and Little Washougal, between 2002 and 2004. This information indicates water temperatures commonly exceed 70^0 F in the three streams.

5.2.8 Columbia River Tributaries Subbasin

With the exception of the Gibbons Creek watershed, little water quality data exists for the Columbia River Tributaries subbasin. Gibbons Creek watershed, located just east of the City of Washougal, is on the 303(d) list for violation of fecal coliform standards. The Department of Ecology developed a fecal coliform cleanup plan (TMDL) for Gibbons Creek in 1996, which defined pollution loading limits required to meet water quality standards throughout the watershed. According to the cleanup plan, suspected sources of elevated fecal coliform levels include failing septic systems and agricultural runoff from small farms and animal-keeping operations.

5.3 Framework for Prioritizing Cleanup Plans

Under state and federal law, Ecology must develop and implement cleanup plans for all impaired waterbody segments. According to Ecology staff, future cleanup plans will address every impaired water quality parameter in the subbasin: load allocations will be developed for all listed segments and parameters, not just for select tributaries or parameters like was common in previous cleanup planning efforts. For that reason, water quality impaired subbasins in WRIAs 27 and 28 will be ranked from highest to lowest priority for TMDLs.

Policy SWQ-1

The Washington State Department of Ecology's program to set Total Maximum Daily Loads (TMDLs) for water bodies that do not meet state water quality standards is the primary vehicle for addressing water quality at the regional scale.

The sections below describe Ecology's general process for prioritizing TMDLs, followed by the Planning Unit's specific recommendations for TMDL prioritization in WRIAs 27 and 28. Ecology staff have indicated that the recommendations prepared by the Planning Unit have been used in their program activities for establishing TMDL priorities.

5.3.1 Ecology's Listing Methodology to Prioritize TMDLs

Ecology revised its Water Quality Program Policy 1-11 in September 2002. This policy, otherwise known as the "listing methodology" or WQP Policy 1-11, describes the State's process to periodically assess and prepare a list of waters in which beneficial uses are impaired due to water quality problems and for which TMDL cleanup plans are required. This policy was developed to assess systematically the water quality monitoring status of all waterbody segments in the State, regardless of whether water quality conditions are being monitored or not. It also provides guidance for data submittal and quality assurance and for assigning a segment to the 303(d) list.

Surface water quality standards used for this assessment process are found in Chapter 173-201A WAC, and the federal National Toxic Rule and Human Health Criteria in 40 CFR Part 131. Criteria for 303(d) listed waters were developed to identify only those waters for which there is good documentation of impairment. Under this policy, every waterbody segment in the State will be assigned to one of five categories. Segments assigned to Categories 1-4 do not require a cleanup plan (TMDL) and are intended to "inform the public and other water quality efforts in the state." Only waterbodies in Category 5 constitute 303(d) listed waters, or those segments that require preparation of a cleanup plan.

Under the listing methodology, Ecology formulated their own means of prioritizing development of cleanup plans. As described in this policy, waterbody segments on the 303(d) list will be prioritized as high, medium, or low priority for preparing a TMDL. Primary and secondary criteria were developed to evaluate the listed segments. Ecology's primary criteria include:

- Vulnerability of waterbodies to degradation
- Risks to public health, including drinking water
- Risk to aquatic life and other water-dependent wildlife, especially threatened and endangered species.

If a waterbody segment ranks high for any one of these criteria, the cleanup plan will be given a high priority. Secondary criteria may also be considered – such as technical feasibility or prioritization from other planning processes – which will raise the priority level of that TMDL if one or more of these secondary criteria is identified that would make a TMDL significantly more beneficial, effective, feasible, or timely.

During 2003, Ecology assessed the 1998 and 2002 lists of impaired waterbody segments and held scoping meetings to schedule cleanup plans in WRIAs 27 and 28. The preliminary draft of the water quality assessment has been made available for public comment during January through March of 2004, with a final priority list anticipated to be submitted to USEPA for approval in the summer 2004. Also, under a Memorandum of Agreement signed in 1997 by USEPA and Ecology, all waterbody segments on the 1996 303(d) list must have TMDL studies completed by 2014.

5.3.2 Planning Unit Recommendations for Prioritizing Cleanup Plans

A sub-group of the Planning Unit was assembled to propose and apply criteria to prioritize impaired waterbody segments, and then use the findings from this analysis as the basis for recommending cleanup plans. A summary of this effort is provided below as local input to Ecology for implementing the TMDL program.

As an initial step in this process, the sub-group proposed criteria to guide the prioritization. These were proposed to help the Planning Unit take into account factors such as the defined objectives of the planning process, the importance of particular waterbodies in meeting those objectives, the quality of water quality monitoring data, the availability of management techniques for improving water quality, vulnerability of waterbodies due to anticipated growth and development in the subbasins, and other factors.

Six criteria were proposed and evaluated to prioritize cleanup plans in water quality impaired subbasins in the planning area. The criteria were based on the watershed planning goals and objectives of the planning unit, as well as issues associated with the practicality of cleanup success, anticipated development, and adequate data to substantiate prioritization. The criteria included:

- Surface water quality impairing water supplies (including ground water under the influence of surface water)
- Surface water quality harming human health from contact recreation
- Surface water quality harming listed fish species or other aquatic life
- Feasibility of water quality improvement in terms of practicality and cost
- Proactive management preferred due to anticipated land use changes
- Adequacy of data available for sound decision-making

These criteria were then applied to the subbasins in WRIAs 27 and 28 and used to develop recommendations for prioritization of cleanup plans.

Recommendation:

The Planning Unit recommends that Ecology develop TMDLs according to the priority list shown in Table 5-3. At such time as the 2002/2004 303(d) list is approved by Ecology and EPA, these priorities should be revisited.

Table 5-3
Summary Recommendations to Prioritize Cleanup Plans in WRIAs 27 and 28

Priority for Cleanup Plan (TMDL)	Water Quality Impaired Subbasin	Basis
1st	East Fork Lewis River	▪ Significant development anticipated ▪ Water quality threatens listed salmon species ▪ Potential human health impacts from contact recreation
2nd	Salmon Creek*	▪ Significant development anticipated ▪ Water quality threatens listed salmon species ▪ Potential human health impacts from contact recreation
3rd	Lacamas Creek	▪ Significant development anticipated ▪ Potential human health impacts from contact recreation ▪ Potential fisheries impact below dam
4th	Burnt Bridge Creek	▪ Programs in place to address water quality impacts for Burnt Bridge Creek
5th	Kalama River	▪ Limited temperature impairments in Kalama River

* Ranked 2nd because a TMDL is already developed in Salmon Creek for turbidity and fecal coliform.

The Planning Unit recommends that the East Fork Lewis River subbasin be the highest priority for a cleanup plan, while the Salmon Creek subbasin should be prioritized second. As the human population grows in this planning area, significant land use changes are anticipated to occur rapidly in some areas and minimally in others. Previous analysis in this watershed planning effort indicates significant anticipated land use changes in the East Fork Lewis River, Salmon Creek, and Lacamas Creek subbasins, and to a lesser extent in the other subbasins. Water quality in rapidly developing and developed watersheds is already showing signs of degradation from land use and other growth activities. In addition, the East Fork Lewis and Salmon Creek subbasins are accessible to listed salmon stocks; some segments in both of these subbasins are also in violation of temperature standards. Although no municipal water suppliers depend upon surface water from these subbasins, uncertainty exists regarding human exposure to fecal coliform from contact recreation. In short, the East Fork Lewis River subbasin should be prioritized first for a TMDL because Ecology developed a cleanup plan for fecal coliform and turbidity in January 2001 for select tributaries and mainstem of Salmon Creek.

Like the East Fork Lewis River and Salmon Creek subbasins, no municipal water suppliers use surface water from the Lacamas Creek subbasin, and uncertainty exists regarding human exposure to bacteria from contact recreation. The Lacamas Creek subbasin is listed for violations of dissolved oxygen, temperature, pH, and fecal coliform. Though there is a dam near the downstream end of Lacamas Creek, the reach below it supports numerous species of fish, two of which are listed as threatened under the Endangered Species Act (ESA). Because of significant degree of water quality impairment in this subbasin, it is ranked third in priority for a cleanup plan.

Burnt Bridge Creek and Kalama River subbasins are ranked as fourth priority and fifth priority, respectively. Impairments in these subbasins are not less important than in other subbasins. However, they are ranked as the lowest priority because the City of Vancouver is implementing programs to reduce pollutant loading: the “Burnt Bridge Creek Regional Wetland Bank and Greenway Trail Project” undertaken by the Vancouver-Clark County Parks and Recreation includes management measures to reduce pollutant loading and improve water quality in the subbasin; in the mid-1990s the Clark County Water Quality Division developed the “Burnt Bridge Creek Watershed Plan” which implemented a program to develop a capital improvement plan to reduce stormwater runoff and pollutants, investigate sources of pollution in the subbasin, enhance public education and outreach programs to protect water resources, and complete a cost/rate study for flood control and water quality protection.

The Kalama River subbasin is ranked as last priority for cleanup plans. Under the 1998 303(d) list only two waterbody segments are listed for violations of temperature standards in the Kalama River and its tributaries. However, limited water quality monitoring data are available for this subbasin. Therefore, more extensive water quality monitoring in the Kalama River subbasin would improve knowledge of ambient water quality status and trends.

The Washougal River subbasin is not listed as a priority for development of cleanup plans, as it is not included in the 1998 303(d) list. However, the subbasin is included in the draft 2002/2004 303(d) list, for fecal coliform. Additionally, Clark County collected temperature data between 2002 and 2004, for the Washougal River and its major tributaries, the West Fork and Little Washougal. This information indicates water temperatures commonly exceed 70^0 F in the three streams. Therefore, when the 2002/2004 303(d) list is approved by Ecology and EPA, the Washougal River subbasin should be reconsidered for prioritization, based upon the above information.

5.4 Water Quality Monitoring in WRIAs 27 and 28

Gathering information on water quality conditions is an important element in a water quality management program. The WRIA 27 and 28 Planning Unit has identified information needs in two distinct categories. First, it is valuable to have water quality monitoring data to characterize water quality conditions in surface waters. A regional monitoring program is proposed for this purpose. Second, it is valuable to gather information on site-specific sources of water quality impairment. This provides a basis for actions to improve water quality.

Section 5.4 of the Watershed Management Plan presents a proposed approach to water quality monitoring of a range of parameters on a regional basis. Section 5.5 presents a proposed approach to identifying specific non-point sources of water quality impairment.

5.4.1 Existing Water Quality Monitoring Efforts

The list of 303(d) impaired waterbody segments in WRIAs 27 and 28 – and throughout the State for that matter – is driven by the availability of quality-assured water quality monitoring programs and the ambient water quality data they generate. Waterbody segments or subbasins that are thought to be impaired are typically monitored more intensively than those thought to be unimpaired by pollution.

The frequency of water quality monitoring, as well as the monitoring protocols and parameters sampled, are usually not consistent among monitoring programs, locations, or even within subbasins. These inconsistencies are due to factors such as the perception of ambient water quality conditions, permit requirements for wastewater discharges, limitation of resources, technical capabilities, and sampling location accessibility. Again, because of these factors, the 303(d) list of impaired waterbody segments should not be considered a complete inventory of water quality impaired segments or conditions where standards are in violation of water quality criteria in the planning area. Relatively extensive amount of water quality monitoring data exists for the Salmon Creek Subbasin.

Water quality monitoring is occurring throughout the basin under the auspices of various local, State, and federal programs and regulations. A compendium of known local, State, and federal monitoring programs in the study area is provided as Appendix K. A summary of current water quality monitoring activities in the basin include:

- U.S. Forest Service, under the Northwest Forest Plan, is monitoring water temperature at 23 stations in the headwaters of the North Fork Lewis and East Fork Lewis Rivers every 30 minutes from June through September.

- Ecology, through their Statewide and regional water quality assessment program, is monitoring five stations in the study area on a monthly basis.

- Clark County is monitoring water quality at ten long-term index stations on tributaries to Lake River, Salmon Creek, Cedar Creek, Lacamas, Little Washougal, and East Fork Lewis River.
- Clark County is also monitoring water quality in the Salmon Creek subbasin, a program that was started in 1995 by Clark Public Utilities.

5.4.2 Proposed Water Quality Monitoring Program

As part of its assessment of water quality information, the Planning Unit reviewed existing water quality monitoring activities being conducted by local, State, and federal agencies (Appendix H). From this review, it was apparent that water quality monitoring activities currently in place are designed to meet specific needs of various programs but are not comprehensive in terms of either the network of streams or the types of parameters monitored. In the absence of a comprehensive monitoring framework at the regional scale, it is difficult to identify impaired water bodies, characterize status and trends in surface water quality, or develop effective approaches to improving water quality.

The Planning Unit developed a recommended strategy for improving water quality data collected. Full documentation of this strategy is presented in a Technical Memorandum (Barber, 2004). The Planning Unit identified the three primary reasons for monitoring water quality in their watersheds as being able to determine the effects on:

- human health via drinking water systems relying on surface water,
- human health through contact recreation, and
- fish species listed under the Endangered Species Act (ESA) and other aquatic life.

These criteria are primarily associated with monitoring for 1) identifying specific existing or emerging water quality problems and 2) characterizing waters and identifying changes or trends in water quality over time. In addition, the current 303(d) listings show temperature to be a parameter of concern throughout WRIAs 27 and 28. As temperature is also a concern for anadromous fish, all monitoring sites would be equipped with temperature gauges. It should be specifically noted that a premise of the sampling design was that collecting information for improved fisheries management (particularly those listed under ESA) was an essential driver. Many of the proposed sites pose little to no threat to drinking water supplies even under projected population growth estimates. Many of the monitoring sites and parameters would be unnecessary and the frequency of sampling would be different if only human health problems were considered.

The proposed Water Quality Analysis Plan (WQAP) would monitor core water quality information related to flow, temperature, nutrients, and several other parameters at as many as 28 different stream segments (not all parameters measured at each segment). The monitoring plan is shown in Tables 5-4 and 5-5. The types of monitoring objectives that the WQAP would address are those concerned with baseline information and background information for identifying long-term trends.

A range of options was discussed with the Planning Unit members in order to determine the practical scope of the monitoring plan in terms of what could be expected given funding limitations. It became apparent that given the size of the watersheds in WRIAs 27 and 28, sampling each waterbody for parameters such as macroinvertebrates, pesticides, and heavy metals would be too expensive.

Table 5-4
Summary of Field Parameters for the Water Quality Analysis Plan

	Field Sites (locations-frequency)				
Waterbody Segment	**Flow(1)**	**Dissolved Oxygen**	**pH**	**Specific Conductance**	**Temperature(2)**
Burnt Bridge Creek Subbasin					
Burnt Bridge Creek	3-Q	3-M	3-M	3-M	3-M
Columbia River Tributaries					
Gibbons Creek	1-Q	1-Q	1-Q	1-Q	1-Q
Greenleaf Creek	1-Q	1-Q	1-Q	1-Q	1-Q
Kalama Subbasin					
Kalama River	1-Q	1-T	1-T	1-T	1-T
Little Kalama River	1-Q	1-T	1-T	1-T	1-T
Lacamas Creek Subbasin					
China Ditch		1-T	1-T	1-T	1-T
China Lateral		1-T	1-T	1-T	1-T
Fifth Plain Creek	1-Q	1-M	1-M	1-M	1-M
Lacamas Creek	2-Q	2-M	2-M	2-M	2-M
Mill Ditch	1-Q	1-M	1-M	1-M	1-M
Shanghai Creek		1-M	1-M	1-M	1-M
Lake River Subbasin					
Lake River		2-M	2-M	2-M	2-M
Lewis River Subbasin					
Lewis River		2-T	2-T	2-T	2-T
Burris Creek		1-Q	1-Q	1-Q	1-Q
Salmon Creek Subbasin					
Mill Creek	1-Q	1-M	1-M	1-M	1-M
Morgan Creek	2-Q	1-T	1-T	1-T	1-T
Salmon Creek	1-Q	2-M	2-M	2-M	2-M
Weaver Creek		1-M	1-M	1-M	1-M
Washougal Subbasin					
Washougal River Site 1	1-Q	1-T	1-T	1-T	1-T
Washougal River Site 2		1-T	1-T	1-T	1-T
Little Washougal River	1-Q	1-T	1-T	1-T	1-T
West Fork Washougal		1-T	1-T	1-T	1-T

A – annually, C – continuously, M – monthly, T – two months, Q – quarterly
Numbers (1, 2, etc.) refer to number of sites to be sampled
(1) Download of continuous stage recorder and rating curve development
(2) Verification of continuous temperature loggers
Note: Monitoring shown here is in addition to active, ongoing monitoring activities (see Appendix K)

Table 5-5
Summary of Laboratory Parameters for Water Quality Analysis Plan

Waterbody Segment	Field Sites (locations and frequency)				
	TSS	E. Coli	Fecal Coliform	Total Nitrogen	Total Phosphorus
Burnt Bridge Creek Subbasin					
Burnt Bridge Creek	3-M	3-M	3-M	3-M	3-M
Columbia River Tributaries					
Gibbons Creek	1-Q	1-Q	1-Q	1-Q	1-Q
Greenleaf Creek	1-Q	1-Q	1-Q	1-Q	1-Q
Kalama Subbasin					
Kalama River	1-T	1-T	1-T	1-T	1-T
Little Kalama River	1-T	1-T	1-T	1-T	1-T
Lacamas Creek Subbasin					
China Ditch	1-T	1-T	1-T	1-T	1-T
China Lateral	1-T	1-T	1-T	1-T	1-T
Fifth Plain Creek	1-M	1-M	1-M	1-M	1-M
Lacamas Creek	2-M	2-M	2-M	2-M	2-M
Mill Ditch	1-M	1-M	1-M	1-M	1-M
Shanghai Creek	1-M	1-M	1-M	1-M	1-M
Lake River Subbasin					
Lake River	2-M	2-M	2-M	2-M	2-M
Lewis River Subbasin					
Lewis River	2-T	2-T	2-T	2-T	2-T
Burris Creek	1-Q	1-Q	1-Q	1-Q	1-Q
Salmon Creek Subbasin					
Mill Creek	1-M	1-M	1-M	1-M	1-M
Morgan Creek	1-T	1-T	1-T	1-T	1-T
Salmon Creek	2-M	2-M	2-M	2-M	2-M
Weaver Creek	1-M	1-M	1-M	1-M	1-M
Washougal Subbasin					
Washougal River Site 1	1-T	1-T	1-T	1-T	1-T
Washougal River Site 2	1-T	1-T	1-T	1-T	1-T
Little Washougal River	1-T	1-T	1-T	1-T	1-T
West Fork Washougal	1-T	1-T	1-T	1-T	1-T

A – annually, M – monthly, S – semiannually, T- every two months, Q – quarterly
Numbers (1, 2, etc.) refer to number of sites to be sampled
Note: Monitoring shown here is in addition to active, ongoing monitoring activities (see Appendix K).

The WQAP addresses watershed scale issues. It is anticipated that many of the sample locations would be located near the mouths of the streams. It is recognized, however, that it is often difficult to assess changes occurring from multiple land use or remediation activities along the stream using single point monitoring. For example, a stream temperature gauge at one location in a watershed may indicate whether there is a problem somewhere within the watershed. However, multiple sites are needed if there is going to be an attempt to isolate the cause of the problem. For that reason, a select few rivers have more than one proposed sampling location.

The goal was to provide a range of alternatives that fill data gaps currently existing. The technical memorandum on TMDL priorities (EES 2003a) summarized existing monitoring efforts. Every attempt was made not to duplicate ongoing long-term monitoring efforts. Because there are practically an infinite number of viable plans, the water quality monitoring program implemented may be somewhat different than the plan discussed in this document. Implementing agencies may mix and match parameters and locations according to available funding and ongoing projects. Opportunities to partner with other agencies may dictate some priorities and shift monitoring activities. There may also be opportunities to convert existing short-term activities into long-term efforts.

The data would be used by various federal, State, and local government agencies to inform local decisions about where to implement stream restoration projects, prioritize TMDL mitigation procedures, and to publicize any water quality problems and seek community solutions. Since much of the information would be used to satisfy TMDL requirements and assessments that require the approval of the Washington State Department of Ecology, every attempt should be made to follow their accepted procedures for data collection, analysis, format, and assurances. Other State and federal agencies such as the Washington State Department of Fish and Wildlife, the Washington State Department of Health, the US EPA, the National Marine Fisheries Service, Conservation Districts, local schools, Tribal interests, and other users would be given access to the data. However, each of these users will likely have different data requirements. BPA could also use this information to help prioritize their salmon recovery programs. In the future, program coordinators may want to contact as many potential information users as possible to determine their data needs and protocols.

The estimated cost of this plan includes: 1) upfront equipment and installation costs, and 2) annual sample analysis costs and coordination costs. The upfront equipment costs of the WQAP are $65,650. The annual cost is $154,650. The total first year cost for the WQAP is $214,600. This cost could potentially be reduced if volunteers were used to collect samples. However, use of volunteers does not always reduce costs, due to the need for ongoing training and logistical requirements to maintain a fixed monitoring program. Annual data processing and data management costs were not included in the budget. This plan assumes that a half-time staff person would be hired in order to coordinate monitoring activities.

For further information on the recommended water quality monitoring program, see the Technical Memorandum referenced above (Barber, 2004).

5.5 Framework for Assessing Non-Point Sources of Impairment

This section describes a proposed approach to assessing sources of water quality impairment. At this time, an initial framework has been developed to guide this activity. The framework is intended to serve as a basis for development of a more detailed assessment approach during the Implementation Phase, following adoption of this Watershed Management Plan.

Recommendation:

It is recommended that a detailed assessment strategy be developed for WRIAs 27 and 28 to identify sources of water quality impairment (specific sites or areas). Following completion of the strategy, it is recommended that funds be sought to carry out this assessment and take corrective actions where needed.

The purpose of the assessment strategy is to obtain specific information on sources of non-point source pollution, so they can be targeted for action. Once sites or areas are identified in each subbasin, follow-up actions can be defined, such as outreach and technical assistance to landowners; specific projects to eliminate or control sources; or, where appropriate, enforcement actions.

The following steps are identified for the assessment framework:

1. Identify and prioritize target activities or conditions, by subbasin;
2. Define metrics and techniques for gathering information on each target activity or condition;
3. Perform field work or other activities to gather information as defined;
4. Evaluate results;
5. Define and carry out follow-up actions to correct problems identified.

This sequence of steps is intended to be carried out for each subbasin within WRIAs 27 and 28 (See Exhibit 2-2). The full strategy should identify the sequence of subbasins for assessment, based on prioritization for water quality improvement as well as the extent to which assessment and corrective actions are already under way. The prioritization shown in Table 5-2 may be appropriate as a starting point.

The types of activity targeted will vary from one subbasin to the next, largely based on land uses and land cover. For example, several subbasins in WRIAs 27 and 28 have forested lands at the upper end of the subbasin; a mixture of forest, farm land, and rural residential lands; and, a limited amount of urban and suburban developed lands.

For this type of subbasin, the first two steps of the assessment framework would include elements such as those included in Table 5-6. This table was developed solely for purposes of illustrating this concept, and is not meant to serve as a comprehensive list of sources or assessment techniques. To carry out the third and fourth steps of the process, the information gathered would be evaluated in terms of actions needed to control or eliminate each specific source of impairment identified. This process can be carried out for each subbasin in the region.

For some types of impairment, the information techniques shown in Table 5-6 may need to be supplemented with site-specific water quality monitoring activities. These can help narrow down areas needing attention within a given subbasin; and can also serve to document effectiveness of actions designed to correct specific water quality problems in selected areas. This type of monitoring would be localized and have highly specific objectives. This is different from the regional monitoring program discussed in Section 5.4.

Assessment of this type has already been carried out for some activities, in some places within the region. Where this is the case, any renewed assessment activity should first take stock of information already gathered and control programs already in place.

Table 5-6
Source Assessment Process – Illustrative Examples

Land Use	Target Activities or Conditions	Metrics	Means of Gathering Information
Forested	Road failures and sediment loading due to improperly designed roads and culverts.	Percentage of road miles with culverts that pass 100-yr. flood event.	Field surveys
	Elevated water temperature due to insufficient shading from timber harvesting.	Miles of stream where desired buffers are intact or management practices to increase shading are under way.	Aerial photography and field surveys
	Other items as needed	TBD	TBD
Agricultural	Poor management of animal waste resulting in excessive nutrient loading	Number of farms with farm plans; degree of compliance with BMPs	Outreach to agricultural community via Conservation District
	Livestock grazing practices result in damage to riparian and aquatic areas	Same as above	Outreach, plus windshield surveys and aerial photography
	Cropping practices that result in soil erosion and loading of sediment	Same as above	Same as above
	Other items as needed	TBD	TBD
Rural and Rural Residential	Failing septic systems leading to loading of pathogenic bacteria.	Number of failing septic systems; aging septic systems; etc.	Analyze parcel data to identify parcels with potential to contribute to surface waters; public outreach; voluntary sanitary surveys/inspections.
	Inadequate sanitary control at recreation site restrooms	Number of sites failing health standards	Health district inspections
	Other items as needed	TBD	TBD
Urban/Suburban	Inadequate runoff detention facilities	Volume of runoff without adequate facilities	Field surveys, reports from transportation and utility work crews; public outreach
	Spills of hazardous substances impairing surface waters	Frequency and volume of spills of hazardous substances that reach surface waters	Dept. of Ecology spills reporting database
	Sediment from roads	Miles of roads with inadequate sediment control structures or O & M	Field surveys, reports from transportation and utility work crews, public outreach.
	Sediment from construction sites	Number and acres of construction sites with inadequate controls or permit violations	Field surveys, reports from transportation and utility work crews, public outreach.
	Other items as needed	TBD	TBD

TBD: To be developed at time the assessment program is developed fully.

5.6 Implementation Considerations for Surface Water Quality

Table 5-7 summarizes implementation considerations for the surface water quality recommendations discussed throughout Section 5, above. Implementation issues may vary somewhat from those listed in the table, depending on the specific action, and community involved. Where there are staffing impacts that would likely require hiring of at least ½ FTE by the implementing organization(s), they are called out in the funding column.

Table 5-7
Implementation Considerations for Surface Water Quality Actions

Priority[1]	Activity	Implementers[3] [4]	Cost[2]	Funding Sources
Category: Surface Water Quality				
Medium	Develop water body cleanup plans (TMDLs) for subbasins, in prioritized sequence as indicated in Watershed Management Plan. Carry out necessary modeling, reporting, public involvement, and waste load allocations.	*Lead*: Ecology *Other*: Local governments, Conservation Districts, other interested parties	High	*Main*: Leg. appropriations (Ecology budget) *Additional*: N/A
Medium	Within authorities, develop full scale assessment strategy for non-point sources	*Lead*: counties *Other*: Ecology, conservation districts, USFS, DNR	Low	Phase 4 implementation Grant
Medium	Within authorities, carry out source assessment of non-point sources	Same as above	Medium	TBD, (combination of State, federal, and local sources)
Medium	Actions to correct sources of impairment	*Lead:* Party causing impairment *Other:* Ecology, conservation districts	Medium to High	TBD (combination of State, federal, local and private source)
Low	Expand water quality monitoring activities to improve understanding of status and trends. Install monitoring equipment; collect and analyze samples; manage and analyze data; report results.	Shared efforts by State, local, federal agencies. Ecology will take lead on promoting cooperative arrangements among agencies.	High	Combination of State, local, federal funding sources (to be developed further in Implementation Phase)

(1) Priority in context of all actions in Watershed Management Plan.
(2) Preliminary, generalized estimates of financial or economic costs to the affected community, implementing organization or water user. High: greater than $500,000; Medium: $50,000 to $500,000; Low: less than $50,000. Total cost, whether up-front or over a period of time up to ten years.
(3) "Lead" implementer would take responsibility for organizing efforts under this action, including pursuing funding sources listed in the far right column.
(4) Lead and support roles will vary depending on jurisdiction and geographical area.
Abbreviations: TMDLs = Total Maximum Daily Loads, N/A = Not Applicable, Leg. = Legislative, TBD = To be developed

Section 6
Management of Ground Water Quality

6.1 Introduction

Many communities in Water Resource Inventory Areas (WRIAs) 27 and 28 (WRIAs 27 and 28) rely upon ground water as a primary source of water supply. The Planning Unit for WRIAs 27 and 28 published a Level 1 Assessment in which the Planning Unit evaluated water quantity and quality issues for both ground water and surface water sources. The Planning Unit subsequently established goals to guide the watershed planning efforts. The two goals related to water quality include:

- Protect surface water quality for designated uses, with an emphasis on protection of aquatic biota, including fish species in their various life stages.
- Protect surface and ground water needed for public drinking water supplies.

The first goal addresses surface water quality, which is discussed in Section 5. The second goal emphasizes the protection of water supply for drinking water purposes and is in line with state mandates which call for the protection of water as a resource for drinking water supplies. The purpose of this section is to present approaches and strategies for protecting ground water supply for drinking water purposes in WRIAs 27 and 28. "Drinking water purposes" include uses by the municipal, industrial, and domestic sectors.

It is recognized that within WRIAs 27 and 28, water supplies are used for a variety of uses, including agriculture, livestock, and dairies, however there is little indication that water quality concerns represent a significant limitation on other uses of ground water in WRIAs 27 and 28 beyond municipal, industrial and domestic uses.

The Vancouver Lake lowland has been identified as a major source of water supply for the region over the next 20 or more years and is of particular concern for managing potential water quality impacts to the source.

A variety of factors have the potential to contribute to the degradation in quality of ground water supplies, such as point and non-point pollution sources, shallow aquifer depth, and unprotected ground water supplies.[1] Furthermore, it is recognized that ground water and surface water are interrelated in that ground water discharging to surface water can affect surface water quality. However, with the possible exception of temperature impacts, ground water quality is likely not a major contributor to surface water quality in comparison with the many other factors affecting surface water. Thus, within WRIAs 27 and 28, ground water and surface water quality can be treated as discrete topics with their own set of protection criteria.

[1] In the context of this Plan, an "unprotected" ground water supply generally means an unconfined aquifer or the presence of improperly sealed wells.

Geographically, the focus is placed on the aquifers in the southwest portion of the planning area, because most of the ground water used for drinking water supply occurs in that area. While each of the different sizes and classes of water purveyors require equal attention, they have differing needs when it comes to ground water quality management. For example, larger purveyors may focus efforts on better implementation of existing wellhead protection plans or plan upgrades, whereas smaller purveyors may find it useful to focus resources in ways that reduce risks at those few sites which may pose a risk. It must be noted that these assumptions over-generalize the land use status of both types of purveyors. The strategies espoused in this section must be applied where appropriate and tailored to meet the needs of individual purveyors.

Land use is a major factor to consider while developing strategies to protect ground water quality. The characteristics of the sources play an important role also in the vulnerability or risk of source contamination. Assessment is needed to both prioritize areas for protection and to select the most appropriate actions or strategies to address those risks. Some of the management actions recommended in this section address this further.

6.2 Ground Water Quality Management Goals

What follows are general management goals that articulate the overall goal of protecting ground water supplies previously mentioned. These management goals were further refined based on a review of the specific conditions in WRIAs 27 and 28, and were used to guide the development of management objectives and actions described in detail in Section 6.5. The management goals may also serve as general benchmarks from which to measure the overall success of management objectives and actions. The following management goals are recommended for WRIAs 27 and 28.

- Prevent future impacts to clean ground water supplies
- Prevent further degradation of currently impacted ground water supplies
- Clean up impacted ground water supplies

In the context of this discussion, “clean” water means potable water that has contaminant concentrations consistent with background levels and “impacted” water means water with contaminant concentrations elevated above background levels. It should be noted that although naturally occurring constituents may also require treatment for the ground water source to be used as drinking water, the strategies presented here address anthropogenic sources and contamination that may impact ground water quality.

6.3 Summary of Ground Water Usage and Water Quality

Based on the Level 1 Assessment (GeoEngineers, 2001), there are two “geologic regions” within WRIAs 27 and 28 associated with the northern area and southwest area. Regarding the northern area of WRIAs 27 and 28, the Level 1 Assessment states:

> “The geology of the northern portion of the study area north of the North Fork Lewis River and the eastern portion of the study area within the Cascade Range consists of Miocene to Eocene volcanic and intrusive (igneous) formations. These formations consist of low permeability older

> rocks which generally do not form regionally extensive aquifers. An exception may be in higher permeability zones in basalt interflow zones or in localized river valley alluvium."

Essentially, ground water in the northern portion of the basin is not highly utilized because of the hydrogeologic conditions. The area is primarily heavily forested and does not have much development and projected population growth. The Level 1 Assessment goes on to describe the southwest portion of the basin where more of the development occurs:

> "The southwest portion of the study area comprises the northern half of the Portland Basin. The Portland Basin is a southeast-northwest trending syncline filled with approximately 1,400 feet of sedimentary deposits. These deposits include multiple aquifers capable of high ground water yields which serve almost exclusively as the public supply source for Clark County."

Thus, most of the ground water usage for drinking water supply occurs in the southwest portion of the basin where the most productive aquifers exist. For the purposes of developing ground water quality management objectives and actions, the focus is on issues related to the usage of ground water for drinking water supplies in the southwest portion of the basin.

Table 6-1 summarizes the hydrogeologic properties of the major geologic formations within WRIAs 27 and 28 for each subbasin, and includes comments on the usage and water quality of the ground water based on information from the Level 1 Assessment.

The southwestern portion of WRIAs 27 and 28, including the Salmon Creek subbasin, Burnt Bridge Creek subbasin, the western half of the East Fork Lewis River subbasin and the Lacamas Creek subbasin is filled with layers of approximately 1,400 feet of unconsolidated sediments. The unconsolidated sediments consist of layers of coarse-grained sand, gravel, and cobble deposits and layers of fine-grained silt and clay deposits. The coarse-grained deposits contain the principal aquifers within the planning area and the fine grained deposits act as aquitards or confining units, which separate the aquifers from one another. Some of the aquifers are capable of high ground water production and serve as the primary sources of supply to the larger water purveyors, industrial users, and others in Clark County. The most productive aquifer occurs within the Pleistocene Alluvial deposits which exist as a shallow unconfined aquifer in southern and western portions of Clark County. For example, many of the City of Vancouver's wells are completed in the Upper and Lower Orchards Aquifers, which are within the Pleistocene Alluvial deposit. Other important aquifers (in order of increasing depth) include the Upper and Lower Troutdale Aquifers and the Sand and Gravel Aquifer. The Pleistocene Alluvial and the Upper Troutdale Aquifers are considered to be most susceptible to contamination due to the lack of significant overlying confining units. Extensive confining units overlie the Lower Troutdale and Sand and Gravel Aquifers and provide protection from contaminant impacts.

Table 6-1
Summary of Ground Water Usage and Water Quality by Subbasin

Subbasin	Geologic Formations and Hydrogeologic Properties	Comments on Ground Water Usage	Comments on Water Quality
WRIA 27			
East Fork Lewis River Watershed	Pleistocene alluvial deposits and Sand and Gravel Aquifer are major aquifers	Domestic, irrigation, and small public and private wells are completed in the alluvial sand and gravel deposits CPU maintains a network of public supply wells throughout the Upper Troutdale Formation.	Ground water quality reported for the Upper Troutdale Aquifer is good; levels of primary and secondary parameters are within federal MCLs. The potential for ground water contamination exists due to a lack of a significant overlying confining unit.
North Fork Lewis River Watershed	Lower portion consists of Goble Volcanics, Upper Troutdale Formation and alluvial deposits Upper portion consists of volcanic rocks of Cascade Mountains	Upper Troutdale Formation is used for domestic or irrigation purposes Lower Lewis River Valley alluvial deposits capable of supporting large-capacity irrigation or public supply well. City of Woodland has a large Ranney Well in the Columbia River sand and gravel deposits, which draws from below the Lewis River and is subject to tidal influence.	Very little information is available on ground water quality in this watershed. The City of Woodland has records of pH, temperature, turbidity, inorganic and organic contaminants, nitrate, and radionuclides pertaining to their Ranney Well source. The potential for ground water contamination exists due to a lack of a significant overlying confining unit.
Kalama River Watershed	Basaltic andesite flows, Goble volcanics Composed mainly of rock with little alluvial deposits Low aquifer yield	City of Kalama utilizes highly permeable sand and gravel deposits in the lower end of the watershed; the source is a Ranney Well drawing from below the Kalama River and may be subject to tidal influence.	Very little information is available on ground water quality. The City of Kalama has records of pH, temperature, turbidity, inorganic and organic contaminants, nitrate, and radionuclides pertaining to their Ranney Well source. Water quality analysis performed for the City of Kalama indicated the presence of a shallow aquifer in the lower portion of the watershed near Kalama River is suitable for city use. The potential for ground water contamination exists due to a lack of a significant overlying confining unit.

Table 6-1 (cont.)
Summary of Ground Water Usage and Water Quality by Subbasin

Subbasin	Geologic Formations and Hydrogeologic Properties	Comments on Ground Water Usage	Comments on Water Quality
WRIA 28			
Burnt Bridge Creek Watershed	Pleistocene Alluvial Aquifer, Upper Troutdale Formation, Lower Troutdale Formation, Sand and Gravel Aquifer.	Pleistocene Alluvial Aquifer is extremely permeable and productive Upper Troutdale Formation also a water supply aquifer but has lower production than Pleistocene Alluvial Aquifer City of Vancouver has water rights in Orchards, Upper Troutdale, and Sand and Gravel Aquifer.	Excellent quality in the Pleistocene Alluvial Aquifer Contamination has been found for several municipal wells. Contamination of inorganic compounds in the Lower Troutdale Aquifer has been found and Vancouver has had to treat to remove iron and manganese for several deep wells in the Sand and Gravel Aquifer; however these are considered naturally occurring. Elevated levels of naturally occurring iron and manganese within the Sand and Gravel Aquifer require treatment of ground water prior to use as drinking water.
Salmon Creek Watershed	Recent alluvium, Upper Troutdale, Lower Troutdale Formation, and Sand and gravel aquifer are major aquifers	Domestic, irrigation, and small public and private wells are completed in the alluvial sand and gravel deposits CPU maintains a network of public supply wells throughout the Upper and Lower Troutdale Formations.	Upper Troutdale Aquifer has levels of primary and secondary parameters within federal MCLs and will permit extensive development of municipal ground water supplies. Once developed, ground water treatment need not go beyond chlorination. Elevated levels of naturally occurring iron and manganese within the Lower Troutdale and Sand and Gravel Aquifer require treatment of ground water prior to use as drinking water. The potential for ground water contamination exists from septic systems, fuel storage and other sites.

Table 6-1 (cont.)
Summary of Ground Water Usage and Water Quality by Subbasin

Subbasin	Geologic Formations and Hydrogeologic Properties	Comments on Ground Water Usage	Comments on Water Quality
Lacamas Creek Watershed	Upper Troutdale formation is a major aquifer for the watershed	Ground water is used for public supply, irrigation, industrial/commercial use and domestic use	Upper Troutdale Aquifer is of known good quality. Treatment to remove iron and other naturally occurring inorganic compounds has been recommended for some wells. Susceptible to contamination due to the lack of a significant overlying confining unit.
Washougal River Watershed	Upper portion consists of volcanic and intrusive bedrock Lower portion consists of Pleistocene Alluvial and Sand and Gravel Aquifer	Pleistocene Alluvial Aquifer in the Camas and Washougal area is used for municipal supply	Water quality is reported as good. Some deeper wells have been found with elevated levels of manganese and iron, which are considered naturally occurring. Susceptible to contamination due to the lack of a significant overlying confining unit.
Columbia River Tributaries Watershed	Composed of alluvium deposits, Boring Lava and basalt flows	Limited yield and capacity based on low permeability and poor infiltration capacity of formations City of North Bonneville withdraws a small municipal supply form alluvial deposits	No information was available from the Level 1 Assessment on ground water quality in this subbasin. Susceptible to contamination due to the lack of a significant overlying confining unit.

Information on ground water quality is fairly limited in the basin. However, the information available suggests that, in general, water quality is currently in good condition in the primary aquifers used for drinking water supply. Levels of primary and secondary parameters are generally within federal maximum contaminant levels (MCLs), although there are elevated levels of inorganic constituents such as iron and manganese that require treatment in some of the deeper wells screened in the Upper and Lower Troutdale formations. Recall, however, that naturally occurring constituents such as iron and manganese are not being addressed under the ground water protection actions discussed in this memorandum. The focus of the strategies presented here are the anthropogenic contaminants or those related to human activity.

6.4 Existing Approaches to Protecting Ground Water Quality

Existing statewide regulations, regional management programs, and additional programs have been reviewed for relevance to WRIAs 27 and 28. Each of these regulations and programs are available tools that can be used to help accomplish the overall goal of protecting the quality of ground water supplies.

6.4.1 Federal and State Regulations

A number of federal environmental laws are directly or indirectly designed to protect ground water from contamination. Examples of these laws include the Safe Drinking Water Act (SDWA); Resource Conservation and Recovery Act (RCRA); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); Toxic Substances Control Act (TSCA); and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). In most cases, state agencies are responsible for promulgating regulations in the state of Washington in accordance with these federal laws. Examples of state agencies with regulatory authority to protect ground water quality under the aforementioned federal laws include the Washington State Department of Health (DOH), Ecology, and the Department of Agriculture (WSDA).

Statewide regulations have some important limitations with respect to protecting ground water supplies from contamination. A summary of both applications and key limitations is presented in Table 6-2. Table 6-2 is not intended as a comprehensive guide, but provides an overview of applicable regulations for the purposes of this Watershed Management Plan.

6.4.2 Regional Management Programs

As noted above, existing statewide regulations have limitations which occasionally fail to protect ground water from contamination. Local government agencies often need to develop and implement a ground water management program to address the limitations of the regulations. Four existing ground water management programs provide a framework for local governments to protect ground water quality on a regional scale. Advantages and disadvantages of each of these programs are shown in Table 6-3.

Table 6-2
Existing Federal and State Regulations for Protecting Ground Water Quality

Regulated Activity	Regulatory Agency in Washington	Application to Ground Water Quality Goals in the Basin	Limitations for Ground Water Protection
Monitoring of Drinking Water Sources	DOH Drinking Water Division & County Health Departments	Detect impacts to drinking water supplies	Limited monitoring of Group A Public Water System sources [1,2] Minimal monitoring of Group B Public Water System sources [1,3] No monitoring of private household wells
Wellhead Protection	DOH Division of Drinking Water	Prevent degradation of drinking water supplies	Only applies to Group A Public Water Systems Some Group A Public Water Systems are non-compliant [4]
Solid and Hazardous Waste Management	Various Ecology Programs [5] & EPA Superfund Program	Regulate waste management activities and clean up actions to prevent degradation of ground water quality	Remediation actions occasionally fail to clean up contaminant concentrations to acceptable drinking water levels Difficult to regulate non-point sources of contamination
Hazardous Material Spills	Ecology Spill Prevention, Preparedness, and Response Program	Require facility prevention and preparedness plans; Respond to spills of hazardous materials to prevent degradation of ground water quality	Prevention and preparedness plans not required for small facilities Aquifer may be impacted despite spill response action Limited response to small spills
Wastewater Disposal	County Health Departments, DOH Wastewater Management Program, and Ecology Water Quality Program	Regulate septic systems and land application of wastewater to prevent degradation of ground water quality	Difficult to manage non-permitted and improperly installed systems Anecdotal evidence of septic system failures
Agricultural Practices	Washington Department of Agriculture	Regulate agricultural activities [6] to prevent degradation of ground water quality	Difficult to enforce permits and plans Not all agricultural and animal feeding operations are regulated

(1) A Group A Public Water System regularly serves 15 or more residential connections or 25 or more people per day for at least 60 days per year. A Group B Public Water System serves more than one residence or farm and less than 15 residential connections and 25 people per day.
(2) Sources are monitored for inorganic compounds (IOCs), volatile organic compounds (VOCs) and synthetic organic compounds (SOCs) every 3 years and monitored for radionuclides every 4 years. However, monitoring waivers are often granted by DOH to small Group A Systems by DOH for reduced monitoring of VOCs and SOCs. In addition, systems serving less than 10,000 people are not required to monitor for unregulated contaminants. Examples of unregulated contaminants include methyl tertiary-butyl ether (MTBE) and hormones and antibiotics. MTBE is an additive in some gasoline products that has impacted ground water supplies in some parts of the country. Hormones and antibiotics from concentrated animal feeding operations have impacted ground water supplies in some parts of the country.
(3) Sources are monitored for IOCs initially and monitored for nitrate once every 3 years.
(4) Approximately 8 percent of Group A Public Water Systems were non-compliant Statewide in 1999 according to DOH Publication 331-148.
(5) Including Solid Waste Program, Hazardous Waste and Toxics Reduction Program, Nuclear Waste Program, and Toxics Clean up Program.
(6) Including use and storage of pesticides and fertilizers and concentrated animal feeding operations.

Table 6-3
Existing Regional Programs for Protecting Ground Water Quality

Program Name	Advantages	Disadvantages	Washington Examples
Sole Source Aquifer (SSA) Program	EPA review of federally financed projects Provides justification for receiving grants Increases public support for protecting ground water	Have to apply for designation with EPA Federal involvement in local issues Additional bureaucracy	Spokane Valley Lewiston Basin Whidbey Island None in WRIAs 27 and 28
Ground Water Management Area (GWMA) Program	Protect ground water quality **and** quantity Existing water rights are recognized Allows for coordinated management Increases potential for state grants	Have to apply for designation with Ecology and satisfy statutory obligations Would require extensive coordination for implementation in two counties Additional bureaucracy	Columbia Basin Kitsap County South King County
Aquifer Protection Area (APA) Program	Raises money for local ground water protection activities Provides local funding source	Legislature would need to designate aquifer protection area Additional taxation for water & septic use Program sunsets in 2006 and may not be re-authorized by Washington Legislature	Spokane County
Critical Aquifer Recharge Area (CARA) Designation	Ground water protection issues addressed during land use planning Developed at local level	Local zoning and land use ordinances would be needed Designation does nothing to prevent degradation of ground water quality unless specific strategies are implemented	City of Vancouver Clark County

The United States Environmental Protection Agency (USEPA) has a Sole Source Aquifer (SSA) Program for qualifying ground water supplies. The Ground Water Management Area (GWMA) Program under Ecology's Water Resource Program can be used to address ground water quality and quantity issues (see Section 6.3). The State of Washington legislature has also established guidelines for an Aquifer Protection Area (APA) Program. Finally, cities and counties are required to designate Critical Aquifer Recharge Areas (CARAs) in accordance with Washington's Growth Management Act (GMA). Of course, local governments can also adopt and implement an independent ground water management program if the existing programs do not satisfy local needs.

6.4.3 Clark County – Ground Water Management Program

In 1987, Clark County received designation to become a GWMA and formed a Ground Water Advisory Committee (GWAC) to develop a ground water management program and protection plan (GWMP) (Clark County, 1992). Clark County, local government jurisdictions (e.g., City of Vancouver, Clark Public Utilities), and the U.S. Geological Survey (USGS) contributed to the development of the management plan. The goal of the GWMP was "to manage, preserve, and properly manage ground water and related resources by applying the most feasible and reasonable water and land use regulations; and through education, develop an attitude of individual and community stewardship of ground water in Clark County."

The GWMP involved primarily USGS staff performing water level measurements throughout the County to develop a database, and the development of a complex hydrogeologic-based computer model for water flow analysis in Clark County. As part of this process, a County-wide water quality testing program established a water quality benchmark and status report. The GWAC also developed several issue papers that identified ground water threats and strategies and activities to manage those threats. The final plan was a multi-volume, ground water management plan that was finalized in December 1992. Categories of activities recommended by the GWMP include management of ground water resources, public awareness/education, commercial chemical management, wellhead protection, emergency abatement and restoration management, ground water supply planning, and stormwater management.

With respect to implementation of plan activities, affected jurisdictions would implement strategies that they could feasibly and reasonably carry out within their authority. Implementation was structured such that a Water Planning Forum was to be responsible for developing regulations and making available funding necessary to implement activities identified in the GMWP. Clark County was to develop model ordinances and suggested annual work plans to guide a coordinated program.

The GWMP was never formally adopted by County Commissioners, and hence was used in the County simply as guidance in developing other related programs in subsequent years. Currently, programs and activities developed by Clark County are implemented as a result of other regulatory requirements rather than stemming directly from the GWMP recommendations. For example, programs such as the "Stormwater and Watershed Program" and "Clean Water Program" incorporate components of the GWMP, but were developed to comply with the Clean Water Act. Many of the recommended activities have been implemented in Clark County. Furthermore, many of the activities are supported by actions recommended in this Watershed Management Plan.

6.4.4 Additional Programs

Two existing small-scale programs were identified that attempt to protect ground water from contamination by providing technical and/or financial assistance to individual homeowners and farm owners. The national "Home-A-Syst/Farm-A-Syst" Program has been used by Washington State University (WSU) Cooperative Extension to assist owners of private household wells in conducting voluntary water quality risk assessments. Technical assistance is available about well and septic system maintenance, household hazardous waste, petroleum storage, livestock management, fertilizer use, and pesticide use.

Another small-scale program is the Environmental Quality Incentives Program (EQIP) operated by the United States Department of Agriculture's Natural Resources Conservation Service (NRCS). EQIP provides individual farmers and ranchers with financial and technical assistance to conduct environmental improvements on their farms and ranches. For instance, incentive payments can be granted to farmers who implement best management practices (BMPs) related to nutrient and pesticide use.

6.4.5 Ground Water Protection Status of the Largest Public Water Systems

The ground water quality review is focused on protecting ground water supplies used for drinking water purposes. Furthermore, the focus is placed on the aquifers used for this purpose in the southwest portion of the basin, because most of the ground water used for drinking water supply occurs in that area. The current program for protecting ground water drinking water supplies in the WRIAs 27 and 28 basin is the Wellhead Protection Program and Critical Aquifer Recharge Area program. All Group A Public Water Systems with ground water as a source are required to have a wellhead protection plan as part of their water system plan (WAC 246-290-135). Critical Aquifer Recharge Areas (CARAs) are required to be classified, designated, and regulated when a municipality (e.g. a city, a county, a water district) has aquifer recharge areas within its boundaries (RCW 36.70A).

As Table 6-4 shows, the largest public water systems (with the exception of Ridgefield) have up-to-date wellhead protection plans approved by DOH and CARA ordinances in place. All three counties associated with WRIAs 27 and 28 (Clark, Cowlitz, and Skamania Counties) have critical areas ordinances that regulate activities in critical areas including aquifer recharge areas. It should be noted that Clark Public Utilities does not have legal authority to pass ordinances and must rely on cities and Clark County to pass and implement CARA ordinances for implementing its wellhead protection plan. Most cities in WRIAs 27 and 28 and Clark County have CARA ordinances. Local CARA ordinances may be tailored to minimize or eliminate the limitations for the regional management programs listed in Table 6-3. However, as demonstrated by CPU's situation, enforcement may be difficult if purveyors do not have jurisdiction or authority to enforce their management strategies. In general, however, Clark County has been proactive in its programs to protect ground water and has coordinated with the local jurisdictions through its Clean Water Program and Storm water and Watershed Resource Program.

Table 6-4
Ground Water Protection Status of the Largest Public Water Systems in WRIAs 27 and 28

Large Group A Public Water Systems	WRIAs	Drinking Water Source	Wellhead Protection Plan	CARA Ordinance
Clark County	28	(3)		X
Clark Public Utilities	28	GW	X	(2)
Vancouver	28	GW	X	X
Washougal	28	GW	X	X
Battle Ground	28	GW	X	(1)
Camas	28	GW, SW	X	(1)
Yacolt	28	GW	X	X
Ridgefield	27	GW		

GW means ground water; SW means surface water.

(1) Battle Ground and Camas do not have a CARA ordinance; however both are in the legislative process and are expected to adopt them by the end of 2003.

(2) Clark Public Utilities does not have legal authority to pass ordinances, so therefore relies on cities and counties to pass and implement such ordinances.

(3) Clark County is not a water purveyor; however has an ordinance to protect wells located outside of the jurisdictions of cities, but within unincorporated Clark County. Clark County is included in this table, because CPU relies on their ordinance to implement its wellhead protection plan. Note, Skamania and Cowlitz Counties also have a critical areas ordinance that specifies regulated activities on designated critical areas including aquifer recharge areas.

The City of Vancouver recently passed a "Water Resources Protection Ordinance" (VMC Chapter 14.26) in November 2002, which establishes development regulations and minimum standards to reduce risks of contaminants entering the water resources of the City. The ordinance designates the entire City of Vancouver as the critical recharge aquifer area, which prohibits certain new uses from locating in the City. Other actions are set forth in the ordinance to prevent ground water, surface water, and storm water contamination. In addition, "Special Protection Areas" are designated around the wellheads in the City's boundaries. Besides, the designations and development restrictions, the ordinance also includes best management practices and other measures to protect water resources and provides education and technical assistance programs for residents and businesses to protect ground water sources.

In general, the primary disadvantage associated with the CARA program (see Table 6-3) is that local ordinances must be developed in order to define actual steps to protect the aquifers. For the most part the largest public water systems have developed these local ordinances and have begun to implement the programs.

6.5 Recommended Management Objectives and Actions

Five management objectives were developed for ground water quality purposes in WRIAs 27and 28 and are described below. For each recommended objective, a discussion of the purpose, rationale, and relationship to other objectives is presented. Specific actions and implementation considerations for each objective are also discussed. The management objectives were based on the conclusions and recommendations found in the Level 1 Assessment. A table showing proposed agency involvement for completing the objective is included in the "Implementation Considerations" section found after each objective and list of action items. This table also contains a planning-level assessment of staff resources, implementation cost, short-term benefit, and long-term benefit. These objectives are generally consistent with Clark County's Ground Water Management Program (see Section 6.3).

Recommendation: The Planning Unit recommends that steps be taken to:

- Improve public understanding and awareness of issues related to drinking water quality;
- Assess susceptibility of ground water supplies to contamination on a regional basis;
- Improve local wellhead protection programs;
- Implement management strategies to minimize impacts of land use activities on ground water supplies
- Clean up ground water contamination.

6.5.1 Objective 1: Improve Public Understanding and Awareness of Issues Related to Drinking Water Quality

Purpose: Enable the public to recognize potential problems and make educated decisions that help protect ground water quality.

Rationale: Educating the public about the importance of ground water quality will over time change mindsets and practices. An aware public will likely be able to facilitate more change in terms of ground water protection than local government agencies. In addition, broad public support will be necessary to successfully implement technical management strategies selected by the implementing agency.

Proposed Actions

Action 1A. Provide outlets for ground water protection information. The public should have easy access to relevant information about ground water supplies and water quality. Region-specific information about the ground water resource, risk assessment activities, monitoring programs, wellhead protection activities, technical management strategies, and clean up efforts should be provided to the public. Information about existing national programs for private homeowners such as "Home-A-Syst/Farm-A-Syst" and NRCS's EQIP should also be provided to the public. All information related to ground water protection should be compiled, synthesized, and periodically updated by the local implementing agency. Information should be available to the public in a variety of mediums such as compact disk, web site, flyers, workshops, community fairs, etc.

Action 1B. Develop a mass media campaign for ground water protection. Advertisements and public service announcements in print, radio, and television can reach a broad audience. A mass media campaign is often the most effective way of raising awareness about a particular issue such as drinking water.

Action 1C. Make available and/or coordinate with a ground water protection program for schools. Classroom education will influence a large portion of the community and will establish a long-term legacy. The program could include class presentations, class exercises, and field trips and should be integrated into existing science or environmental education programs.

Action 1D. Conduct periodic public opinion surveys related to ground water protection efforts. Surveys would provide an indicator of the apparent effectiveness of ground water protection strategies. Surveys would also provide valuable feedback about which strategies the public supports.

Relationship to Other Objectives*:* ***In general, this objective is tied to all the other objectives in this section since broad public support will be necessary to successfully implement management strategies.***

Implementation Considerations

- Public education programs require expertise often unavailable in the existing staff resources of the anticipated implementing agencies.
- A long-term commitment of resources (both funds and staff time) will be required to develop a successful public education program.

While a mass media campaign can quickly improve the public's name-recognition of a particular issue, it is not an efficient means of educating the public about complex or technical ideas.

Table 6-5
Agency Involvement and Resource Needs for Objective 1

Action	Proposed Agency Involvement(1)	Staff Resources Required(2)	Initial Implementation Cost(3)	Short-term Benefit	Long-term Benefit
1A. Provide outlets for ground water protection information	*County health department* Conservation districts Water purveyors	Medium	Medium	X	X
1B. Develop a mass media campaign for ground water protection	*County health department* Conservation districts	High	Medium	X	
1C. Develop a ground water protection program for schools	*County health department* Conservation districts School districts	High	Medium	X	X
1D. Conduct periodic public opinion surveys related to ground water protection efforts	*County health department* Conservation districts	Medium	Medium	X	

(1) The proposed lead agency is shown in italics. Agency lead roles may vary depending on authorities (see Section 8.5). Other listed agencies may support the lead agency with data and/or resources. Interagency agreements may be a vehicle for promoting cooperation.

(2) Low = Need ¼ to ¾ fulltime equivalent (FTE) to implement. Medium = Need 1-2 FTE to implement. High = Need > 2 FTE and/or contracted services to implement. Staffing estimates are relative, and would likely be reduced if multiple actions are implemented simultaneously.

(3) In general, Low = Less than $50,000 per county. Medium = Between $50,000 and $250,000. High = Greater than $250,000.

6.5.2 Objective 2: Assess Susceptibility of Ground Water Supplies to Contamination on a Regional Basis

Purpose: Identify ground water supplies used for drinking water purposes currently unprotected and "at risk" of becoming contaminated.

Rationale: It is not feasible or cost effective to implement management strategies that protect all unprotected ground water. Rather, management strategies should focus resources primarily on drinking water supplies that are unprotected and "at risk" of becoming impacted in the future. Although some anecdotal evidence of impacted supplies is described in the Level 1 Assessment prepared as part of the watershed planning process, the extent of impacted supplies may be assessed in more detail with Objective 3. In the interim, the risk assessment procedures described in this section will be used to rank ground water supplies in terms of relative susceptibility to contamination. This will enable management strategies to be prioritized for maximum benefit in preventing ground water supplies from becoming impacted.

Proposed Actions

Action 2A. Conduct Risk Assessment. This preliminary assessment is intended as a relatively cost-effective way to determine general areas that are susceptible to ground water contamination. The assessment should focus on aquifers likely to be tapped in the future as well as aquifers currently used. A source of such useful information is Water Supply Plans for Group A water purveyors. Land use and hydrogeologic screening criteria could be applied to a ground water quality database to rank the susceptibility of all ground water supplies. Land use and hydrogeologic screening criteria that could be used to delineate "at risk" supplies include:

- Presence of Washington State Department of Ecology or United States EPA regulated facilities and sites
- Presence of domestic on-site septic systems (i.e., unsewered areas)
- Presence of land application of untreated, non-domestic wastewater
- Presence of concentrated animal feeding operations
- Presence of agricultural operations requiring frequent fertilizer and pesticide application
- Presence of untreated stormwater dry wells above some specified threshold density
- Presence of mining activities
- Presence of wells above some specified threshold density
- Presence of shallow wells (e.g., less than 100 feet below ground surface)
- Presence of unconfined, shallow aquifers (as described in the Level 1 Assessment) in which a shallow well could be completed
- Presence of regional aquifer recharge area
- Presence of water quality monitoring exceedances attributed to human causes

- Presence of source designated as "ground water under the influence of surface water"

As shown in Table 2-1, 87 percent of the land area in WRIAs 27 and 28 is forested (see Section 2). These percentages break down as 98 percent in Skamania County, 95 percent in Cowlitz County, and 67 percent in Clark County. In Clark County, the forested areas are primarily located outside the southwest portion of the County. The predominance of forested (undeveloped) land suggests low susceptibility to contamination due to human activity. For example, according to the Level 1 Assessment, nearly all the confirmed and suspected contaminated sites listed on Washington State Department of Ecology's list of the same name occur primarily within the most developed areas of WRIAs 27 and 28 (e.g. Vancouver, Ridgefield, Washougal, etc.) whereas very few such sites, if any, exist in the forested portions of WRIAs 27 and 28 as described above. Objective 2's assessment, therefore, should focus on those areas in which development has occurred or is likely to occur within the Planning Unit's 20 year planning horizon.

Clark County staff reported that their Health Department currently monitors failures of on-site septic systems. If an area shows a high level of failures, all septic system owners in the area are asked to check their systems.

To meet the overall objective of assessing areas most susceptible to contamination, a ground water quality database could be built with data obtained from DOH, Ecology, county governments, and other agencies. The ground water quality database should be maintained at the local level with a single data management system as described in Action 2C. Table 6-6 shows potential sources of data for a ground water quality database and how the data might be incorporated into a single data management system.

Depending on the outcomes of the preliminary risk assessment various follow-up actions may be warranted. These could include, for example:

- Direct outreach to well users in an area deemed to be at risk
- Outreach and/or enforcement action to parties contributing to ground water contamination
- Further, more intensive data collection to better define sources of further contamination. If appropriate, seek funding for local ground water monitoring.

Table 6-6
Creating a Ground Water Quality Database for Use with Level I Risk Assessment

Type of Information	Potential Information Source[(1)]	Incorporating into Single Data Management System
Locations of many facilities/sites regulated by Ecology (e.g., leaking underground storage tank sites, hazardous waste sites, etc.)	Ecology	Existing coverage available through facility/site database (web site provided in references)
Locations of EPA regulated facilities/sites	EPA	Existing coverage available through Envirofacts database (web site provided in references)
General locations of residential developments not connected to sewers or public water systems	County health departments County planners Utility plans	Would need to create coverage based on local knowledge unless county has coverage of sewered areas
General locations of land application of untreated, non-domestic wastewater (including liquid manure)	Ecology County health departments County planners Conservation districts	Would need to create coverage based on local knowledge unless county or Ecology has coverage
General locations of animal feeding operations	Ecology Conservation districts County planners WSDA	Would need to create coverage based on local knowledge unless WSDA has coverage
General locations of agricultural activities	Conservation districts Irrigation districts WSDA County planners	Would need to create coverage based on local knowledge unless WSDA has coverage
General locations of dense residential development	County planners Public works departments	Would need to create coverage based on local knowledge unless county has coverage
Locations of stormwater discharges	Public works departments County planners	Would need to create coverage based on local knowledge
Locations of sanitary landfills, surface mines, and gravel pits	Ecology DNR County health departments County planners	Would need to create coverage based on agency data and local knowledge
Locations of Group A and Group B PWS Sources	DOH	Existing Geographic Information System (GIS) coverage available
Locations of Group A PWS Wellhead Protection Areas	DOH	Existing GIS coverage available
General locations of areas served predominantly by shallow, unconfined, or improperly sealed wells	DOH County health departments	Would need to create coverage based on local knowledge
General locations of shallow or unconfined aquifers that could be used for ground water supplies	USGS County health departments Hydrogeologic consultants	Would need to create coverage based on local knowledge
Locations of designated Critical Aquifer Recharge Areas	EPA WA Dept. of Transportation	Existing GIS coverage available
General locations of ground water supplies with known water quality exceedances	DOH County health departments USGS	Would need to create coverage based on local knowledge
General locations of ground water supplies with sources classified as "ground water under the influence of surface water"	DOH County health departments	Would need to create coverage based on local knowledge

[(1)]The proposed lead agency for information is shown in italics. Agency lead roles may vary depending on authorities (see Section 8.5).

Action 2B. Evaluate existing data management system and improve system if necessary. A considerable amount of potentially useful ground water quality data can be easily acquired from a variety of sources to build the database described in Action 2A. Unfortunately, this data is often provided in incompatible formats. For instance, DOH, Ecology, and Clark Public Utilities currently maintain GIS databases and AutoCAD files with locations of wells and regulated facilities and sites. However, other water quality data is currently only available in tab-delimited text files, Microsoft Access databases, Microsoft Excel, or paper files. For example, DOH is in the process of upgrading their water quality database software to proprietary software called Sentry, which will house the names of and the types of public water systems, sample results and other water quality monitoring information. This data can be extracted to Microsoft Excel. Thus, a data management system populated with relevant WRIAs 27 and 28 data is needed in order to store, link, manipulate, and present data acquired from a variety of sources. GIS software such as ArcInfo is capable of providing the database and mapping tools needed to complete the risk assessment described in this objective. Other data management systems such as AutoCAD may have sufficient database and mapping capabilities as well.

Action 2C. Produce regional maps showing results of the risk assessment. Areas with "at risk" ground water supplies and potential sources of contamination should be highlighted at a minimum. These maps can be used as graphical tools to select management strategies and locations for strategy implementation. The mapping products can also be used by local agencies, water purveyors, and facility/site operators for planning activities and as a public education tool.

Relationship to Other Objectives: The risk assessment described in Objective 2 is intended to guide the selection and implementation of subsequent management strategies. For example, improvements to local wellhead protection activities (Objective 3) should be focused on areas with supplies determined to be susceptible to contamination. Likewise, selection of management strategies to minimize ground water impacts (Objective 4) should be targeted primarily in "at risk" areas. Public outreach activities (Objective 1) could use the risk assessment database and mapping results as presentation and education tools.

Implementation Considerations

- The accuracy of some data will be compromised due to inherent inaccuracies and inconsistencies in the data source. For instance, the accuracy of a well location on a Water Well Report (e.g., well log) is to be limited by the restraints of the Public Land Survey System (e.g., locations typically delineated according to ¼ Section or ¼ ¼ Section of a given Township and Range). Field mapping using Global Positioning Systems (GPS) may be necessary if precise locations are needed.
- Some of the larger water providers, such as Clark Public Utilities and the City of Vancouver, already maintain maps of their respective service territories, well locations, recharge zones, etc. These maps could be used as a means to begin compiling the regional map. Of particular challenge would be the mapping of those

"at risk" areas for which no area map exists (e.g. the very small Group A and Group B public water systems).

- It will be difficult to establish uniform hydrogeologic and land use ranking criteria that apply to all ground water supplies. For instance, it will be difficult to qualitatively or quantitatively assess the relative potential for contamination from different land use activities.
- The tendency when working with a large database is to summarize the data record. Actually ranking the susceptibility of ground water supplies and then prioritizing management strategies based on that ranking will be a much more difficult process.
- A considerable amount of work would be required to compile all the data suggested for a Level II Risk Assessment. If the Level II Risk Assessment is not completed due to budget constraints, some of the data for the Level II Risk Assessment could still be gathered for use in the Level I Risk Assessment.
- Technical map products may be misunderstood by some public audiences.

Table 6-7
Agency Involvement and Resource Needs for Objective 2

Action	Proposed Agency Involvement(1)	Staff Resources Required(2)	Initial Implementation Cost(3)	Short-term Benefit	Long-term Benefit
2A. Conduct Level I Risk Assessment	*County health department* County planning department Ecology DOH Local water purveyors	Medium	Medium	X	
2B. Evaluate existing data management system and improve if necessary	*County health department*	Low to Medium	Low	X	X
2C. Produce regional maps showing results of risk assessment	*County health department* County planning department Local water purveyors	Low	Low	X	

(1) The proposed lead agency is shown in italics. Agency lead roles may vary depending on authorities (see Section 8.5). Other listed agencies may support the lead agency with data and/or resources. Interagency agreements may be a vehicle for promoting cooperation.

(2) Low = Need ¼ to ¾ fulltime equivalents (FTE) to implement. Medium = Need 1-2 FTE to implement. High = Need > 2 FTE and/or contracted services to implement. Staffing estimates are relative, and would likely be reduced if multiple actions are implemented simultaneously.

(3) In general, Low = Less than $50,000 per county. Medium = Between $50,000 and $250,000. High = Greater than $250,000.

6.5.3 Objective 3: Improve Local Wellhead Protection Programs

Purpose: Improve management of unprotected ground water sources located outside the service areas of large and medium water purveyors.

Rationale: Local water purveyors have the greatest ability to assess, protect and manage their own ground water sources. Unfortunately, many small water systems lack the resources to develop a formal wellhead protection program or implement wellhead protection activities. Technical and/or financial assistance could be provided to these small systems to complete formal or informal wellhead protection activities. Assistance should be concentrated in areas with ground water supplies that are already impacted or "at risk" of becoming impacted in the future.

Proposed Actions

Action 3A. Determine which Group A public water systems have a Wellhead Protection Program and enforce Wellhead Protection Program requirements. The majority of Group A PWSs in WRIAs 27 and 28 have established acceptable Wellhead Protection Programs. However, a number of Group A PWSs have not established a Wellhead Protection Program at all. Other Group A PWSs have submitted Wellhead Protection Program documentation to DOH, but have not established or maintained adequate wellhead protection area delineations, contaminant inventories, or management programs. DOH should require compliance for all Group A PWSs and provide additional technical and/or financial assistance, if necessary. Enforcement actions and assistance should be focused in areas with supplies that are impacted or "at risk" of becoming impacted in the future.

Action 3B. Facilitate use of a computer model for delineating select Group A PWS wellhead protection areas. The model could delineate accurate wellhead protection areas (e.g., capture zones) around Group A PWS ground water supplies that are impacted or "at risk" of becoming impacted in the future. Determining accurate capture zones around an "at risk" or impacted ground water supply would enable a water purveyor to more precisely pinpoint the location and type of management strategies to be implemented.

Action 3C. Encourage Group B PWSs to voluntarily establish a Wellhead Protection Program. Group B PWSs are not required to do any wellhead protection planning under current regulations. However, most Group B PWSs would benefit from going through the process of establishing a simplified Wellhead Protection Program which could build upon the water system application submitted by Group Bs to DOH. Existing wellhead protection regulations and guidance documents for Group A PWSs could be distilled into an easy-to-use guide for Group B PWSs. The guide would essentially be an informational packet with suggestions for establishing wellhead protection area delineations, contaminant inventories, and simple management programs. This guide could be mass-mailed to all Group B PWSs. Additional technical and/or financial assistance could be offered to Group B PWSs in areas with "at risk" or impacted ground water supplies.

Relationship to Other Objectives: Wellhead protection area delineations and contaminant inventories completed by local water purveyors could be added to the ground water quality database used for the risk assessment (Objective 2). Assistance to local water purveyors should be targeted in areas identified as "at risk" in Objective 2. Successful implementation of this objective will greatly improve public understanding and awareness of issues related to drinking water quality (Objective 1).

Implementation Considerations

- 100 percent compliance of Group A PWS's with wellhead protection regulations may not be attainable.
- Group A PWSs and local government agencies may not have the technical staff to use computer models to generate more accurate wellhead protection area delineations. This may require reliance on USGS staff or contracted services.
- Many local water purveyors lack the technical background to accurately identify potential sources of contamination.
- Many Group B PWSs will not perform wellhead protection activities even if technical and financial assistance is provided.
- Wellhead protection literature and informational packets may be misunderstood by some public audiences.

Table 6-8
Agency Involvement and Resource Needs for Objective 3

Action	Proposed Agency Involvement[1]	Staff Resources Required[2]	Initial Implementation Cost[3]	Short-term Benefit	Long-term Benefit
3A. Enforce Wellhead Protection Program requirements for all Group A PWSs	*DOH* Local water purveyors (Group A)	Low	Low to Medium	X	
3B. Facilitate use of a computer model for delineating select Group A PWS wellhead protection areas	*DOH* Local water purveyors (Group A) USGS County health department	High	High	X	X
3C. Encourage Group B PWSs to voluntarily establish a Wellhead Protection Program	*County health department* Local water purveyors (Group A) WSU Cooperative Extension	Low to Medium	Medium	X	X

(1) The proposed lead agency is shown in italics. Agency lead roles may vary depending on authorities (see Section 8.5). Other listed agencies may support the lead agency with data and/or resources. Interagency agreements may be a vehicle for promoting cooperation.

(2) Low = Need ¼ to ¾ fulltime equivalent (FTE) to implement. Medium = Need 1-2 FTE to implement. High = Need > 2 FTE and/or contracted services to implement. Staffing estimates are relative, and would likely be reduced if multiple actions are implemented simultaneously.

(3) In general, Low = Less than $50,000 per county. Medium = Between $50,000 and $250,000. High = Greater than $250,000.

6.5.4 Objective 4: Implement Management Strategies to Minimize Impacts of Land Use Activities on Ground Water Quality

Purpose: Prevent degradation of ground water supplies by various land use activities.

Rationale: A variety of land use activities can act together as non-point sources to impact ground water supplies. It is more efficient and cost-effective to prevent land use activities from impacting ground water supplies than attempt to clean up ground water supplies after they have been impacted. One approach for preventing ground water contamination from land use activities is through implementation of the CARA ordinances discussed in Section 6.4.4. Another approach for preventing contamination is through the use of region-specific management strategies. Potential management strategies that could be adopted for WRIAs 27 and 28 are presented in this objective.

Proposed Actions

Action 4A. Coordinate and promote management strategies. The local implementing agency can coordinate and promote selection and implementation of management strategies based upon input from local and state governments, stakeholders, interest groups, and the general public. Carrying out these strategies will depend on availability of funding from various sources (see Section 6.6.2). Examples of specific management strategies that might be selected and implemented in WRIAs 27 and 28 include:

- Develop operations and maintenance program for on-site septic systems
- When considering whether to convert areas served by septic systems to a public sanitary sewer system, the local "water balance" should be considered. If homes in an area rely on domestic wells for water supply, conversion to a public sewer system may transfer water out of the local watershed, with unintended effects on summertime base flows in nearby surface streams. These effects should be considered from a comprehensive perspective involving water quantity as well as water quality.
- Establish more stringent guidelines for land application of wastewater effluent
- Establish more stringent guidelines prohibiting on-site disposal of non-domestic wastewater from commercial and industrial facilities
- Establish more stringent design and operation standards for chemical storage and handling operations
- Promote implementation of BMPs for fertilizer and pesticide application (e.g., Field Operations Technical Guide - FOTG), with special application to small non-commercial (“hobby”) farms
- Promote implementation of BMPs for irrigation management practices that protect ground water quality, with special application to small non-commercial farm
- Promote implementation of BMPs for manure handling, with special application to small non-commercial farms
- Establish more stringent guidelines for siting of concentrated animal feeding operations
- Provide technical and financial assistance to agricultural and animal feeding operations for ground water quality improvement projects
- Organize regional information sharing groups for farmers and ranchers
- Maintain local household hazardous waste collection and disposal programs; and, State producer pesticide collection (WSDA)
- Consider feasibility study for a manure digester power plant to address waste issues associated with manure generation in Clark County
- Support research on contaminant fate and transport issues

Relationship to Other Objectives: The type of management strategies that need to be implemented and the locations where the strategies need to be implemented should be based on the risk assessment (Objective 2). Locations where management strategies are implemented should be added to the data management system described in Objective 2. Public outreach activities (Objective 1) could use management strategy case studies as presentation and education tools.

Table 6-9
Agency Involvement and Resource Needs for Objective 4

Action	Proposed Agency Involvement[1]	Staff Resources Required[2]	Initial Implementation Cost[3]	Short-term Benefit	Long-term Benefit
4A. Coordinate and promote management strategies	*County health department* Ecology Conservation districts WSDA NRCS	High	High	X	X

(1) The proposed lead agency is shown in italics. Agency lead roles may vary depending on authorities (see Section 8.5). Other listed agencies may support the lead agency with data and/or resources. Interagency agreements may be a vehicle for promoting cooperation.
(2) Low = Need ¼ to ¾ fulltime equivalent (FTE) to implement. Medium = Need 1-2 FTE to implement. High = Need > 2 FTE and/or contracted services to implement. Staffing estimates are relative, and would likely be reduced if multiple actions are implemented simultaneously.
(3) In general, Low = Less than $50,000 per county. Medium = Between $50,000 and $250,000. High = Greater than $250,000.

Implementation Considerations

- It may be difficult to discern from the results of the risk assessment and monitoring program which land use activities and contaminants need to be addressed.
- Selection and implementation of technical management strategies do not guarantee adequate protection of ground water supplies from contamination.
- Management strategies should not be applied uniformly to all locations. Some locations and land uses may require site-specific strategies.

6.5.5 Objective 5: Clean Up Ground Water Contamination

Purpose: Restore impacted, unprotected ground water supplies outside the service areas of large water purveyors for potential use as a drinking water source.

Rationale: While prevention is the most effective way of protecting clean ground water supplies, a significant number of unprotected ground water supplies may already be impacted. These impacted ground water supplies cannot be safely used as an existing or future source of supply. Impacted ground water supplies should be cleaned up such that the resulting ground water quality would be acceptable for use as a drinking water source.

Proposed Actions

Action 5A. Evaluate the need for greater involvement by local organizations as stakeholders in clean up actions at Ecology regulated facilities and sites. Remediation activities at Ecology regulated facilities and sites are already reviewed and approved by Ecology. While most remediation activities are required to restore impacted ground water to acceptable drinking water levels, Ecology occasionally allows ground water contaminants to be left in place at concentrations significantly above maximum contaminant levels (MCLs). Ecology should notify the local implementing agency about sites in WRIAs 27 and 28 in which proposed remediation actions will not restore impacted ground water to concentrations below MCLs. Then the local implementing agency could get more involved as an active participant in the public notification process to ensure that remediation actions are sufficient to protect existing and future ground water supplies. The local implementing agency can identify geographic locations of many currently regulated sites and facilities at the Ecology facility/site database web site listed in the References section. A number of geographic searches can be conducted with this database including latitude/longitude, city, zip code, and county searches.

Action 5B. Evaluate the need for independent clean up actions. Some land use activities that have contributed to ground water contamination cannot be easily assigned to responsible parties. Examples of contaminant sources that may not be fully addressed by Ecology clean up programs include septic systems, animal feeding operations, agricultural operations, chemical storage facilities under a certain size threshold, etc. The local implementing agency should investigate the potential for providing technical and/or financial assistance to remove or remediate sources of contamination and downgradient impacts associated with these land use activities.

Relationship to Other Objectives: Impacted ground water supplies would most likely be identified through follow-up actions to the risk assessment (Objective 2). Public outreach activities (Objective 1) could use some clean up case studies as presentation and education tools.

Implementation Considerations

- It may be difficult to stay up-to-date with the status of all remediation activities in the county or basin unless significant resources are earmarked for this task.
- It may be extremely difficult in most cases to identify specific land use activities that have contributed to ground water contamination and need to be cleaned up. A strong link between an impacted ground water supply and a land use activity would need to be firmly established.

Table 6-10
Agency Involvement and Resource Needs for Objective 5

Action	Proposed Agency Involvement[1]	Staff Resources Required[2]	Initial Implementation Cost[3]	Short-term Benefit	Long-term Benefit
5A. Evaluate the need for greater involvement as a stakeholder in clean up actions at Ecology regulated facilities and sites	*County health department* Ecology Local water purveyors	Medium	Low		X
5B. Evaluate the need for independent clean up actions	*County health department* Ecology WSDA	High	High	X	X

(1) The proposed lead agency is shown in italics. Agency lead roles may vary depending on authorities (see Section 8.5). Other listed agencies may support the lead agency with data and/or resources. Interagency agreements may be a vehicle for promoting cooperation.
(2) Low = Need ¼ to ¾ fulltime equivalent (FTE) to implement. Medium = Need 1-2 FTE to implement. High = Need > 2 FTE and/or contracted services to implement. Staffing estimates are relative, and would likely be reduced if multiple actions are implemented simultaneously.
(3) In general, Low = Less than $50,000 per county. Medium = Between $50,000 and $250,000. High = Greater than $250,000.

6.6 General Implementation Considerations

6.6.1 Overview

Table 6-11 summarizes implementation considerations for the ground water quality recommendations discussed throughout Section 6. Implementation issues may vary somewhat from those listed in the table, depending on the specific action, and community involved. Where there are staffing impacts that would likely require hiring of at least ½ FTE by the implementing organization(s), they are called out in the funding column.

6.6.2 Potential Sources of Funding

The degree to which the Watershed Plan can be implemented will depend largely on the amount of funding available. The implementing agency should initiate attempts to obtain long-term sources of funding immediately. A preliminary list of potential sources of funding for ground water protection activities include:

- Federal grants from EPA and United States Department of Agriculture
- Cooperative agreements with federal agencies (e.g., USGS) in which the federal government funds a portion of the project
- Clean Water Act Section 319 Non-point Source Fund
- Centennial Clean Water Fund
- Washington State Revolving Fund
- Washington State Water Pollution Control Fund
- Grants from the Washington Conservation Commission

- Create septic system maintenance utility
- Tax or fee on septic system and/or water use with Aquifer Protection Area Program
- User fees on drinking water systems not associated with Aquifer Protection Area Program
- Property tax or other local taxes
- Plan review fees and permit fees
- Water rate surcharges adopted by public water systems benefiting from program
- Other state or local appropriations

Where funding is derived from targeted fees or taxes, care must be taken to ensure that principles of fairness and equity are addressed.

Table 6-11
Implementation Considerations for Ground Water Quality Actions

Priority(1)	Activity	Implementers(3)	Cost(2)	Funding Sources
Category: Ground Water Quality				
High	Improve public awareness of ground water quality issues. Information outlets. Mass-media campaign. Schools program. Public opinion surveys.	*Lead*: County health departments *Others*: Cities, DOH.	Medium	*Main*: TBD Substantial staffing needs *Additional*: TBD
High	Assess susceptibility of ground water supplies to contamination. Risk assessment. Evaluate data management and improve if necessary. Regional mapping.	*Lead*: County health departments *Others*: Cities, Ecology, DOH.	Low to Medium	*Main*: TBD Substantial staffing needs *Additional*: TBD
Medium	Improve local wellhead protection. Determine which Group A Systems have wellhead program. Apply technical assistance and enforcement to meet state requirements. Facilitate use of computer modeling. Encourage Group B systems to voluntarily establish wellhead programs.	Lead: DOH and County health departments *Others*: Public water systems	Medium to High	*Main*: TBD Substantial staffing needs *Additional*: TBD
Low	Minimize impacts of land use activities on ground water supplies, through technical management strategies. Identify land uses and activities needing attention. Select and implement strategies to prevent impacts to ground water quality.	*Lead*: County health departments *Others*: County planning departments, conservation districts, Ecology, Wash. Dept. of Agriculture, NRCS	Medium to High	*Main*: TBD Substantial staffing needs *Additional*: TBD
Low	Clean up sources of ground water contamination. Evaluate need for greater involvement by local organizations. Evaluate need for independent cleanup actions outside Ecology programs.	*Lead*: County health departments *Others*: Ecology, Public Water Systems, Wash. Dept. of Agriculture	Medium to High	*Main*: TBD *Additional*: TBD

(1) Priority in context of all actions in Watershed Management Plan.
(2) Preliminary, generalized estimates of financial or economic costs to the affected community, implementing organization or water user. High: greater than $500,000; Medium: $50,000 to $500,000; Low: less than $50,000. Total cost, whether up-front or over a period of time up to ten years.
(3) "Lead" implementer would take responsibility for organizing efforts under this action, including pursuing funding sources listed in the far right column. Agency lead roles may vary depending on authorities (see Section 8.5).
Abbreviations: NRCS = Natural Resources Conservation Service, DOH = Department of Health, TBD = To Be Developed.

6.6.3 Implementation Priorities

It is recognized that funding may not be available to implement all actions recommended in this section. However, many of the five objectives could be pursued independently, in a scaled-back program. The objectives can be prioritized based on relative importance, cost, staffing availability, and the sequential relationship of some objectives. It is recommended that Objectives 1 and 2 be given the highest priority. Accomplishing the public education objective (Objective 1) will provide broad support for the remaining actions. The risk assessment objective (Objective 2) is a foundation for all subsequent strategies since it will reveal which locations are most susceptible to ground water contamination.

It is recommended that Objective 3 has a slightly lower priority than Objectives 1 and 2. The local implementing agency has the ability to make improvements to wellhead protection (Objective 3) activities; however, existing state and federal programs are already addressing these objectives to a certain extent.

If a more limited program is undertaken, it should be recognized that Objectives 4 and 5 will likely prove the most complex and expensive to carry out. While preventing ground water contamination from land use activities (Objective 4) is critical, it may be expensive and difficult to implement this objective effectively. Likewise, taking actions to clean up contaminant sources (Objective 5) is anticipated to be expensive and difficult to implement. In addition, existing state and federal programs already exist for cleaning up most contaminant sources.

6.6.4 General Management Considerations

A number of common-sense suggestions should be considered for successful implementation of a WRIA 27 and 28 ground water protection program. The following suggestions were modified from lessons learned from implemented ground water protection programs for the Spokane Valley/Rathdrum Prairie Aquifer:

- Effective leadership and a clear understanding of roles and responsibilities will benefit implemented objectives and actions.
- Successful programs will require cooperation, communication, and information exchange between local water purveyors, cities, counties, and state government agencies.
- Key leadership and staff positions should be stable over a long-term period (e.g., need staff with institutional memory to sustain programs since local planners and elected officials are continually changing).
- Successful implementation of most strategies requires sustained commitment of dedicated technical staff.
- Long-term success will depend on the ability to integrate management programs into core local government responsibilities (such as wellhead protection, land use planning, permitting septic systems).

- An effective methodology is needed for monitoring the performance of implemented objectives and actions.
- The public should be involved throughout the adoption and implementation process.
- Short-term successes should be promoted to boost the success of the entire program.

Section 7
Management of Fish Habitat Conditions (Non-flow)

Early in the watershed planning process, the Planning Unit elected to work collaboratively with the Lower Columbia Fish Recovery Board to develop the habitat element of the watershed plan. This unique arrangement was significant to the lower Columbia Region because it ensured a high degree of interconnectedness between watershed planning and the recovery of Endangered Species Act-listed species. In particular, the habitat element was developed using water quality, quantity and instream flow information from the Planning Unit's efforts coupled with other habitat data and modeling efforts developed through the recovery planning process. The result is a highly integrated habitat element for the watershed management plan that is the same as found in the recovery plan.

Each subbasin includes an extensive review of the available habitat information and analyses as well as extensive new analysis of stream condition, watershed conditions, and habitat forming processes. Modeling tools were applied that highlight a series of habitat perturbations in these watersheds that need to be addressed. Qualified local experts were convened to provide input to models where needed or where other data sources were lacking. Model outputs were also compared to other independent assessments of limiting factors to corroborate results. The outputs of these models identify reach scale issues that need to be addressed and provide a prioritization scheme for proposed actions.

A series of Subbasin Plans (Volumes II.F-II.I) [1] describe local conditions and detail implementation at the subbasin level. Each subbasin plan includes:

- An ***overview summary*** of key priorities.
- An ***assessment*** that describes the subbasin, species of interest, subbasin habitat conditions, stream habitat limitations, watershed process limitations, other factors such as hatcheries, harvest, hydropower, and out-of-subbasin effects. The assessment includes qualitative and quantitative information.
- A ***program and project inventory*** describing significant activities in the subbasin.
- A ***management plan*** that details a subbasin vision, biological objectives, integrated strategy, and specific measures and actions in each threat category.

The following descriptions give a brief regional perspective for each subbasin:

Kalama Subbasin

This subbasin is particularly important to regional recovery. Populations of fall Chinook, spring Chinook, winter steelhead and summer steelhead will need to be restored to a high

[1] Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plans, LCFRB 2004 and as amended.

level of viability to meet regional recovery objectives. Coho will need to improve to a medium level of viability and chum established and stabilized. Priority actions include:

- Managing forests to restore watershed processes,
- Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.) managing growth and development to protect watershed processes and habitat conditions. This includes limiting the effects of conversion of agricultural and timber lands to developed uses,
- Restoring passage at culverts and other artificial barriers,
- Aligning hatchery priorities with conservation objectives, and
- Reducing out-of-subbasin impacts.

Lewis Subbasin

This subbasin is particularly important to regional recovery by virtue of its large size and diverse habitats. It includes upper North Fork, lower North Fork, and East Fork watersheds. One or more populations of tule fall Chinook, bright fall Chinook, spring Chinook, chum, winter steelhead, summer steelhead, and coho are present and many need to be restored to high levels of viability to meet regional recovery objectives. Priority actions include:

- Restoring access above dams in the upper portion of the North Fork,
- Protecting intact forests in headwaters,
- Managing forest land to protect and restore watershed processes,
- Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.) managing growth and development to protect watershed processes and habitat conditions. This includes limiting the effects of conversion of agricultural and timber lands to developed uses,
- Restoring passage at culverts and other artificial barriers,
- Restoring lowland floodplain function, riparian conditions, and stream habitat diversity
- Addressing immediate risks with short term habitat fixes,
- Aligning hatchery priorities with conservation objectives, and
- Reducing out-of-subbasin impacts.

Lower Columbia Tributaries

This subbasin includes a series of small tributaries between the Lewis River and Bonneville Dam including Salmon, Lake, Duncan, Hardy, and Hamilton creeks. Salmon and Lake Creeks have been heavily urbanized while the gorge tributaries are largely in forest lands. The urban streams will play a limited role in salmon recovery. Populations of fall chinook, winter steelhead, chum and coho in lower gorge tributaries will be important to recovery. Priority actions include:

- Restoring floodplain function, riparian conditions, and stream habitat diversity,
- Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.) managing growth and development to protect watershed processes and habitat conditions. This includes limiting the effects of conversion of agricultural and timber lands to developed uses,
- Managing forests to restore watershed processes,
- Restoring passage at culverts and other artificial barriers,
- Addressing immediate risks with short term habitat fixes,
- Aligning hatchery priorities with conservation objectives, and
- Reducing out-of-subbasin impacts.

Washougal Subbasin

This subbasin is particularly important to regional recovery because it contains fall chinook, chum, and summer steelhead that will need to be restored to a high level of viability and coho and winter steelhead that will need to be restored to a medium level of viability. The subbasin is diverse with significant portions in forest, agriculture, rural residential, and city uses. Priority actions include:

- Protecting intact forests in headwaters,
- Managing forest land to protect and restore watershed processes,
- Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.) managing growth and development to protect watershed processes and habitat conditions. This includes limiting the effects of conversion of agricultural and timber lands to developed uses,
- Restoring passage at culverts and other artificial barriers,
- Restoring lowland floodplain function, riparian conditions, and stream habitat diversity
- Addressing immediate risks with short term habitat fixes,
- Aligning hatchery priorities with conservation objectives, and reducing out-of-subbasin impacts.

Full details for each of these three subbasins can be found in the Subbasin Plans, Volumes II-F, II-G, II-H, and II-I. These are bound separately and serve as Appendices to this Watershed Management Plan. Tables 7-1 to 7-6 provide additional information on recommended actions for habitat.

It is recognized that the actions listed in the Subbasin Plans are subject to availability of funding resources. Section 8 describes a coordinated approach to pursuing necessary funding.

Table 7-1
Habitat actions for the Lower North Fork Lewis River Basin

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[2]	Expected Biophysical Response[3]	Certainty of Outcome[4]
L-Lew 1. Manage regulated stream flows to provide for critical components of the natural flow regime	Expansion of existing program or activity	PacifiCorp, Cowlitz County PUD, FERC, WDFW, NOAA Fisheries, USFWS	3	High: Lower mainstem Lewis River	High: Adequate flows for life stage requirements and habitat-forming processes	High
L-Lew 2. Ensure standards in land use and environmental programs and plans afford adequate protection of ecologically important areas (i.e. stream channels, riparian zones, floodplains, CMZs, wetlands, unstable geology)	Expansion of existing program or activity	Clark County, Cowlitz County, City of Woodland	1 & 2	High: Applies to all private lands under county jurisdiction (residential, agricultural, and forest lands)	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
L-Lew 3. Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.), manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the effects of conversion of agriculture and timber lands to developed uses.	Expansion of existing program or activity	Clark County, Cowlitz County, Woodland	1 & 2	High: Applies to all private lands under county jurisdiction (residential, agricultural, and forest lands)	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
L-Lew 4. Within authorities, conduct floodplain restoration where feasible along the mainstem and in major tributaries that have experienced channel confinement. Build partnerships with landowners and agencies and provide financial incentives	New program or activity	NRCS, C/WCD, CCD, NGOs, WDFW, LCFRB, USACE, LCFEG	4, 5, 8, 9 & 11	High: Lower mainstem Lewis and lower portion of major tributaries	Medium: Restoration of floodplain function, habitat diversity, and habitat availability.	High
L-Lew 5. Within authorities, prevent floodplain impacts from new development through land use controls and Best Management Practices	New program or activity	Clark County, Cowlitz County, Woodland, WDOE	1	Medium: Applies to privately owned floodprone lands under county jurisdiction	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
L-Lew 6. Increase funding available to purchase easements or property in sensitive areas in order to protect watershed function where existing programs are inadequate	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	1 & 2	Medium: Residential, agricultural, or forest lands at risk of further degradation	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High

[2] Relative amount of basin affected by action
[3] Expected response of action implementation
[4] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-1 (cont.)
Habitat actions for the Lower North Fork Lewis River Basin

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area1[5]	Expected Biophysical Response[6]	Certainty of Outcome[7]
L-Lew 7. Review and adjust operations to ensure compliance with the Endangered Species Act	Expansion of existing program or activity	Cowlitz County, Clark County, Woodland	1, 7, 8, & 9	Low: Applies to lands under public jurisdiction	Medium: Protection of water quality, greater streambank stability, reduction in road-related fine sediment delivery, restoration and preservation of fish access to habitats	High
L-Lew 8. Within authorities, increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing the incentives (financial or otherwise) and increasing program marketing and outreach	Expansion of existing program or activity	NRCS, C/WCD, CCD, WDNR, WDFW, LCFEG, Cowlitz County, Clark County, Woodland	1, 2, 4, 5, 6, 7, 8, 9, 10 & 11	High: Private lands. Applies to lands in agriculture, rural residential, and forestland uses throughout the basin	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
L-Lew 9. Within authorities, create and/or restore lost side-channel/off-channel habitat for chum spawning and coho overwintering	New program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, C/WCD, CCD	6	Medium: Lower mainstem Lewis	High: Increased habitat availability for spawning and rearing	Medium
L-Lew 10. Fully implement and enforce the Forest Practices Rules (FPRs) on private timber lands in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 5, 7, 8 & 9	Medium: Private commercial timber lands	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
L-Lew 11. Implement the prescriptions of the WRIA 27/28 Watershed Planning Unit regarding instream flows	Activity is currently in place	WDOE, WDFW, WRIA 27/28 Planning Unit, City of Woodland	7	High: Entire basin	Medium: Adequate instream flows to support life stages of salmonids and other aquatic biota.	Medium
L-Lew 12. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships, providing incentives to landowners, and increasing funding	Expansion of existing program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, Cowlitz CD, Clark CD, LCFEG	4, 5, 6, 7, 8, 9 & 11	High: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality, LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium

[5] Relative amount of basin affected by action
[6] Expected response of action implementation
[7] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-1 (cont.)
Habitat actions for the Lower North Fork Lewis River Basin

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[8]	Expected Biophysical Response[9]	Certainty of Outcome[10]
L-Lew 13. Increase technical support and funding to small forest landowners faced with implementation of Forest and Fish requirements for fixing roads and barriers to ensure full and timely compliance with regulations	Expansion of existing program or activity	WDNR	1, 2, 5 & 7	Low: Small private timberland owners	High: Reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
L-Lew 14. Protect and restore native plant communities from the effects of invasive species	Expansion of existing program or activity	Weed Control Boards (local and state); NRCS, Cowlitz CD, Clark CD, LCFEG	1 & 8	High: Greatest risk is in agriculture and residential use areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
L-Lew 15. Assess the impact of fish passage barriers throughout the basin and restore access to potentially productive habitats	Expansion of existing program or activity	WDFW, WDNR, Clark County, Cowlitz County WSDOT, City of Woodland, LCFEG	5	Medium: As many as 16 miles of stream are potentially blocked by artificial barriers	Medium: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is marginal in most cases	Medium
L-Lew 16. Conduct forest practices on state lands in accordance with the Habitat Conservation Plan in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 5, 7, 8 & 9	Medium: State timber lands in the Lower NF Lewis Basin (approximately 16% of the basin area)	Medium: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats. Response is medium because of location and quantity of state lands	Medium
L-Lew 17. Address water quality issues through the development and implementation of water quality clean up plans (TMDLs)	Expansion of existing program or activity	WDOE	9	Medium: streams with temperature concerns and streams on 303(d) list	Medium: Protection and restoration of water quality	Low
L-Lew 18. Within existing authorities, coordinate with appropriate entities to limit the effects of intensive recreational use of the mainstem Lewis during critical periods, where problems are identified.	Expansion of existing program or activity	Clark County, Cowlitz County, WDFW, Implementing partners	12	Low: Key reaches in the mainstem Lewis	Medium: Increased survival of salmonids	Low

8 Relative amount of basin affected by action
9 Expected response of action implementation
10 Relative certainty that expected results will occur as a result of full implementation of action

Table 7-2
Habitat actions for the Upper North Fork Lewis Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[11]	Expected Biophysical Response[12]	Certainty of Outcome[13]
U-Lew 1. Restore access through the hydropower system for anadromous and resident fish	Expansion of existing program or activity	PacifiCorp, Cowlitz County PUD, FERC, WDFW, NOAA Fisheries	1	High: the system of dams on the Lewis blocks anadromous access to approximately 170 miles of habitat and blocks migrations of adfluvial Bull Trout	High: Increased spawning and rearing capacity due to access to blocked habitat	High
U-Lew 2. Continue to manage federal forest lands according to the Northwest Forest Plan	Activity is currently in place	USFS	2, 3, 4, 5, 6 & 7	High: National Forest and National Monument lands in the upper basin	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	High
U-Lew 3. Fully implement and enforce the Forest Practices Rules (FPRs) on private timber lands in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	2, 3, 4, 5, 6 & 7	Medium: Private commercial timber lands	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
U-Lew 4. Ensure standards in land use and environmental programs and plans afford adequate protections of ecologically important areas (i.e. stream channels, riparian zones, floodplains, CMZs, wetlands, unstable geology)	Expansion of existing program or activity	Cowlitz County, Clark County, Skamania County	2 & 3	Low: Private lands under County jurisdiction (reservoir tributary basins)	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
U-Lew 5. Within authorities, prevent new floodplain development through County ordinance and with support from the State	New program or activity	Cowlitz County, Clark County, Skamania County, WDOE	2	Low: Private lands under County jurisdiction (reservoir tributary basins)	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High

[11] Relative amount of basin affected by action
[12] Expected response of action implementation
[13] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-2 (cont.) Habitat actions for the Upper North Fork Lewis Basin						
Action	**Status**	**Responsible Entity**	**Measures Addressed**	**Spatial Coverage of Target Area**[14]	**Expected Biophysical Response**[15]	**Certainty of Outcome**[16]
U-Lew 6. Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.), manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the effects of conversion of agricultural and timber lands to developed uses.	Expansion of existing program or activity	Cowlitz County, Clark County, Skamania County	2 & 3	Low: Private lands under County jurisdiction (reservoir tributary basins)	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
U-Lew 7. Implement the prescriptions of the WRIA 27/28 Watershed Planning Unit regarding instream flows	Activity is currently in place	WDOE, WDFW, WRIA 27/28 Planning Unit	9	High: Entire basin	Medium: Adequate instream flows to support life stages of salmonids and other aquatic biota.	Medium
U-Lew 8. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships, providing incentives to landowners, and increasing funding	Expansion of existing program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, C/WCD, CCD, UCD, LCFEG	4, 5, 6, 7 & 8	High: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality, LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium
U-Lew 9. Increase technical support and funding to small forest landowners faced with implementation of Forest Practices Rules to ensure full and timely compliance with regulations	Expansion of existing program or activity	WDNR	2, 3, 4, 5, 6 & 7	Low: Small private timberland owners	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
U-Lew 10. Monitor an notify FERC of significant license violations, enforce terms and conditions of section 7 consultations on FERC relicensing agreements, and encourage implementation of section 7 conservation recommendations on FERC relicensing agreements	Activity is currently in place	NOAA, USFWS	1, 6, 7, 9	High: Entire basin	High: Increased spawning and rearing capacity due to access to blocked habitat, improved conditions related to water quality, adequate instream flows to support life stages of salmonids and other aquatic biota	High

[14] Relative amount of basin affected by action
[15] Expected response of action implementation
[16] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-2 (cont.)
Habitat actions for the Upper North Fork Lewis Basin

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[17]	Expected Biophysical Response[18]	Certainty of Outcome[19]
U-Lew 11. Review and adjust operations to ensure compliance with the Endangered Species Act	Activity is currently in place	Cowlitz County, Clark County, Skamania County	2, 4, 5, & 6	Low: Applies to public lands under county jurisdiction	Medium: Protection of water quality, greater streambank stability, reduction in road-related fine sediment delivery, restoration and preservation of fish access to habitats	High
U-Lew 12. Increase funding available to purchase easements or property in sensitive areas in order to protect watershed function where existing programs are inadequate	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	2 & 3	Low: Private lands in sensitive areas at risk of further degradation	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High
U-Lew 13. Within authorities, increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing the incentives (financial or otherwise) and increasing program marketing and outreach	Expansion of existing program or activity	NRCS,Cowlitz CD, Clark CD, UCD, WDNR, WDFW, LCFEG	2, 3, 4, 5, 6, 7, 8 & 9	Low: Private lands. Applies primarily to lands in rural residential or forestry uses along river corridors	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
U-Lew 14. Assess the impact of fish passage barriers throughout the basin and restore access to potentially productive habitats (passage obstruction at mainstem dams is considered in a separate action)	Expansion of existing program or activity	WDFW, WDNR, Cowlitz County, Clark County, Skamania County, WSDOT, LCFEG	7	Medium: There are many minor barriers throughout the Basin. The full extent is unknown	Medium: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is believed to be marginal in most cases	High
U-Lew 15. Conduct forest practices on state lands in accordance with the Habitat Conservation Plan in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	2, 3, 4, 5, 6 & 7	Low: State timber lands in the U. Lewis Basin (approximately 11% of the basin area)	Medium: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats. Response is medium because of location and quantity of state lands	Medium

[17] Relative amount of basin affected by action
[18] Expected response of action implementation
[19] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-2 (cont.)
Habitat actions for the Upper North Fork Lewis Basin

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[20]	Expected Biophysical Response[21]	Certainty of Outcome[22]
U-Lew 16. Protect and restore native plant communities from the effects of invasive species	Expansion of existing program or activity	Weed Control Boards (local and state); NRCS, Cowlitz CD, Clark CD, UCD, LCFEG	2 & 5	Low: Greatest risk is in residential use areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
U-Lew 17. Local jurisdictions should assess, and require upgrading and replacement of on-site sewage systems in conformance with current regulations	Expansion of existing program or activity	Cowlitz County, Clark County, Skamania County, Clark CD, Cowlitz CD, UCD	7	Low: Private rural residential lands	Medium: Protection and restoration of water quality (bacteria)	Medium

[20] Relative amount of basin affected by action
[21] Expected response of action implementation
[22] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-3
Habitat actions for the East Fork Lewis Basin

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[23]	Expected Biophysical Response[24]	Certainty of Outcome[25]
EF Lew 1. Ensure standards in land use and environmental programs and plans afford high levels of protection of ecologically important areas (i.e. stream channels, riparian zones, floodplains, CMZs, wetlands, unstable geology)	Expansion of existing program or activity	Clark County Battleground	1 & 2	High: Applies to all private lands under county jurisdiction	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
EF Lew 2. Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.), manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the effects of conversion of agricultural and timber lands to developed uses.	Expansion of existing program or activity	Clark County Battleground	1 & 2	High: Applies to all private lands under county jurisdiction	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
EF Lew 3. Within authorities, conduct floodplain restoration where feasible along the mainstem and in major tributaries that have experienced channel confinement. Address past and potential avulsions into gravel processing ponds. Build partnerships with landowners and agencies and provide financial incentives	New program or activity	NRCS, CCD, NGOs, WDFW, LCFRB, USACE, LCFEG, Tribes	3, 5, 6, 8 & 9	High: Lower mainstem EF Lewis and lower portion of major tributaries	Medium: Restoration of floodplain function, habitat diversity, and habitat availability.	High
EF Lew 4. Continue to manage federal forest lands according to the Northwest Forest Plan	Activity is currently in place	USFS	1, 2, 4, 5, 6 & 8	Medium: National Forest lands in the upper basin	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	High
EF Lew 5. Within authorities, prevent floodplain impacts through land use controls and Best Management Practices	Expansion of existing program or activity	Clark County, Battleground WDOE	1	Medium: Applies to privately owned flood prone lands under local jurisdiction	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High

[23] Relative amount of basin affected by action
[24] Expected response of action implementation
[25] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-3 (cont.) Habitat actions for the East Fork Lewis Basin						
Action	**Status**	**Responsible Entity**	**Measures Addressed**	**Spatial Coverage of Target Area**[26]	**Expected Biophysical Response**[27]	**Certainty of Outcome**[28]
EF Lew 6. Monitor, evaluate, and enforce the Stordahl Habitat Conservation Plan	Activity is currently in place	NOAA, USFWS	9	Medium: Applies to privately owned lands downstream of Daybreak Park	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), erosion, mass wasting, bank stability and sediment supply processes	High
EF Lew 7. Increase funding available to purchase easements or property in sensitive areas in order to protect watershed function where existing programs are inadequate	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	1 & 2	Medium: Residential, agricultural, or forest lands at risk of further degradation	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High
EF Lew 8. Review and adjust operations to ensure compliance with the Endangered Species Act	Expansion of existing program or activity	Clark County, Battleground	1, 4, 5, & 6	Low: Applies to lands under public jurisdiction	Medium: Protection of water quality, greater streambank stability, reduction in road-related fine sediment delivery, restoration and preservation of fish access to habitats	High
EF Lew 9. Within authorities, increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing incentives (financial or otherwise) and increasing program marketing and outreach	Expansion of existing program or activity	NRCS, CCD, WDNR, WDFW, LCFEG, Clark County, Battleground	All measures	High: Private lands. Applies to lands in agriculture, rural residential, and forestland uses throughout the basin	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
EF Lew 10. Fully implement and enforce the Forest Practices Rules (FPRs) on private timber lands in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 4, 5, 6 & 8	Medium: Private commercial timber lands	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
EF Lew 11. Implement the prescriptions of the WRIA 27/28 Watershed Planning Unit regarding instream flows. Develop a regional water source in the Vancouver Lake Lowlands within 10 years and assess the feasibility of a regional source in the North Fork Lewis tidal reach	Activity is currently in place	WDOE, WDFW, WRIA 27/28 Planning Unit, CPU, Battleground, Ridgefield	7	High: Entire basin	High: Adequate instream flows to support life stages of salmonids and other aquatic biota.	High

[26] Relative amount of basin affected by action
[27] Expected response of action implementation
[28] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-3 (cont.)
Habitat actions for the East Fork Lewis Basin

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[29]	Expected Biophysical Response[30]	Certainty of Outcome[31]
EF Lew 12. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships, providing incentives to landowners, and increasing funding	Expansion of existing program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, CCD, LCFEG	3, 4, 5, 6, 7, 8, & 10	High: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality, LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium
EF Lew 13. Increase technical support and funding to small forest landowners faced with implementation of Forest and Fish requirements for fixing roads and barriers to ensure full and timely compliance with regulations	Expansion of existing program or activity	WDNR	1, 2, 4, 5, 6 & 8	Medium: Small private timberland owners	High: Reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
EF Lew 14. Protect and restore native plant communities from the effects of invasive species	Expansion of existing program or activity	Weed Control Boards (local and state); NRCS, CCD	1 & 5	High: Greatest risk is in agriculture and residential use areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
EF Lew 15. Assess the impact of fish passage barriers throughout the basin and restore access to potentially productive habitats	Expansion of existing program or activity	WDFW, WDNR, Clark County WSDOT, LCFEG, Clark CD	8	Medium: As many as 30 miles of stream are potentially blocked by artificial barriers	Medium: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is marginal in most cases	Medium
EF Lew 16. Conduct forest practices on state lands in accordance with the Habitat Conservation Plan in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 4, 5, 6 & 8	Medium: State timber lands in the EF Lewis Basin (approximately 16% of the basin area)	Medium: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats. Response is medium because of location and quantity of state lands	Medium

[29] Relative amount of basin affected by action
[30] Expected response of action implementation
[31] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-3 (cont.)
Habitat actions for the East Fork Lewis Basin

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[32]	Expected Biophysical Response[33]	Certainty of Outcome[34]
EF Lew 17. Address water quality issues through the development and implementation of water quality clean up plans (TMDLs)	Expansion of existing program or activity	WDOE	6	Medium: Temperature impaired and 303(d) listed streams	Medium: Protection and restoration of water quality	Low
EF Lew 18. Within authorities, create and/or restore lost side-channel/off-channel habitat for chum spawning and coho overwintering	New program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, Clark CD	10	Low: Lower mainstem EF Lewis	High: Increased habitat availability for spawning and rearing	Low

[32] Relative amount of basin affected by action
[33] Expected response of action implementation
[34] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-4
Habitat actions for the Bonneville Tributaries Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[35]	Expected Biophysical Response[36]	Certainty of Outcome[37]
Bon-Tribs 1. Within authorities, conduct floodplain restoration where feasible along the lower reaches of streams before their confluence with the Columbia where they have experienced channel confinement due to development and transportation corridors. Build partnerships with landowners and agencies and provide financial incentives	New program or activity	NRCS, UCD, NGOs, WDFW, LCFRB, USACE	3, 5, 6, 8 & 10	Medium: Lower reaches of several tributaries	High: Restoration of floodplain function, habitat diversity, and habitat availability.	High
Bon-Tribs 2. Within authorities, prevent floodplain impacts from new development through land use controls and Best Management Practices	New program or activity	Skamania County, WDOE	1	Medium: Applies to privately owned floodprone lands under county jurisdiction	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
Bon-Tribs 3. Within authorities, create and/or restore lost side-channel/off-channel habitat for chum spawning and coho overwintering	New program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, UCD, LCFEG	10	Medium: Lower reaches of several streams	High: Increased habitat availability for spawning and rearing	High
Bon-Tribs 4. Ensure standards in land use and environmental programs and plans afford adequate protections of ecologically important areas (i.e. stream channels, riparian zones, floodplains, CMZs, wetlands, unstable geology)	Expansion of existing program or activity	Skamania County	1 & 2	Medium: Applies to all private lands under county jurisdiction	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
Bon-Tribs 5. Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.), manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the effects of conversion of agricultural and timber lands to developed uses.	Expansion of existing program or activity	Skamania County	1 & 2	Medium: Applies to all private lands under county jurisdiction	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
Bon-Tribs 6. Increase funding available to purchase easements or property in sensitive areas in order to protect watershed function where existing programs are inadequate	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	1 & 2	Low: Residential, agricultural, or forest lands at risk of further degradation	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High

[35] Relative amount of basin affected by action
[36] Expected response of action implementation
[37] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-4 (cont.)
Habitat actions for the Bonneville Tributaries Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[38]	Expected Biophysical Response[39]	Certainty of Outcome[40]
Bon-Tribs 7. Review and adjust operations to ensure compliance with the Endangered Species Act	Expansion of existing program or activity	Skamania County	1, 4, 6, & 8	Low: Applies to lands under public jurisdiction	Medium: Protection of water quality, greater streambank stability, reduction in road-related fine sediment delivery, restoration and preservation of fish access to habitats	High
Bon-Tribs 8. Within authorities, increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing the incentives (financial or otherwise) and increasing program marketing and outreach	Expansion of existing program or activity	NRCS, UCD, WDNR, WDFW, LCFEG, Skamania County	All measures	Medium: Private lands. Applies to lands in agriculture, rural residential, and forestland uses throughout the basin	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
Bon-Tribs 9. Continue to manage federal forest lands according to the Northwest Forest Plan	Activity is currently in place	USFS	1, 2, 4, 5, 6 & 8	Low: National Forest lands	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	High
Bon-Tribs 10. Fully implement and enforce the Forest Practices Rules (FPRs) on private timber lands in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 4, 5, 6 & 8	Medium: Private commercial timber lands	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
Bon-Tribs 11. Implement the prescriptions of the WRIA 27/28 Watershed Planning Unit regarding instream flows	Activity is currently in place	WDOE, WDFW, WRIA 27/28 Planning Unit, Skamania County	9	High: Entire basin	Medium: Adequate instream flows to support life stages of salmonids and other aquatic biota.	Medium

[38] Relative amount of basin affected by action
[39] Expected response of action implementation
[40] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-4 (cont.)
Habitat actions for the Bonneville Tributaries Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[41]	Expected Biophysical Response[42]	Certainty of Outcome43
Bon-Tribs 12. Conduct forest practices on state lands in accordance with the Habitat Conservation Plan in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 3, 4, 5 & 7	Medium: State timber lands in the Washougal Basin (approximately 30% of the basin area)	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats. Response is medium because of location and quantity of state lands	Medium
Bon-Tribs 13. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships, providing incentives to landowners, and increasing funding	Expansion of existing program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, UCD, LCFEG	3, 4, 5, 6, 7, 8 & 10	Medium: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality, LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium
Bon-Tribs 14. Assess the impact of fish passage barriers throughout the basin and restore access to potentially productive habitats	Expansion of existing program or activity	WDFW, WDNR, Skamania County, WSDOT, LCFEG	5	Medium: As many as 6 miles of stream are potentially blocked by artificial barriers	Medium: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is marginal in most cases	Medium
Bon-Tribs 15. Increase technical support and funding to small forest landowners faced with implementation of Forest and Fish requirements for fixing roads and barriers to ensure full and timely compliance with regulations	Expansion of existing program or activity	WDNR	1, 2, 4, 5, 6 & 8	Low: Small private timberland owners	Medium: Reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
Bon-Tribs 16. Protect and restore native plant communities from the effects of invasive species	Expansion of existing program or activity	Weed Control Boards (local and state); NRCS, UCD, LCFEG	1 & 4	Medium: Greatest risk is in agriculture and residential use areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
Bon-Tribs 17. Assess water quality issues through the development and implementation of water quality clean up plans (TMDLs)	Expansion of existing program or activity	WDOE	5	Medium: temperature concerns throughout basin and 303(d) listings	Medium: Protection and restoration of water quality	Low

[41] Relative amount of basin affected by action
[42] Expected response of action implementation
[43] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-5
Habitat actions for the Salmon Creek Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[44]	Expected Biophysical Response[45]	Certainty of Outcome[46]
Salm 1. Ensure standards in land use and environmental programs and plans afford adequate protections of ecologically important areas (i.e. stream channels, riparian zones, floodplains, CMZs, wetlands, unstable geology)	Expansion of existing program or activity	Clark County, City of Vancouver	1 & 2	High: Applies to nearly all of the basin	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
Salm 2. Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.), manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the effects of conversion of agricultural and timber lands to developed uses. Use availability of water to help guide growth.	Expansion of existing program or activity	Clark County, City of Vancouver, City of Battleground	1 & 2	High: Applies to nearly all of the basin	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
Salm 3. Within authorities, prevent floodplain impacts from new development through land use controls and Best Management Practices	New program or activity	Clark County, City of Vancouver, WDOE	1	Medium: Applies to privately owned floodprone lands under county jurisdiction	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
Salm 4. Increase funding available to purchase easements or property in sensitive areas in order to protect watershed function where existing programs are inadequate	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	1 & 2	Medium: Residential, agricultural, or forest lands at risk of further degradation	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High
Salm 5. Review and adjust operations to ensure compliance with the Endangered Species Act	Expansion of existing program or activity	Clark County, Vancouver, Battleground	1, 4, 6, & 7	Low: Applies to lands under public jurisdiction	Medium: Protection of water quality, greater streambank stability, reduction in road-related fine sediment delivery, restoration and preservation of fish access to habitats	High
Salm 6. Within authorities, increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing the incentives (financial or otherwise) and increasing program marketing and outreach	Expansion of existing program or activity	NRCS, Clark CD, WDNR, WDFW, LCFEG, Clark County, Vancouver	All measures	High: Applies to agriculture, forest, and developed lands throughout the basin	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium

[44] Relative amount of basin affected by action
[45] Expected response of action implementation
[46] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-5 (cont.)
Habitat actions for the Salmon Creek Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[47]	Expected Biophysical Response[48]	Certainty of Outcome[49]
Salm 7. Implement the prescriptions of the WRIA 27/28 Watershed Planning Unit regarding instream flows. Develop a regional water source in the Vancouver Lake Lowlands within 10 years	Activity is currently in place	WDOE, WDFW, WRIA 27/28 Planning Unit, Vancouver, Clark Public Utilities	3	High: Entire basin	High: Adequate instream flows to support life stages of salmonids and other aquatic biota.	Medium
Salm 8. Within authorities, conduct floodplain restoration where feasible along the mainstem Salmon Creek and in major tributaries that have experienced channel confinement. Build partnerships with landowners and agencies and provide financial incentives	New program or activity	NRCS, CCD, NGOs, WDFW, LCFRB, USACE, LCFEG	4, 5, 6, 8 & 10	Medium: Mainstem Salmon Creek and lower portion of major tributaries	Medium: Restoration of floodplain function, habitat diversity, and habitat availability.	Medium
Salm 9. Protect and restore native plant communities from the effects of invasive species	Expansion of existing program or activity	Weed Control Boards (local and state); NRCS, Clark CD, LCFEG	1 & 5	High: Greatest risk is in agriculture and residential use areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
Salm 10. Address water quality impairments through the development and implementation of water quality clean up plans (TMDLs)	Expansion of existing program or activity	WDOE	6	High: Private agricultural and rural residential lands	Medium: Protection and restoration of water quality	Low
Salm 11. Fully implement and enforce the Forest Practices Rules (FPRs) on private timber lands in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 4, 6, 7 & 10	Low: Private commercial timber lands	Medium: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
Salm 12. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships, providing incentives to landowners, and increasing funding	Expansion of existing program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, Clark CD, LCFEG	4, 5, 6, 7, 8, 10 & 11	Low: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality, LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium

[47] Relative amount of basin affected by action
[48] Expected response of action implementation
[49] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-5 (cont.)
Habitat actions for the Salmon Creek Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area50	Expected Biophysical Response51	Certainty of Outcome52
Salm 13. Increase technical support and funding to small forest landowners faced with implementation of Forest and Fish requirements for fixing roads and barriers to ensure full and timely compliance with regulations	Expansion of existing program or activity	WDNR	1, 2, 4, 6, 7 & 10	Low: Small private timberland owners	Medium: Reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
Salm 14. Assess the impact of fish passage barriers throughout the basin and restore access to potentially productive habitats	Expansion of existing program or activity	WDFW, WDNR, Clark County WSDOT, LCFEG	10	Low: Only approximately 3 miles of potential habitat is blocked by artificial barriers	Medium: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is marginal in most cases	Medium
Salm 15. Conduct forest practices on state lands in accordance with the Habitat Conservation Plan in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 4, 6, 7 & 10	Low: State timber lands in the Salmon Creek Basin (approximately 4% of the basin area)	Medium: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats. Response is medium because of location and quantity of state lands	Medium
Salm 16. Within authorities, create and/or restore lost side-channel/off-channel habitat for chum spawning and coho overwintering	New program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, Clark CD, LCFEG	11	Low: Lake River and lower mainstem Salmon Creek	High: Increased habitat availability for spawning and rearing	Low
Salm 17. Within existing authorities, coordinate with appropriate entities to limit the effects of intensive recreational use of priority reaches in Salmon Creek during critical periods where problems are identified.	Expansion of existing program or activity	Clark County, City of Vancouver, WDFW, Implementing Partners	9	Low: Key reaches in Salmon Creek	Medium: Increased survival of salmonids	Low

[50] Relative amount of basin affected by action
[51] Expected response of action implementation
[52] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-6
Habitat actions for the Washougal Subbasin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[53]	Expected Biophysical Response[54]	Certainty of Outcome[55]
Wash 1. Ensure standards in land use and environmental programs and plans afford high levels of protections of ecologically important areas (i.e. stream channels, riparian zones, floodplains, CMZs, wetlands, unstable geology)	Expansion of existing program or activity	Clark County, Skamania County, City of Washougal, City of Camas	1 & 2	High: Applies to all private lands under county jurisdiction	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
Wash 2. Using available planning tools (e.g., GMA, comprehensive planning, zoning, best management practices, etc.), manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the effects of conversion of agricultural and timber lands to developed uses.	Expansion of existing program or activity	Clark County, Skamania County, City of Washougal, City of Camas	1 & 2	High: Applies to all private lands under county jurisdiction	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
Wash 3. Within authorities, conduct floodplain restoration where feasible along the lower mainstem and in major tributaries that have experienced channel confinement. Build partnerships with landowners and agencies and provide financial incentives	New program or activity	NRCS, Clark CD, UCD, NGOs, WDFW, LCFRB, USACE, LCFEG	4, 5, 7, 8 & 9	Medium: Lower mainstem Washougal, Little Washougal, and Lacamas Creek	Medium: Restoration of floodplain function, habitat diversity, and habitat availability.	High
Wash 4. Within authorities, prevent floodplain impacts from new development through land use controls and Best Management Practices	New program or activity	Clark County, Skamania County, City of Washougal, City of Camas, WDOE	1	Medium: Applies to privately owned floodprone lands under local government jurisdiction	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
Wash 5. Increase funding available to purchase easements or property in sensitive areas in order to protect watershed function where existing programs are inadequate	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	1 & 2	Medium: Residential, agricultural, or forest lands at risk of further degradation	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High
Wash 6. Review and adjust operations to ensure compliance with the Endangered Species Act	Expansion of existing program or activity	Clark County, Skamania County, Camas, Washougal	1, 3, 4, & 5	Low: Applies to lands under public jurisdiction	Medium: Protection of water quality, greater streambank stability, reduction in road-related fine sediment delivery, restoration and preservation of fish access to habitats	High

[53] Relative amount of basin affected by action
[54] Expected response of action implementation
[55] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-6 (cont.)
Habitat actions for the Washougal Subbasin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[56]	Expected Biophysical Response[57]	Certainty of Outcome[58]
Wash 7. Within authorities, increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing the incentives (financial or otherwise) and increasing program marketing and outreach	Expansion of existing program or activity	NRCS, CCD, UCD, WDNR, WDFW, Clark County, Skamania County	All measures	High: Private lands. Applies to lands in agriculture, rural residential, and forestland uses throughout the basin	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
Wash 8. Continue to manage federal forest lands according to the Northwest Forest Plan	Activity is currently in place	USFS	1, 2, 3, 4, 5 & 7	Low: National Forest lands in the upper basin	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	High
Wash 9. Fully implement and enforce the Forest Practices Rules (FPRs) on private timber lands in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 3, 4, 5 & 7	Medium: Private commercial timber lands	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
Wash 10. Implement the prescriptions of the WRIA 27/28 Watershed Planning Unit regarding instream flows. Develop a regional water source in the Vancouver Lake Lowlands (or Steigerwald area) within 10 years	Activity is currently in place	WDOE, WDFW, WRIA 27/28 Planning Unit, City of Camas, City of Washougal	6	High: Entire basin	High: Adequate instream flows to support life stages of salmonids and other aquatic biota.	High
Wash 11. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships, providing incentives to landowners, and increasing funding	Expansion of existing program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, Clark CD, UCD, LCFEG	3, 4, 5, 7, 8, 9 & 10	High: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality, LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium
Wash 12. Increase technical support and funding to small forest landowners faced with implementation of Forest and Fish requirements for fixing roads and barriers to ensure full and timely compliance with regulations	Expansion of existing program or activity	WDNR	1, 2, 3, 4, 5 & 7	Medium: Small private timberland owners	High: Reduction in road-related fine sediment delivery; restoration and preservation of fish access to habitats	Medium

[56] Relative amount of basin affected by action
[57] Expected response of action implementation
[58] Relative certainty that expected results will occur as a result of full implementation of action

Table 7-6 (cont.)
Habitat actions for the Washougal Subbasin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[59]	Expected Biophysical Response[60]	Certainty of Outcome[61]
Wash 13. Conduct forest practices on state lands in accordance with the Habitat Conservation Plan in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 3, 4, 5 & 7	Medium: State timber lands in the Washougal Basin (approximately 30% of the basin area)	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats. Response is medium because of location and quantity of state lands	Medium
Wash 14. Protect and restore native plant communities from the effects of invasive species	Expansion of existing program or activity	Weed Control Boards (local and state); NRCS, Clark CD, UCD, LCFEG	1 & 4	High: Greatest risk is in agriculture and residential use areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
Wash 15. Assess the impact of fish passage barriers throughout the basin and restore access to potentially productive habitats	Expansion of existing program or activity	WDFW, WDNR, Clark County, Skamania County WSDOT, LCFEG	7	Medium: Several miles of stream are potentially blocked by artificial barriers	Medium: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is marginal in most cases	Medium
Wash 16. Local jurisdictions should assess and require upgrading and replacement of on-site sewage systems, in conformance with current regulations	Expansion of existing program or activity	Clark County, Skamania County, Clark CD, UCD, LCFEG	5	High: Private agricultural and rural residential lands	Medium: Protection and restoration of water quality (bacteria)	Low
Wash 17. Within authorities, create and/or restore lost side-channel/off-channel habitat for chum spawning and coho overwintering	New program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, Clark CD, UCD, LCFEG	10	Low: Lower mainstem Washougal	High: Increased habitat availability for spawning and rearing	Low

[59] Relative amount of basin affected by action
[60] Expected response of action implementation
[61] Relative certainty that expected results will occur as a result of full implementation of action

Section 8
Plan Implementation Considerations

Previous sections of this watershed management plan identify a range of recommended actions in the areas of water supply, stream flow management, surface water quality, ground water quality, and habitat. In each of these sections, implementation considerations were described, including prioritization of actions, identification of organizations that would have implementation responsibilities, cost, and potential sources of funding.

This section addresses overall implementation needs to provide a solid foundation for those individual actions. This Section builds on information and recommendations presented in a Report to the Legislature prepared by the Phase 4 Watershed Plan Implementation Committee in 2002. These recommendations have been reshaped to match local circumstances in WRIAs 27 and 28.

8.1 Plan Adoption Process and Resulting Obligations

The Watershed Management Act prescribes a specific process for adoption of a watershed plan, and voluntary acceptance of obligations under the plan (Section 90.82.130 RCW). This is a two-stage process. First, the Planning Unit considers the plan for approval, and individual members of the Planning Unit consider what actions they will commit to carrying out. Once this is completed, the Plan is sent to the Boards of County Commissioners of all Counties in the planning area for their consideration. If the Commissioners approve the plan, the voluntary commitments made by members of the planning unit become binding.

Through this process, no organization or person is required to take on a commitment without their consent. However, once an organization has formally agreed to implement actions under the Plan, and the Plan has been approved, these commitments must be implemented.

This Watershed Management Plan does not create any obligations for private businesses, citizens or landowners. However, there are actions identified for *voluntary* action in the private sector.

Actions recommended in this plan are intended to be specific enough to clearly specify the action and result; yet general enough to permit some flexibility in carrying them out. The Planning Unit recognizes that some actions require further investigation prior to full implementation. The Planning Unit also recognizes that some actions can be carried out only if funding is provided by the State Legislature or funding agencies, and that funding decisions will be made over a period of months or years following plan adoption. Therefore, the recommendations of this Plan have been crafted to recognize these limitations and to allow for further decision-making on the road to achieving the Plan’s objectives.

It will be important that any rules adopted by the State of Washington to implement this watershed plan remain consistent with the intent expressed by the Planning Unit in this Watershed Management Plan. The strategies presented in this Watershed Management Plan are intended to provide a balanced suite of actions to manage water resources in the planning area. In the event that a State rule-making process, legislative action, or court decision substantially alters implementation of the provisions outlined in the Plan, the other organizations with implementation responsibilities reserve the right to re-visit their implementation commitments as well. This is particularly true for County governments, which have the role of adopting the plan through the approval process under Chapter 90.82.130 RCW.

8.2 Grant Funding for Implementation Phase

In 2003 the Washington State Legislature amended the Watershed Planning grants program to provide Phase 4 grants to support implementation of watershed plans (Section 90.82.040 RCW). Application for the grant can be made following approval of the Watershed Plan by both the Planning Unit and Counties, following the procedure described in Section 90.82.130 RCW.

The WRIAs 27 and 28 Planning Unit is eligible for up to $125,000 per year in each of the first three years of implementation. Following this, $62,500 per year can be awarded in the fourth and fifth years of implementation. A match of ten percent is required, which can include either financial contributions or in-kind goods and services.

It is not expected that this limited amount of funding will cover implementation of the projects and programs discussed in this Watershed Management Plan. Instead, these funds should be considered “seed money” to strengthen the organizational foundation for Plan implementation and to pursue more substantial funding for the many activities recommended in this Plan. Section 8.5 discusses additional sources of funding that can be developed, if appropriate, during the implementation phase.

The Legislature also provided that the Planning Unit must complete a detailed implementation plan within one year of accepting the Phase 4 funding. Disbursements of Phase 4 funding for subsequent years is conditioned upon completion of the implementation plan. The implementation plan must contain strategies, timelines and milestones; define coordination and oversight responsibilities, any needed interlocal agreements, rules or ordinances; any needed state or local administrative approvals and permits, and specific funding mechanisms. In addition, the planning Unit must consult with other organizations developing plans in the same area, and identify and seek to eliminate activities or policies that are duplicative or inconsistent.

The WRIAs 27 and 28 Planning Unit anticipates applying for the Phase 4 grant funding, at such time as this Watershed Management Plan is approved. The discussion of implementation considerations in the Plan provides a starting point for eventual development of the detailed implementation plan described above.

The Planning Unit anticipates that full implementation of Plan recommendations will require a time frame on the order of five to fifteen years. Many actions can be carried out in the first five years; while others will require longer to obtain funding, permits, and other necessary approvals. As noted above, the grant funding program is designed only for the first five years of this time frame.

8.3 Overall Coordination of Plan Implementation

The recommendations presented in this Watershed Management Plan span a range of natural resources, activities, and organizations. Recommendations are identified for county governments, public water systems, several state agencies, private industry, landowners and others. The intent has been to provide a balanced mix of recommended actions that collectively achieve the objectives stated in Section 1.3.

With a range of organizations involved, and an implementation period spanning many years, it will be important to put in place some mechanism for coordination and oversight. Some of the activities included under coordination and oversight are:

- Tracking implementation of Plan actions by the many organizations involved, to ensure actions are being carried out in a timely fashion; that the balanced nature of the plan is retained as actions are implemented; and that the most important priorities defined by the Planning Unit are being addressed;
- Coordinating efforts to seek funding for Plan actions, to avoid duplication of effort and ensure the State legislature and funding agencies see well-organized and unified support for funding requests on an ongoing basis;
- Providing information to the public on Plan implementation and resulting improvements in watershed conditions;
- Providing early warning systems and joint responses to changing conditions, including physical conditions in the watershed; new regulatory developments; and new project proposals that may emerge from time to time.
- Monitoring of watershed conditions across jurisdictional boundaries, data management, and providing data access.
- Periodic review of the Plan, and updating if warranted.

This list is not necessarily complete, but it shows the value of creating a system of coordination and oversight for the implementation phase.

Recommendation:
In order to provide a venue for these activities, it is recommended that the WRIAs 27 and 28 Planning Unit transition from planning functions to coordination and oversight functions as listed above. The purpose is to foster an organized and collaborative approach, as many individual organizations carry out specific actions under their jurisdictions, and to secure funding for implementation. The Planning Unit, at its option, may choose to form subcommittees to follow up on selected areas for implementation, such as securing resources to install additional stream flow gauges; assessing alternative sources of supply to reduce stream flow impacts; protecting ground water quality, etc.

It is also recommended that LCFRB continue to provide staff resources to support the Planning Unit in this activity. Funding for these purposes can be based on the State Phase 4 grants for the first five years of the implementation phase.

An interlocal agreement may be useful in defining coordination and oversight responsibilities. Such an agreement may also be beneficial in further defining other implementation commitments among the organizations involved, beyond the level of detail presented in this Plan.

The Planning Unit will not take on any regulatory responsibilities or authorities. Regulatory activity will continue to be the responsibility of State or federal agencies and local governments, consistent with existing laws.

In order for the group to be effective in the coordination and oversight role, local jurisdictions such as counties, cities, and water purveyors will need to make staff resources available. For example, a core group could include Clark, Cowlitz, and Skamania Counties, the City of Vancouver, and Clark Public Utilities, as well as the Department of Ecology. Other cities, purveyors, and groups in the region may also elect to participate.

8.4 Implementation Actions by Individual Organizations

The Coordination and Oversight role, while important, will not alone ensure effective implementation. It is critical that the individual organizations that voluntarily commit to carrying out Plan actions follow through on these commitments. These include the respective counties, cities, public water systems, state agencies and others, assuming each of them accepts certain commitments. It is important to recognize that the mix of actions in this plan results in a sharing of commitments. This will help to spread the burden of carrying out plan actions, and will also provide for delivering real benefits across the region's jurisdictions.

For each organization carrying out actions under the plan, several steps will be needed. First, it is critical that elected decision-makers and top managers of the organization be involved at the plan review and approval stage, before the Planning Unit approves the Plan. Second, once the Plan is approved organizations will need to budget for plan actions and identify funding sources. This should be incorporated in the budget process each year (or biennium for State agencies). Third, it will be important to identify staff who will be responsible for carrying out that organization's commitments, and provide for reporting back to management and to the Planning Unit. Finally, depending on how the organization operates, there may be a need for work plans to be prepared to define actions and schedule.

The involvement of individual organizations in carrying out their commitments is vital to this Plan. The Watershed Planning Unit has no independent capability to implement Plan actions. It is the counties, cities, water purveyors, and State agencies, among others, that will ultimately carry out plan elements. Therefore, it is critical that their management and governing elected bodies take note of responsibilities described here.

8.5 Summary of Implementation Roles and Considerations

Throughout this Watershed Management Plan, implementation roles and considerations have been identified in the areas of water supply, stream flow management, surface water quality, and ground water quality. Table 8-1 lists the organizations that have been identified for "lead" roles in implementing this watershed plan.

For each organization, specific activities are listed. Table 8-2 provides additional detail on all of these activities, including involvement by other organizations, relative costs of each activity, and potential funding sources. It should be noted that many of these activities will also require staff resources. At the same time, many of these activities can be integrated with existing programs and should not necessarily be viewed as new, additional responsibilities.

Throughout this Watershed Management Plan, various terms are used in relation to management actions, activities and recommendations. The terms "shall", "may" and "should" are frequently used, and are defined as follows:

- The term "shall" is mandatory;
- The term "may" is permissive and does not impose a mandatory requirement;
- The term "should" is a recommendation and does not impose a mandatory requirement.

Lead roles were identified based on a general understanding of the various functions and activities of each organization. However, it is recognized that authority or responsibility for undertaking specific actions may be associated with entities other than those identified as lead. Roles can vary significantly between otherwise similar organizations depending on legal authorities, staffing, and budget limitations. **These roles are not mandatory and cannot become operational without the formal approval of specific activities by elected boards and commissions, or upper-level managers at the respective organizations. The Planning Unit requests each organization consider its recommended role(s) and provide a written indication of its capacity and intent to carry out these actions.** Where potential discrepancies in roles exist, appropriate lead organizations will be determined during the implementation phase. In accordance with RCW 90.82.130 (3), roles and commitments become effective upon acceptance and approval by the designated lead organization.

Table 8-1
Lead Implementation by Organization

Lead for Implementation	Category	Activity
Counties, cities, public water systems, LCFRB, State agencies, others	Coordination and oversight	Track implementation of Watershed Management Plan, pursue funding, report to the public on Plan implementation and results, forum for ongoing discussion and periodic update of Plan.
Counties, cities, local governments, Ecology, and/or others as appropriate.	Stream Flow Management	Source substitution for selected areas served by domestic wells: relatively higher densities and likelihood of stream impacts; dependent on feasibility and cost.
Counties and Planning Unit	Stream Flow Management	Wetlands inventories and ordinances: assess and protect hydrologic functions, consider strengthening mitigation ratios.
Counties and others	Surface Water Quality	Within authorities, develop full scale assessment strategy
County health departments	Ground Water Quality	Within authorities, improve public awareness of ground water quality issues. Information outlets. Mass-media campaign. Schools program. Public opinion surveys.
County health departments	Ground Water Quality	Within authorities, assess susceptibility of ground water supplies to contamination. Risk assessment. Evaluate data management and improve if necessary. Regional mapping.
County health departments	Ground Water Quality	Within authorities, coordinate and promote strategies to prevent impacts to ground water quality from land use activities.
County health departments	Ground Water Quality	Within authorities, clean up sources of ground water contamination. Evaluate need for greater involvement by local organizations. Evaluate need for independent cleanup actions outside Ecology programs.
Counties, cities	Water Supply	Consider the effects of individual domestic wells when modifying or adopting comprehensive plans, zoning designations, or other land use regulations.
Counties, Cities	Stream Flow Management	Review effects of stormwater discharges on stream flow and habitat. Where needed to protect key habitat, implement programs that exceed minimum requirements.
Counties, Cities	Stream Flow Management	When modifying or adopting comprehensive plans, zoning designations, or other land use regulations, jurisdictions should consider the water balance implications of allowing extension of sewer service to communities formerly served by septic systems.
	Coordination and Oversight	

Table 8-1 (cont.)
Lead Implementation by Organization

Lead for Implementation	Category	Activity
Public Water System	Water Supply	Public Water Systems develop new or expanded supplies. Requires engineering studies; approval of water system plan; water rights processing; other permitting; SEPA compliance; construction; operations & maintenance. Standard procedures exist for all of these.
Public Water System	Water Supply	Planning studies to explore alternative sources of supply to replace an existing source (selected communities).
Public Water System	Water Supply	Replace an existing source of supply with a different source to reduce impacts on stream flow. Requires engineering studies; water rights processing; other permitting; inter-local agreements or contracts; construction; operations & maintenance.
Public Water System	Water Supply	Enhanced conservation exceeding state requirements in selected communities.
Selected public water systems; hydropower operators	Stream Flow Management	Large water users and hydropower facilities: short-term drought response curtailment programs, to protect stream flows.
Counties, cities, State agencies with land management responsibilities	Stream Flow Management	Within authorities, protect floodplains from modifications that would impair hydrologic functions or habitat.
Counties, cities, State agencies with land management responsibilities	Stream Flow Management	Within authorities, identify floodplain restoration projects and implement where feasible.
LCFRB and Planning Unit or successor organization	Stream Flow Management	Establish target flow monitoring and management program
Private industry (large plants)	Water Supply	Industrial supplies: Expand conservation & reuse; develop non-potable sources; connect to municipal systems.
Landowner	Water Supply	Agricultural supplies: switch from surface to ground water. Discourage new uses of surface water (use ground water instead).
Agricultural producer	Stream Flow Management	Water conservation by farmers practicing irrigated agriculture. Technical assistance by Conservation District in each county.
Party causing impairment	Surface Water Quality	Actions to correct sources of impairment
Ecology	Stream Flow Management	Maintain existing stream gauges. Install new gauges at selected locations. Select exact sites; permit and construct gauges; O&M; data management.
Ecology	Stream Flow Management	Adopt closures and/or minimum instream flows in State Rule
Ecology	Stream Flow Management	Initial surveys in selected subbasins to identify unauthorized uses and take enforcement actions. Follow-up in other basins if warranted.
Ecology	Stream Flow Management	Purchase or lease of water rights from willing sellers, for State Trust program.
Ecology	Surface Water Quality	Develop water body cleanup plans (TMDLs) for subbasins, in prioritized sequence as indicated in Watershed Management Plan. Carry out necessary modeling, reporting, public involvement, and waste load allocations.
DNR, USFS	Stream Flow Management	Consider and address effects of forest practices on stream flow. Monitor effectiveness of F&F Rules and NW Forest Plan. Report to public periodically.
DOH and County health departments	Ground Water Quality	Improve local wellhead protection. Determine which Group A Systems have wellhead program. Apply technical assistance and enforcement to meet state requirements. Facilitate use of computer modeling. Encourage Group B systems to voluntarily establish wellhead programs.
Shared efforts by State, local, federal agencies	Surface Water Quality	Within authorities and as staffing and funding allow, expand water quality monitoring activities to improve understanding of status and trends. Install monitoring equipment; collect and analyze samples; manage and analyze data; report results.

Table 8-2
Implementation Considerations for Watershed Plan

Priority[1]	Activity	Implementers[3]	Financial/ Economic Costs[2]	Funding Sources
Category: Water Supply				
High	Public Water Systems develop new or expanded supplies. Requires engineering studies; approval of water system plan; water rights processing; other permitting; SEPA compliance; construction; operations & maintenance. Standard procedures exist for all of these.	*Lead*: Public Water System *Others*: DOH, Ecology	Medium	*Main*: Water rates and hookup charges in affected service area *Additional*: Grants or low-interest loans from existing state & federal programs
High	Planning studies to explore alternative sources of supply to replace an existing source (selected communities).	*Lead*: Public Water System	Low	*Main*: Water rates in affected service area
High	Replace an existing source of supply with a different source to reduce impacts on stream flow. Requires engineering studies; water rights processing; other permitting; inter-local agreements or contracts; construction; operations & maintenance.	*Lead*: Public Water System *Others*: DOH, Ecology, adjacent water system(s) to serve as wholesaler	Medium to High	*Main*: Leg. appropriation *Additional*: Water rates in affected service area
Medium	Develop map of region's aquifers with emphasis on surface water hydraulic continuity.	*Lead:* Ecology *Support*: Public water systems	Medium	*Main:* Grants, water purveyor revenues
Medium	Enhanced conservation exceeding state requirements in selected communities.	*Lead*: Public Water System *Other*: Ecology, Conservation districts	Low to medium	*Main*: public water system *Additional*: Grants from DOH or Ecology
Medium	Industrial supplies: Expand conservation & reuse; develop non-potable sources; connect to municipal systems.	*Lead*: Private industry (large plants) *Others*: Ecology & DOH (technical assistance; water rights processing if applicable)	Low to High (Varies by facility)	*Main*: Private industry *Additional*: Leg. appropriations
Low	Consider the effects of individual domestic wells when modifying or adopting comprehensive plans, zoning designations, or other land use regulations.	*Lead*: Counties, cities	Low	*Main*: counties, cities general fund, permitting fees, or grants
Low	Agricultural supplies: switch from surface to ground water. Discourage new uses of surface water (use ground water instead).	*Lead*: Landowner *Others*: Ecology, Conservation Districts	Low to medium	*Main*: Landowner *Additional*: Leg. appropriations
Low	Within authorities an as staffing and funding allow, develop water-level monitoring program for aquifers	*Lead:* Water purveyors *Others*: USGS, counties	Medium	*Main:* Grants, water purveyor revenues
Category: Stream Flow Management				
High	Maintain existing stream gauges. Install new gauges at selected locations. Select exact sites; permit and construct gauges; O&M; data management.	*Lead*: Ecology *Other*: USGS, LCFRB, Counties	Medium	*Main*: Leg. appropriations (Ecology budget); Congr. appropriations (USGS budget); *Additional*: Counties; Public Water Systems

Table 8-2 (cont.)
Implementation Considerations for Watershed Plan

Priority[1]	Activity	Implementers[3]	Financial/ Economic Costs[2]	Potential Funding Sources
High	Adopt restrictions on issuance of new water rights in State Rule	*Lead*: Ecology *Other*: LCFRB	Low	*Main*: Ecology (staff time) *Additional*: LCFRB (staff time)
High	Selected actions involving water supply and intended to protect stream flow. See water supply items listed above.	*See Section 3.6*	*See Section 3.6*	*See Section 3.6*
High	Establish target flow monitoring and management program	*Lead*: LCFRB and Planning Unit or successor organization *Other*: Ecology, DFW		*Main*: Phase 4 implementation funds *Additional*: TBD
High	Initial surveys in selected subbasins to identify unauthorized uses and take enforcement actions. Follow-up in other basins if warranted.	*Lead*: Ecology *Other*: N/A	Low to medium	*Main*: Leg. appropriations (Ecology budget & staffing) *Additional*: N/A
High	Consider and address effects of forest practices on stream flow. Monitor effectiveness of F&F Rules and NW Forest Plan. Report to public periodically.	*Lead*: DNR, USFS *Other*: Private forest landowners	Low to medium	*Main*: Leg. appropriations (DNR budget); Congr. appropriations (USFS budget), Timber producers *Additional*: N/A
High	Within authorities, protect floodplains from modifications that would impair hydrologic functions or habitat.	*Lead*: Counties, cities, State agencies with land management responsibilities *Other*: DFW	Low	*Main*: County permitting fees or general fund revenues, grants *Additional*: State agency budgets
Medium	Review effects of stormwater discharges on stream flow and habitat. Where needed to protect key habitat, implement programs that exceed minimum requirements.	*Lead*: Counties, Cities *Other*: Ecology	Low to Medium	*Main*: County, City general funds; Stormwater assessment and fees, grants *Additional*: N/A
Medium	Purchase or lease of water rights from willing sellers, for State Trust program.	*Lead*: Ecology *Other*: N/A	Low to medium	*Main*: Leg. appropriations (Ecology budget) *Additional*: N/A
Medium	Within authorities, identify floodplain restoration projects and implement where feasible.	*Lead*: Counties, cities, State agencies with land management responsibilities *Other*: DFW	Medium to High	*Main*: State or federal grants; Leg. appropriations *Additional*: N/A
Medium	Wetlands inventories and ordinances: assess and protect hydrologic functions, consider strengthening mitigation ratios.	*Lead*: Counties and Planning Unit *Other*: N/A		*Main*: County development fees or general fund revenues (note staffing impact), grants *Additional*: N/A

Table 8-2 (cont.)
Implementation Considerations for Watershed Plan

Priority[1]	Activity	Implementers[3]	Financial/ Economic Costs[2]	Potential Funding Sources
Medium	Large water users and hydropower facilities: short-term drought response curtailment programs, to protect stream flows.	*Lead*: Selected public water systems; hydropower operators *Other*: N/A	Low to medium	*Main*: Large water users and hydropower facilities *Additional*: N/A
Low	When modifying or adopting comprehensive plans, zoning designations, or other land use regulations, jurisdictions should consider the water balance implications of allowing extension of sewer service to communities formerly served by septic systems.	*Lead*: Counties, Cities *Other*: sewer agencies if different from Counties, Cities.	Low	*Main*: Counties, Cities general funds, permitting fees, grants *Additional*: N/A
Low	Water conservation by farmers practicing irrigated agriculture. Technical assistance by Conservation District in each county.	*Lead*: Agricultural producer *Other*: Conservation Districts	Medium	*Main*: Agricultural producer *Additional*: Leg. Appropriations (Cons. Commission & CD budgets).
Low	Source substitution for selected areas served by domestic wells: relatively higher densities and likelihood of stream impacts; dependent on feasibility and cost.	*Lead*: Counties, cities, local governments, Ecology, and/or others as appropriate. *Other*: Public water systems	Medium to high	*Main*: Assessments on affected properties (local improvement districts), grants *Additional*: Federal and State salmon recovery funding; Leg. appropriations
Category: Surface Water Quality				
Medium	Develop water body cleanup plans (TMDLs) for subbasins, in prioritized sequence as indicated in Watershed Management Plan. Carry out necessary modeling, reporting, public involvement, and waste load allocations.	*Lead*: Ecology *Other*: Local governments, Conservation Districts, other interested parties	High	*Main*: Leg. appropriations (Ecology budget) *Additional*: N/A
Medium	Within authorities, develop full scale assessment strategy for non-point sources	Lead: counties *Other*: Ecology, conservation districts, USFS, DNR	Low	Phase 4 implementation Grant
Medium	Carry out source assessment of non-point sources	Same as above	Medium	TBD, (combination of State, federal, and local sources)
Medium	Actions to correct sources of impairment	*Lead:* Party causing impairment *Other*: Ecology, conservation districts	Medium to High	TBD (combination of State, federal, local and private sources)

Table 8-2 (cont.)
Implementation Considerations for Watershed Plan

Priority[1]	Activity	Implementers[3]	Financial/ Economic Costs[2]	Potential Funding Sources
Low	Within authorities and as staffing and funding allow, expand water quality monitoring activities to improve understanding of status and trends; and, install monitoring equipment; collect and analyze samples; manage and analyze data; report results.	Shared efforts by State, local, federal agencies Ecology will take lead in promoting cooperative arrangements among agencies	High	Combination of State, local, federal funding sources (to be developed further in Implementation Phase)
Category: Ground Water Quality				
High	Within authorities, improve public awareness of ground water quality issues. Information outlets. Mass-media campaign. Schools program. Public opinion surveys.	*Lead*: County health departments *Others*: Cities, DOH.	Medium	*Main*: grants Substantial staffing needs
High	Within authorities, assess susceptibility of ground water supplies to contamination. Risk assessment. Evaluate data management and improve if necessary. Regional mapping.	*Lead*: County health departments *Others*: Cities, Ecology, DOH.	Low to Medium	*Main*: grants Substantial staffing needs
Medium	Within authorities, improve local wellhead protection. Determine which Group A Systems have wellhead program. Apply technical assistance and enforcement to meet state requirements. Facilitate use of computer modeling. Encourage Group B systems to voluntarily establish wellhead programs.	Lead: DOH and County health departments *Others*: Public water systems	Medium to High	*Main*: grants Substantial staffing needs
Low	Within authorities, coordinate and promote management strategies to prevent impacts to ground water quality from land use activities..	*Lead*: County health departments *Others*: County planning departments, conservation districts, Ecology, Wash. Dept. of Agriculture, NRCS	Medium to High	*Main*: grants Substantial staffing needs
Low	Within authorities, clean up sources of ground water contamination. Evaluate need for greater involvement by local organizations. Evaluate need for independent cleanup actions outside Ecology programs.	*Lead*: County health departments *Others*: Ecology, Public Water Systems, Wash. Dept. of Agriculture	Medium to High	*Main*: grants

(1) Priority in context of all actions in Watershed Management Plan.
(2) Preliminary, generalized estimates of financial or economic cost to the community or water user involved. High: greater than $500,000; Medium: $50,000 to $500,000; Low: less than $50,000. Total cost, whether up-front or over a period of time up to ten years.
(3) “Lead” implementer would take responsibility for organizing efforts under this action, including pursuing funding sources listed in the far right column.
Abbreviations: SEPA = State Environmental Policy Act, DOH = Department of Health, Leg. = Legislative

8.6 Funding Strategy

Tables have been presented in earlier sections of this Watershed Management Plan that summarize implementation considerations[1]. These tables include a preliminary estimate of the magnitude of costs, staffing implications for various organizations, and identification of potential funding sources. A mix of potential funding sources has been identified for different activities in the Plan. These sources include:

- Appropriations from the Washington State Legislature for state agency budgets (Ecology, DOH, DNR, Conservation Districts). This would provide funding and/or staffing that could be utilized under existing state programs to implement elements of the Plan.
- Direct appropriations from the Washington State Legislature for specific projects in WRIAs 27 and 28, based on requests to be formulated as the Plan is implemented;
- Appropriations from the U.S. Congress for federal agency budgets (USGS, USFS) under existing programs;
- Grants or low interest loans from existing funding programs, such as the Public Works Trust Fund, State Revolving Fund for Drinking Water, Salmon Recovery Fund, and many other sources[2].
- Rates and hookup charges collected from customers by public water systems (including cities that operate a water system, CPU, etc.)
- County permitting fees or general fund revenues;
- Assessments on property through local improvement districts, for projects that benefit those properties (subject to local approval);
- Private industry funds, for voluntary projects at selected industrial facilities (supplemented by public funds where possible);
- Landowners, for voluntary projects at selected sites (supplemented by public funds where possible);

While not called out for any specific actions, it is also worth noting that Public Utility Districts and Conservation Districts have authority under State law to levy property taxes up to certain limits. If this source of funding is desired, it must be subjected to a vote of the affected public. This could be a valuable supplementary source of funding, particularly for activities that cross local jurisdictional boundaries.

It is important to recognize that many agencies and jurisdictions are currently funding programs that align closely with the objectives and recommendations of this Plan. In many cases, existing expenditures can be effectively integrated with this Plan, reducing the overall financial impact.

---

[1] Tables listing implementation issues for specific actions appear in Sections 3.6 (water supply); 4.13 (stream flow); 5.5 (surface water quality); 6.6 (ground water quality; and 7 (habitat).

[2] The Phase 4 Committee Report to the Legislature includes an Appendix listing several dozen grant and loan programs that may be suitable for funding watershed actions.

In developing a funding package for implementing the Plan, it is important to match funding to benefits. Some of the actions listed in the Plan, such as development of new ground water supplies, will benefit a specific community. In these cases, it is appropriate that the community contribute a large share of the cost.

Other actions may be carried out by one community, but the purpose is to serve broader needs of the region, State or Nation. For example, if a local community voluntarily wishes to switch from an existing source of supply to a new source to help restore populations of listed species, there will likely be considerable costs. The purpose of a project of this nature is to restore fish populations for the good of the region, the State of Washington and the Nation as a whole. In this case, it is not equitable for a local community to bear the cost. While some cost burden may be acceptable at the local level, the majority of funding for this type of project should come from regional, state or federal sources.

8.7 Monitoring and Adaptive Management

Implementing a true adaptive management program for watershed planning is a very intensive exercise involving the development of conceptual models of the various systems and their interactions in the watershed. For this reason, the concept of adaptive management and its application are introduced here, but its full development is considered most appropriate for the Implementation Phase (Phase 4) of the watershed planning process. The intent of this section is to describe the adaptive management framework and provide a preliminary application of the framework to the stream flow management component of the Watershed Plan. This can be further refined and the same framework can be applied to the water supply, water quality, and habitat components under the Implementation Phase. Furthermore, this section includes a discussion of coordination and oversight for adaptive management, which are key components that need to occur during the Implementation Phase. Funding, as discussed in Section 8.5, is also critical to implement the monitoring and other activities taken under adaptive management. Because coordination, implementation, and funding issues have been discussed in the previous subsections, emphasis is placed on the monitoring aspects of adaptive management in the following discussion.

8.7.1 Background on Adaptive Management

Adaptive management has been defined in State law as “reliance on scientific methods to test the results of actions taken so that the management and related policy can be changed promptly and appropriately” (RCW 79.09.020). It is described as a cycle that occurs in four stages (Manley et al, 1999): (i) identification of information needs; (ii) information acquisition and assessment (monitor); (iii) evaluation and decision-making (evaluate); and (iv) management action or response (respond). Oftentimes, the first and fourth stages can be considered as one, since part of the response to newly evaluated data may be to identify new information needs. Thus, the key stages of the adaptive management cycle as the exhibit shows is to “monitor”, “evaluate”, and “respond.” These three primary stages of adaptive management are described further below.

Adaptive management is a continuing attempt to reduce the risk arising from the uncertainty associated with information used to develop the management actions.

Generally speaking, each stage of the cycle has an associated uncertainty which should decrease through each completed cycle of the process.

This is one perspective to applying adaptive management. An alternative way to look at adaptive management is to consider it as "experimental management" wherein the management actions taken are used to test key hypotheses and assumptions used to develop the management actions. There are subtle differences in application, but conceptually they are similar in that adaptive management attempts to address uncertainty in information.

The watershed planning process culminating in this Watershed Plan can be regarded as having completed one cycle through this process. At this stage of the watershed plan, some management actions have been identified along with additional information needs. Thus, the beginning of the implementation phase of the plan can be considered to be starting the "information acquisition and assessment" stage of the cycle once again. From there, the cycle can continue wherein the new and additional information collected during the Implementation Phase can be evaluated to determine whether the management actions need to be refined or revised.

Monitor – Information Acquisition Programs

The Implementation Phase of the watershed planning process will involve putting into action many of the recommendations in the plan, including collection of additional information. Once the information needs are identified, the next step is to collect information on how the Plan is going. Different types of monitoring that would feed into the adaptive management framework could have different objectives. Three types of monitoring and the corresponding general goals are as follows:

- Validation: determines if initial assumptions used to develop the plan are valid
- Implementation: determines if plans/projects are implemented as designed (yes/no)
- Effectiveness: determines if plans/projects are meeting management objectives

Validation Monitoring

Validation monitoring determines whether the assumptions used to develop the Plan recommendations are valid. Many of the general recommendations were developed based on certain assumptions about population trends, land use trends, and flow information, among other information. The recommendations may need to be changed if it is determined that some of these assumptions are not valid. Specific recommendations for additional validation monitoring include stream flow monitoring at priority streams, conducting engineering and planning studies for new water source development, and researching potential projects for floodplain and wetlands restoration. Preliminary validation monitoring activities are included in Table 8-3.

Table 8-3 includes a summary of the preliminary monitoring activities and studies that should be included in the information acquisition and assessment step of the adaptive management program. The activities are based on the management actions and recommendations in the previous chapters of the Plan. However, the activities included in Table 8-3 do not include habitat and fish recovery activities because those are being addressed under Subbasin Planning and Salmon Recovery Planning. Validation monitoring activities under these programs should be coordinated with the activities under Watershed Planning.

Implementation Monitoring

Implementation monitoring involves tracking whether the recommendations and commitments adopted in the Watershed Plan are being implemented and whether or not these activities have been properly completed (i.e., yes or no). Implementation monitoring generally involves measures whose results or benefits are fairly certain and do not require complex study designs, e.g. confirmation of whether a flow monitoring gauge has been installed at the proper location.

Effectiveness Monitoring

Effectiveness monitoring is commonly applied in those cases where the benefit of a management action is less certain. For those commitments where the benefit is less certain, scientific study is needed to make a judgment of their effectiveness. The study can then also be used in developing or updating management responses that are appropriate. For example, the effectiveness of reconnecting a floodplain through removal of a dike may provide some flow benefits, but the magnitude of the benefit would require some further study. Once the actual benefit is measured, then a judgment can be made whether similar projects are worthwhile and should be continued or whether other options may be more beneficial.

Evaluate – Evaluation of Monitoring Information

Once information is collected through the information acquisition phase, it will be evaluated to determine whether the goals of the Plan are being met and what changes could be needed to achieve the Plan objectives. A general evaluation framework is presented below.

- Management Actions – all of the management actions designed to contribute to a Plan objective are identified. These management actions are evaluated to determine success.
- Performance Metrics – for each management action, one or more units of measurement are used to evaluate the success of the action. The implementation metric is yes/no, while the effectiveness metric is typically a statistical or numeric measurement resulting from the study.
- Triggers – for each performance metric, a threshold is established that serves as the indicator (or trigger) when the adaptive management process starts. The trigger must be measurable in a timeframe meaningful for informing management changes.
- Management response – after the trigger is "tripped" for a given performance metric, the management response process begins.

As part of the evaluation process, the cost-benefit of a particular management action can be considered by incorporating cost information as a performance metric or a trigger. For example, one can consider how the actual cost to implement the action compares with the estimated cost or evaluate how the realized benefits of the action balance the cost to implement the action.

Respond – Management Responses

Management responses are developed after the monitoring data are evaluated. The responses are then incorporated into the implementation of the Plan in a feedback loop. However, because of the limitations in information, the management response cannot always be known until the new information is collected and evaluated, and additional "negotiation" occurs. Therefore, three general responses can occur under adaptive management:

- Predefined mandatory management response – completely defined at the outset of the Plan.
- Mandatory collaborative management response – mandatory if a specific triggering condition is observed, but the Plan does not specifically describe in advance what the management response would be.
- Cooperative management response – result from opportunities to alter management activities that arise from observations during Plan implementation.

Because many of the recommendations and policies in the Plan are not enforceable on a "regulatory basis" many of the management responses are collaborative or cooperative in nature.

Table 8-4 illustrates the relationship between the performance metrics and triggers and the management responses. Table 8-4 includes an example for the stream flow management recommendations in this Watershed Plan. As indicated earlier, a similar framework can be used for water supply and water quality.

8.7.2 Recommendations for Implementing an Adaptive Management Program for the Watershed Plan

Washington State Senate Bill (SSB 5637) was passed in 2001 relating to monitoring of watershed health and salmon recovery. Through the act an action plan and comprehensive statewide monitoring strategy (CMS) was developed which noted adaptive management as a primary recommendation (Crawford et al, 2002). Although the CMS was directed primarily toward habitat monitoring for salmon recovery, the general recommendations are applicable for the overall watershed plan monitoring and adaptive management, and are specifically applicable to the habitat monitoring portion of this plan. The most relevant recommendations are as follows:

- Establish a permanent "Watershed Monitoring Council" that would provide oversight and act as a central coordinating body for data collected by different parties

- Establish a consistent funding source for monitoring; or alternatively build upon existing monitoring efforts and use coordinating body to fill data gaps.
- Adopt monitoring protocols to provide a consistent means for comparing information across geographical and temporal scales.
- Establish a "data portal" through a State agency such as the Washington State Department of Natural Resources to share data along with developing a universal interface from which to share the database.
- Conduct all three types of monitoring (implementation, effectiveness, and validation), specifically within what is referred to as "Intensively Monitored Watersheds" (IMW), as well as in other watersheds on a less frequent basis to compare how the IMWs relate to the others.

Overall these same recommendations are considered consistent and necessary for the monitoring and adaptive management process to be effective for this Watershed Plan. However, the CMS is yet to be implemented and much of the details in such monitoring remain to be developed. It falls on the individual planning organizations to develop the details of the monitoring and how to integrate this into an adaptive management program.

8.7.3 Next Steps for Adaptive Management Program

The issues discussed above provide a starting point for implementing an adaptive management program for the watershed plan. As mentioned previously, this is a very involved process. Some of the most important adaptive management issues that need further consideration during the Implementation Phase are listed below.

- It is a given that for adaptive management to proceed and be successful, stakeholders must commit to conducting the monitoring and must also commit to the actual adaptive management steps of evaluating the new information, and responding with revisions to management actions. In the Implementation Phase it is important to identify the coordinating and oversight entities (agencies or individuals) that will lead the adaptive management effort.
- "Metrics" and "triggers" need to be evaluated in detail to indicate whether a change in the management action is needed; or with respect to "validation" monitoring whether the management action needs to be reevaluated because of an incorrect input assumption. As part of this evaluation, an "error band" should be estimated for the sources of uncertainty. For example, if demand projections change, then the need for certain management practices may be more critical, e.g. conservation may be more important in projected demands are greater than estimated.
- The intended effects and unintended direct and indirect effects that the management actions have should be evaluated. For example, how might increased flows affect other conditions in the basin such as sediment loads, flushing flows, and bank stability.
- The cost-benefit of the different management objectives should be considered. For example, what are the economic impacts to implementing these management

practices, e.g. in terms of jobs vs. actual improvements in water quality, water quantity, and fish recovery.

The priority for the different management actions are listed in the previous chapters of the Watershed Plan. Generally, this prioritization applies to the associated monitoring activities for stream flow management as listed in Tables 8-3 and 8-4. However, in order to fully evaluate how much monitoring is needed and how much can be coordinated with other competing needs in the basin, a similar adaptive management review for water quantity, water quality, and habitat needs to be done during the Implementation Phase.

Table 8-3
Preliminary Items to Include in Validation Monitoring for Adaptive Management Program

Monitoring/Study	Description	Priority[1]	Implementers and Funding Sources	Spatial Scale and Frequency	Potential Adaptive Action
Planning and Engineering Studies	▪ Primarily feasibility studies and subbasin studies investigating new ground water or alternative supplies ▪ Plan assumes ground water supply development will not have impacts to instream flows	▪ *High*	▪ *Lead:* Water purveyors ▪ *Support:* Ecology, DOH ▪ *Funding:* Public water systems, state or federal grants and loans	▪ *Scale:* Local site- and project-specific ▪ *Frequency:* Initial feasibility and hydrogeologic study and necessary follow-up studies	▪ Studies may indicate that hydraulic connectivity exists or the project is not feasible (costs, capacity, etc.) ▪ Other alternatives may be required, including mitigation
Land Use – Forest Monitoring	▪ Monitor assumptions regarding forest harvest rates and maturation of forests ▪ Plan assumes forest cover will mature and harvest rates decline ▪ Plan assumes no increase in agriculture	▪ *High*	▪ *Lead:* Land owner ▪ *Support:* DNR, USFS ▪ *Funding:* City and county permitting fees and general funds	▪ *Scale:* Forest lands ▪ *Frequency:* Same schedule as county comprehensive plan updates	▪ Can be used in conjunction with flow monitoring to evaluate what factors may be impacting changes in flow conditions
Land Use – Non-Forest Monitoring	Within authorities and as staffing and funding allow: ▪ Monitor agricultural land use trends ▪ Road densities ▪ Rural and urban development ▪ Changes in comp. plans and land use plans	▪ *Medium*	▪ *Lead:* Cities ▪ *Support:* Counties ▪ *Funding:* City and county permitting fees and general funds	▪ *Scale:* WRIA-wide; consistent with county land use planning ▪ *Frequency:* Same schedule as county comprehensive plan updates	▪ May affect the water "reservation" allocation ▪ Can be used in conjunction with flow monitoring to evaluate what factors may be impacting changes in flow conditions
Water Demand Monitoring	Within authorities and as staffing and funding allow: ▪ Monitor population trends in different sectors (urban, rural) ▪ Monitor industrial demands ▪ Confirm population and water demand projections assumed in the Plan	▪ *Medium*	▪ *Lead:* Water purveyors, counties ▪ *Support:* Ecology, DOH ▪ *Funding:* Public water systems, state or federal grants and loans	▪ *Scale:* WRIA-wide; consistent with county comprehensive plans boundaries and water system service areas ▪ *Frequency:* Continuous; same schedule as county comprehensive plan and water system plan updates	▪ May affect the water "reservation" allocation ▪ May need to reevaluate the ability to meet instream needs ▪ Evaluate the need for additional water conservation ▪ Identify areas in the basin where future instream and out-of-stream conflicts may arise and develop actions accordingly

Table 8-3 (cont.)
Preliminary Items to Include in Validation Monitoring for Adaptive Management Program

Monitoring/Study	Description	Priority[1]	Implementers and Funding Sources	Spatial Scale and Frequency	Potential Adaptive Action
Stream Flow Monitoring (basin-wide and project-specific)	Within authorities and as staffing and funding allow: ▪ Monitor flows at priority streams that do not have any flow data to develop basis for potential future flow restrictions or target flows ▪ Monitor flows at priority streams that have adopted flow restrictions or target flows for "compliance" ▪ Flow monitoring to be integrated with land use monitoring to evaluate how land use change is actually affecting flow in priority streams ▪ Monitor flows where specific projects or actions have been implemented (e.g. water conservation, floodplain/wetland restoration, stormwater BMPs) ▪ Plan is currently limited to developing target flows at 4 locations within the basin where historical flow data exists ▪ Plan is relying on modeling data which needs to be validated over the long-term and at points throughout the basin	▪ *High*	▪ *Lead:* Ecology; will act as data clearinghouse ▪ *Support:* Ecology, USGS, LCFRB (or successor), counties, for general flow monitoring activities ▪ *Support:* USFS, DNR for monitoring effectiveness of forest practices ▪ *Support:* Cities and project owners for specific projects and developments ▪ *Funding:* Legislative (Ecology, DNR) and Congressional (USGS, USFS) appropriations; public water systems	▪ *Scale:* WRIA-wide; priority stream reaches and at project specific locations ▪ *Frequency:* Continuous: annual, seasonal , daily; long-term duration (10-40+ yrs); project specific monitoring may be over a shorter period (< 5 years) for effectiveness	▪ Long-term data can be used to develop future minimum instream flows ▪ Assess progress and whether target flows need to be modified ▪ Assess the effectiveness of specific projects and whether additional measures are needed to meet flow objectives

Table 8-3 (cont.)
Preliminary Items to Include in Validation Monitoring for Adaptive Management Program

Monitoring/Study	Description	Priority[1]	Implementers and Funding Sources	Spatial Scale and Frequency	Potential Adaptive Action
Ground Water Level Monitoring	Within authorities and as staffing and funding allow: ▪ Monitor ground water levels in areas where new water supplies have been developed and in areas where significant exempt well use is occurring ▪ Plan assumes that developing ground water supplies will not impact flows in priority stream	▪ *High*	▪ *Lead:* Ecology; will act as data clearinghouse ▪ *Support:* Ecology, USGS, LCFRB (or successor), counties, for general water level monitoring activities ▪ *Support:* Cities and water purveyors for specific projects and developments, and for collection of data ▪ *Funding:* Legislative (Ecology) and Congressional (USGS) appropriations; public water systems; city general funds	▪ *Scale:* WRIA-wide; priority stream reaches and at project specific locations ▪ *Frequency:* Continuous: annual, seasonal , daily; long-term duration (10-40+ yrs); project specific monitoring may be over a shorter period (< 5 years) for effectiveness	▪ Long-term monitoring may show decreased water levels indicating the need for decreased use, conservation, alternative supply or change in management actions
Water quality monitoring	Within authorities and as staffing and funding allow: ▪ Implement components of surface water quality monitoring plan described in Section 5. ▪ Implement ground water risk assessment studies ▪ Cleanup plans have been prioritized in the Plan based on current information ▪ Ground water sources may need protection based on susceptibility	▪ *Medium*	▪ *Lead:*Ecology and County health departments ▪ *Support:* Cities, DOH, public water systems ▪ *Funding:*	▪ *Scale:* WRIA-wide; priority stream reaches and at project specific locations ▪ *Frequency:* Continuous, annual, seasonal	▪ New surface water quality data may result in new priorities or additional streams for cleanup plans ▪ New ground water quality data and susceptibility assessments may lead to new priorities for ground water protection or cleanup

Table 8-4
Adaptive Management Framework for Stream Flow Management

Policy/ Recommendation	Management Action	Type [1]	Performance Metrics	Trigger (if…)	Management Response (then…)
SFP-1	*Maintain existing stream flow gauges and install additional permanent gauges* ▪ Maintain Heisson gauge and add at least one more stream gauge in the East Fork Lewis River subbasin ▪ Replace former stream gauge at RM 9.2 and add at least one more gauge in the Washougal River subbasin ▪ Add gauges in other streams where minimum instream flows or target flows are to be established.	I	*Implementation:* Evaluated through observation/inventory by coordination and oversight agency (COA)[2] or third party. Audit to occur after an initial 2-year period from adoption of Plan and subsequently on a biannual basis.	*Implementation: (yes/no)* Audit determines that stream gauges are not being maintained and no additional gauges are being installed. Furthermore, a minimum number of gauges may be specified for installation within a certain time frame, e.g. 4 new gauges within 2 years of Plan adoption.	*Collaborative Response:* *Implementation:* COA will work with other implementing agencies to develop and implement an action plan for achieving the recommendation. This may include conducting a funding review and options for staffing to enable installation and maintenance of gauges.
SFP-2	*Closures are preferred over use of minimum instream flows, except in selected areas* ▪ Adopt closures and/or minimum instream flows in State Rule	I, E	*Implementation:* COA or third party audit of amendments to State Rule applicable to WRIAs 27 and 28. Audit to occur after an initial 2-year period from adoption of Plan and subsequently on a biannual basis. *Effectiveness:* Metrics will be developed to evaluate the impacts of the closures/minimum flows on protecting stream flows. May include: impacts to water rights applicants and changes in flow statistics (see target flows below). Metric to be evaluated at a minimum of every 5 years.	*Implementation: (yes/no)* Audit determines that no progress has been made toward developing closures/minimum instream flows; alternatively, audit determines agreements have been made on new closures or minimum instream flows but have not been adopted into rule. *Effectiveness:* Specific triggers will be developed if warranted after year 5 from Plan adoption as a mandatory collaborative agreement.	*Collaborative response:* *Implementation:* If no progress has been made, COA will work with Ecology to develop and implement an action plan for Ecology to develop the rule. If agreements have been made but have not been adopted, COA will work with Ecology to finalize or accelerate adoption schedule. *Effectiveness:* May require updates or revisions to closures or minimum instream flows based on effectiveness monitoring. This would require process to go through the rule-making process.

Table 8-4 (cont.)
Adaptive Management Framework for Stream Flow Management

Policy/ Recommendation	Management Action	Type (1)	Performance Metrics	Trigger (if…)	Management Response (then…)
SFP-2	*Apply other land use and water use management in addition to stream closures to manage stream flows*	I	This policy refers to the use of the other specific recommendations and policies in the Plan to manage stream flow. Refer to other management actions for specific metrics, triggers, and responses.		
SFP-3	*State requirements for water conservation is sufficient for most communities* ▪ Additional conservation efforts recommended for Battle Ground, Ridgefield, Yacolt, and Camas ▪ Water conservation by farmers practicing irrigated agriculture, with assistance from Conservation Districts	I, E	*Implementation:* COA or third party audit of water conservation plans developed by the communities/irrigators as part of their water master plan/irrigation plan updates. Audit to occur at every water system/irrigation plan update after adoption of Watershed Plan. *Effectiveness:* Specific metrics on appropriate level of conservation for these communities/irrigators to be developed, but may include percentage of projected demand or a total annual volume.	*Implementation: (yes/no)* Water conservation efforts only meet State's minimum requirements and no indications are evident that additional conservation efforts are planned. *Effectiveness:* Specific triggers will be developed if warranted after year 5 from Plan adoption as a mandatory collaborative agreement. Triggers will consider measurable benefits with costs and inform future management actions for effectiveness and continuous improvement.	*Collaborative response:* *Implementation:* COA will work with communities/irrigators to develop and implement an action plan for achieving conservation goals. *Effectiveness:* Conservation goals may be revised if costs become too high or projected demands are not realized. Other management options may need to be emphasized.
SFP-5	*Develop alternative water sources where stream flows are impacted that minimize these effects.* ▪ Cities of Battle Ground and Ridgefield should consider whole sale purchase of water from CPU ▪ Camas should consider purchase from Vancouver	I, E	*Implementation:* COA or third party audit of water master plan updates or other engineering/planning studies to determine whether alternative water sources are being evaluated. Audit to occur at every water system plan update or after two years after adoption of Watershed Plan. *Effectiveness:* Specific metrics to be developed, but may include: the feasibility of the alternative sources based on new studies or information, other opportunities for improvements in the source of supply as they are identified.	*Implementation: (yes/no)* Audit indicates that communities are not considering other source of water. A finding is made that indicates a departure or an opportunity for improvement. *Effectiveness:* Specific triggers will be developed if warranted after year 5 from Plan adoption as a mandatory collaborative agreement. Triggers will consider measurable benefits with costs and inform future management actions for effectiveness and continuous improvement.	*Collaborative response:* *Implementation:* Coordination and oversight agency (COA) will develop and implement an action plan for refining source substitution goals. *Effectiveness:* Alternative supply sources may be eliminated if feasibility study indicates limitations for proceeding. May need to consider other alternatives as they are identified. May identify other communities that need to consider alternative sources.

Table 8-4 (cont.)
Adaptive Management Framework for Stream Flow Management

Policy/ Recommendation	Management Action	Type [1]	Performance Metrics	Trigger (if…)	Management Response (then…)
SFP-6	*Ecology should use State Trust Program to identify water rights for sale or donation* ■ Battle Ground, Ridgefield, and Yacolt, and Camas should consider transferring water rights to Trust, if source substitution is pursued	I, E	*Implementation:* COA or third party audit of number of water rights in State Trust for sale or lease. Participation of specific communities listed is dependent on whether alternative sources are pursued from SFP-5. *Effectiveness:* Specific metrics to be developed, but may include: the size of the water rights and whether water rights are being sold or leased once alternative sources are identified.	*Implementation: (yes/no)* No water rights are being submitted to State Trust. (An actual minimum number may be specified). A finding is made that indicates a departure or an opportunity for improvement. *Effectiveness:* Specific triggers will be developed if warranted after year 5 from Plan adoption as a mandatory collaborative agreement.	*Collaborative response:* *Implementation:* In conjunction with Ecology, COA will work directly with communities that have opportunities to transfer their rights to the State Trust and will refine goals for transferring to State Trust.
SFP-7	*Ecology to conduct initial surveys for unauthorized water use and take enforcement action when necessary*	I, E	*Implementation*: COA or third party audit of whether Ecology has conducted the survey after two years from adoption of the Watershed Plan. *Effectiveness*: Metrics will be developed after Ecology does initial survey, but may include number of unauthorized users or annual volume of use.	*Implementation: (yes/no)* Ecology has not conducted surveys after 2 years from Plan adoption. *Effectiveness:* Specific triggers will be developed if warranted after year 5 from Plan adoption as a mandatory collaborative agreement.	*Collaborative response:* *Implementation:* COA to work with Ecology to develop and implement an action plan for accelerating the survey schedule. *Effectiveness:* COA to work with Ecology to develop a response depending on the extent of unauthorized use and the cost-benefits of enforcement.
SFP-9	*Consider effects of forest management practices on stream flow in making forest management decisions, and monitor the effects and provide public documentation*	I, E	*Implementation:* COA or third party audit of USFS, DNR, and private land owner compliance with F&F and Northwest Forest Plan requirements, specifically implementation of monitoring requirements. *Effectiveness:* Specific metrics to be developed, but may include: length of roads upgraded (in compliance), percent sediment reduction, compliance with other BMPs.	*Implementation: (yes/no)* Audit indicates non-compliance with forest management requirements. *Effectiveness:* A finding is made that indicates a departure or an opportunity for improvement. Monitoring studies will compare measurable benefits with costs and inform future management actions for effectiveness and continuous improvement.	*Collaborative response:* *Implementation:* COA to work with USFS, DNR, and private land owners to improve compliance. *Effectiveness:* Based on findings from monitoring activities, revise or create enhanced BMPs for forest practice requirements/recommendations.

Table 8-4 (cont.)
Adaptive Management Framework for Stream Flow Management

Policy/ Recommendation	Management Action	Type (1)	Performance Metrics	Trigger (if…)	Management Response (then…)
SFP-10	*Clark, Cowlitz Counties and Vancouver, Camas, Washougal, Battle Ground should carry out legal responsibilities for stormwater management; other communities and Skamania Co. should review ordinances for protectiveness*	I, E	*Implementation:* Percent BMP compliance as determined by a combination of State, internal, and COA or third party audits. *Effectiveness:* Specific metrics to be developed, but may include: flow impacts to adjacent streams, water quality impacts, compliance with other BMPs.	*Implementation: (yes/no)* Compliance rate is less than some specified percentage or is some specific requirement(s) are not being complied with. *Effectiveness:* A finding is made that indicates a departure or an opportunity for improvement. Monitoring studies will compare measurable benefits with costs and inform future management actions for effectiveness and continuous improvement.	*Collaborative response:* *Implementation:* COA to work communities to improve compliance. *Effectiveness:* Based on findings from monitoring activities, revise or create enhanced BMPs for stormwater management requirements/recommendations.
SFP-11	*When modifying or adopting comprehensive plans, zoning designations, or other land use regulations, jurisdictions should consider the water balance implications of allowing extension of sewer service to communities formerly served by septic systems.*	I	*Implementation:* COA or third party to audit whether counties have considered water balance implications of sewer extension.	*Implementation: (yes/no)* Counties have not considered water balance implications of sewer extension after 2 years from Plan adoption.	*Collaborative response:* *Implementation:* COA to work with counties to develop and implement an action plan considering water balance implications of sewer extensions.
SFP-12	*Within authorities, local jurisdictions with land-management responsibilities should protect existing floodplains and identify floodplains for restoration*	I, E	*Implementation:* COA or third party to audit number and locations of floodplain restoration projects and the number of designated floodplains for protection every 5 years *Effectiveness:* COA or third party to audit number and locations of floodplain restoration projects every 5 years; in addition, the flow impacts from the floodplain restoration efforts.	*Implementation: (yes/no)* Audit indicates that only a certain percentage of the floodplain survey for restoration has been completed or only a certain percentage of total floodplains has been designated for protection. *Effectiveness:* A finding is made that indicates a departure or an opportunity for improvement. Monitoring studies will compare measurable benefits with costs and inform future management actions for effectiveness and continuous improvement.	*Collaborative response:* *Implementation:* COA to work with counties to develop and implement an action plan for accelerating the floodplain survey schedule and assessment for protection. *Effectiveness:* Based on findings from monitoring activities, revise or create floodplain restoration recommendations. Restoration activities may be reduced if flow impacts are minimal (unless habitat benefits provide justification).

Table 8-4 (cont.)
Adaptive Management Framework for Stream Flow Management

Policy/ Recommendation	Management Action	Type [1]	Performance Metrics	Trigger (if…)	Management Response (then…)
SFP-13	*In conjunction with the Planning Unit, Counties should explore funding opportunities for conducting a county-wide wetland assessment that includes evaluation of hydrological functions. Counties should also require evaluation of hydrological function as part of any site-specific wetland assessments conducted under their critical areas, wetland or other land use ordinances. Their wetlands ordinances should be modified as needed to include hydrologic functions in the wetland protection hierarchy. Counties to consider strengthening mitigation ratios for selected wetlands*	I	*Implementation:* COA or third party to audit whether wetlands surveys for hydrologic function have been completed within 5 years from Plan adoption.	*Implementation: (yes/no)* Counties have not conducted wetlands surveys or have completed only a certain percentage of the survey (e.g. 25%).	*Collaborative response:* *Implementation:* COA and Planning Unit to work with counties to develop and implement an action plan for accelerating the survey schedule.
SFP-4	*Major water users should develop policies and procedures for state-declared drought emergencies* ▪ City of Camas should consider developing a curtailment plan	I	*Implementation:* COA or third party audit of major water users' water master plan updates to occur after an initial 2-year period from adoption of Plan or at first water master plan update.	*Implementation: (yes/no)* Audit determines that major water users have not completed policies and procedures for drought emergencies.	*Collaborative Response:* COA will develop and implement an action plan for accelerating the schedule to develop policies and procedures.

Table 8-4 (cont.)
Adaptive Management Framework for Stream Flow Management

Policy/ Recommendation	Management Action	Type [1]	Performance Metrics	Trigger (if…)	Management Response (then…)
Target Flows	Establish target flow monitoring and management program.	I, E	*Implementation:* COA or third party to audit whether target flows have been established at other locations in the basin. Implementation of this action is directly tied to the installation of stream flow gauges (SFP-1). *Effectiveness:* This recommendation is the general (or "programmatic") metric for the combined effects of the stream flow management actions. The percentage change (5%) is the performance metric to be evaluated and requires significant period of record (e.g. greater than 10-15 years of flow data).	*Implementation: (yes/no)* Audit determines that target flows are not being developed and no additional gauges are being installed. Furthermore, a minimum number of target flows may be specified for development within a certain time frame, e.g. 4 new target flow locations within 2 years of Plan adoption. *Effectiveness:* Flow statistics have not changed (or have changed less then 1% for example); alternatively, flow statistics change beyond the 5% within the planning period. Monitoring study will compare measurable benefits with costs and inform future management actions for effectiveness and continuous improvement	*Collaborative Response:* *Implementation*: COA will work with other implementing agencies to develop and implement an action plan for achieving the number of target flows to be defined. This work would be completed in conjunction with SFP-1. *Effectiveness:* Revise or update flow management actions based upon how flow statistics change. It should be noted that depending on the type of monitoring, it may be difficult to attribute cause-effect relationships in this case, unless specific management actions from above are being monitored individually to measure their effects on flow.

Notes:
[1] Monitoring Types:
- I – Implementation monitoring
- E – Effectiveness monitoring
- V – Validation monitoring

[2] Coordination and oversight agency (COA) – as discussed in Section 8.3, it is recommended that the WRIAs27 and 28 Planning Unit transition from planning functions to coordination and oversight functions to follow-up on selected areas of implementation. This same group or agency is used as the "surrogate" with responsibilities for tracking the triggers in this table.

8.8 Future Plan Updates

This Watershed Management Plan has been developed over a four-year period, with input from dozens of local leaders, state and federal agency staff, and citizens. It is the first effort in this region to assemble a comprehensive portrait of water resource needs, issues and solutions. The actions recommended in this plan were devised given current understanding of conditions as they exist at the time the Plan was developed. Over the next several years, new data will be collected, conditions may change, regulatory and funding programs may change, and new projects affecting water resources may be proposed within the region. In addition, the implementation process may result in some modifications of the recommended actions as they are actually carried out.

To accommodate this ongoing evolution of information and events in the region, it is recommended that the Watershed Management Plan be reviewed from time to time to determine whether an update is needed. This review should be carried out by the Planning Unit, as one of its implementation responsibilities. The first review should occur no later than 2009, and additional reviews shall occur no later than every 7 years thereafter. Plan reviews may be conducted at any time if requested by majority vote of any approving County Board of Commissioners. If identified as a need by the Planning Unit or any approving County Board of Commissioners, rule review may also be initiated as a result of the plan review process.

The Phase 4 Committee Report to the Legislature identified the following questions for a review of this type:

- Have the actions listed in the Plan been implemented?
- Are the desired results being achieved?
- Is the overall intent of the Plan being met?
- Are there new information gaps or changing conditions that require review?
- Are there new issues that were not considered during Plan development, and that need to be addressed?

If the Planning Unit finds that an update is needed, this finding should be communicated to the original Implementing Governments that launched the WRIAs 27 and 28 Watershed Plan process. It should be noted that the Watershed Management Act does not require or address updates to watershed plans, and at this time no funding is available for such updates under the Watershed Planning program. The Implementing Governments should have the responsibility to determine whether to proceed with updating the Plan, and to identify means of funding and staffing an update.

The strategies listed in this plan were designed to function as a combined whole. If any key element is struck down by legislative or court action, or becomes otherwise infeasible to implement, the remainder of the Plan should be revisited to determine whether other elements need to be modified.

References

Barber, Michael. 2002. Technical Memorandum No. 4 (Task 5): Instream Flow Conditions in Four Pilot Streams. December 2002.

Barber, Michael. 2003. Technical Memorandum No. 10 (Task 4): Surface Water Quality Monitoring Strategy for WRIAs 27 and 28. December 2003.

Bohlander, Ted and Tanner, Patrick. 2002. City of Washougal Water System Plan Update. January 2002.

Clark County. 1974. Shoreline Management Master Program. August 1974.

Clark County. 1997. Clark County 20 Year Comprehensive Growth Management Plan. December 1997.

Clark County. 2001. Geographic Information Systems web site: http://www.co.clark.wa.us/assessor/GIS.html.

Clark County Groundwater Advisory Committee. 1992. Ground Water Management Plan. December 1992.

Clark Public Utilities (CPU). 2001. Clark Public Utilities Water System Plan. December 2001.

Clark Public Utilities (CPU). 2002. Salmon Creek Watershed Assessment. October 2002.

Clark County Water Quality Division. 1995. Draft Burnt Bridge Creek Watershed Plan. Developed by Clark County Watershed Protection Program. June 1995.

Curran-McLeod, Inc. 1998. City of Battle Ground Water System Plan Update. October 1998.

Cusimano, Robert F., and D. Giglio. 1995. Salmon Creek Nonpoint Source Pollution TMDL. Ecology Publication Number 95-355. October 1995.

Dyrland, Richard. 2003. (Unpublished). Monitoring of Stream Flow Losses in Lower East Fork Lewis River: Summary Comparison of Reaches and Effects.

EES (Economic and Engineering Services, Inc.). 2002a. Technical Memorandum No. 1 (Task 2): Assessment of Key Issues and Existing Plans for Major Water Users. August 2002.

EES. 2002b. Technical Memorandum No. 2 (Task 3): Water Reclamation and Reuse Opportunities in WRIA 27/28. September 2002.

EES. 2002c. Technical Memorandum No. 3 (Task 3): Comparison of Potential Water Supply Management Strategies. November 2002.

EES. 2002d. Technical Memorandum No. 5 (Task 5): Instream Flow Management Approaches in Four Pilot Streams. October 2002.

EES. 2003a. Technical Memorandum No. 7 (Task 4): Assessment of Priorities for Surface Water Cleanup Plans (TMDLs). March 2003.

EES. 2003b. Technical Memorandum No. 8 (Task 5): Strategies for Managing Flows in Two Pilot Subbasins. July 2003.

EES. 2003c. Technical Memorandum No. 9 (Task 10): Management Actions to Protect Ground Water Quality. July 2003.

EES. 2004. Technical Memorandum No. 14 (Task 2-170): Tidal Effects as Related to Stream Flow Protection Rule. December 2004.

Federal Energy Regulating Commission (FERC). 2000. Scoping Document 1 for the Lewis River Hydroelectric Projects. 17 May 2000.

GeoEngineers. 2001. Level 1 Technical Assessment WRIAs 27 and 28 (series of technical memoranda compiled into report). 29 June 2001.

Gibbs and Olson, Inc. 1995. Woodland Water System Plan Update. October 1995.

Gibbs and Olson, Inc. 1997. Pre-Design Report for City of Woodland Water Treatment Plant. December 1997.

Gray and Osborne, Inc. 1996. City of Vancouver Water System Plan. November 1996.

Gray and Osborne, Inc. 2001. City of Kalama Draft Water System Plan. November 2001.

Gray and Osborne, Inc. 2002. City of Camas 2001 Water System Comprehensive Plan. February 2002.

Howard, Dave. 2001. Salmon Creek Watershed Bacteria and Turbidity Total Maximum Daily Load; Submittal Report. Ecology Publication No. 01-00-007. January 2001.

Kennedy-Jenks. 2002. Technical Memorandum No. 6 (Task 7): Groundwater Development Scenarios. November 2002.

Lower Columbia Fish Recovery Board (LCFRB). 2003. Review Draft LCFRB Recovery/Subbasin Plan Technical Foundation Executive Summary.

Lower Columbia Fish Recovery Board (LCFRB). 2004. Lower Columbia Salmon and Steelhead Recovery and Subbasin Plan (Draft).

Noall, Judy. 2003. Personal communication with Judy Noall, Program Coordinator, Vancouver-Clark Parks and Recreation. 10 March 2003.

Nocon, Emmanuel C., and K. Erikson. 1996. Gibbons Creek Fecal Coliform Total Maximum Daily Load Assessment. Ecology Publication No. 28-3010. April 1996.

Pacific Groundwater Group (PGG). 1998. City of Camas Grass Valley Water Supply Development Study. 20 February 1998.

Pacific Groundwater Group (PGG). 2003a. Technical Memorandum No. 10 (Task 8A): East Fork Lewis River Watershed Groundwater/Surface-Water Relationships. December 2003.

Pacific Groundwater Group (PGG). 2003b. Technical Memorandum No. 11 (Task 8B): Effects of Exempt Wells on Baseflow Washougal River Watershed. December 2003.

Pacific Water Resources (PWR). 2003. Technical Memorandum No. 12 (Task 6): Hydrologic Modeling of Effects of Land Use Changes WRIA 27/28 East Fork of the Lewis River and Washougal River - Draft. December 2003.

Phase 4 Watershed Plan Implementation Committee, 2002. Report to the Legislature.

Post, Rusty. 2000. Gibbons Creek Watershed Fecal Coliform Total Maximum Daily Load; Submittal Report. Ecology Publication No. 00-10-039. June 2000.

Rathdrum Prairie Aquifer Policy Advisory Committee. 1996. Rathdrum Prairie Aquifer Program: Past, Present, and Future. June 1996.

Rupley, Joel. 2006. Build-out Projections of Undeveloped Lots in Rural Clark County, by Watershed, Compared to WRIA 27/28 Watershed Plan Water Reservations. Unpublished Draft Report. May 2006.

Schanbel, Jeff. 2002. Lacamas Lake Restoration Program: WY 2000 and WY 2001 Water Quality Monitoring. Developed by Clark County Public Works, Water Resources Section. March 2002.

Skamania County. 1977. Comprehensive Plan "A". 11 July 1977.United States Census Bureau. 2000. Census 2000. web site: http:///www.census.gov/main/www/cen2000.html

United States Department of Agriculture Natural Resources Conservation Service (NRCS). 2001. Environmental Quality Incentives Program Web site: http://www.nrcs.usda.gov/NRCSProg.html#Anchor-Environmental. July 2001.

United States Environmental Protection Agency (USEPA). 2000. Office of Ground Water and Drinking Water Web site, Designated Sole Source Aquifers in EPA Region 10: http://www.epa.gov/OGWDW/swp/ssa/reg10.html. August 2000.

United States Environmental Protection Agency (USEPA). 2001. Envirofacts Database Web site: http://www.epa.gov/enviro/index_java.html. July 2001.

United States Environmental Protection Agency (USEPA). 2003. Global Warming Website: http://yosemite.epa.gov/oar/globalwarming.nsf/content/climateuncertainties.html 1 October 2003.

University of Washington. 2003. Joint Institute for the Study of the Atmosphere and Oceans Web site: http://www.jisao.washington.edu/PNWimpacts/HWRTheme.htm. 1 October 2003.

Wade, Gary. 2001. Washington State Conservation Commission Salmon and Steelhead Habitat Limiting Factors – WRIA 28. 21 March 2001.

Wallis Engineering. 1996. Water System Plan for City of Ridgefield. April 1996.

Washington Department of Ecology (Ecology). 1998. 303(d) list of impaired waterbody segments in Washington State. Approved by USEPA 20 January 2000.

Washington Department of Ecology. 1999. "East Fork Lewis River Fish Habitat Analysis Using the Instream Flow Incremental Methodology and the Toe-Width Method for WRIA 27," Open File Technical Report, No. 99-151, Olympia, WA.

Washington Department of Ecology (Ecology). 2001. Facility/site Web site: http://www.ecy.wa.gov/services/as/iss/fsweb/fshome.html. July 2001.

Washington Department of Ecology (Ecology). 2001. Geographic Information System Homepage Web site: http://www.ecy.wa.gov/services/gis/index.html#data. July 2001.

Washington Department of Ecology (Ecology). 2002. Water Quality Program Policy 1-11, Assessment of Water Quality for the Section 303(d) List. September 2002.

Washington Department of Ecology (Ecology). 2002. Water Rights Application Tracking System (WRATS) Database. May 2002.

Washington Department of Health (DOH). 1995. Wellhead Protection Program Guidance Document. DOH Publication No. 331-018. April 1995.

Washington Department of Health (DOH). 1999. Washington State's Source Water Assessment Program (SWAP). DOH Publication No. 331-148. May 1999.

Washington Department of Health (DOH). 2001. Drinking Water Automated Information Network (DWAIN). January 2001.

Washington State Conservation Commission. 2002. Habitat Limiting Factors – Executive Summary – WRIA 27, Web site: http://www.conserver.org/salmon/reports/wria27sum.html.

Washington State University (WSU). 2001. Cooperative Extension Home-A-Syst/Farm-A-Syst Program Web site: http://homefarmasyst.wsu.edu. July 2001.

Appendix A
Salmon-Washougal and Lewis Watersheds
Mission Statement

Appendix A
Salmon-Washougal and Lewis Watersheds Mission Statement

Mission Statement:

> "Develop and implement a watershed management plan for the responsible use of water to balance the needs of people and natural resources."

Goals:

- Develop a water quality/quantity management plan so we have good water in the future
- Use water resources while preserving water quantity and quality
- Involve the public early in decision-making
- Maximize public involvement in development of our plan
- Treat all water as a valuable resource
- Develop strategies to work with federal, state and local governments and public/private interests with the goal of stabilizing and recovering native salmonids and their habitat
- Ensure implementation of the plan
- Maximize local control

Appendix B
Planning Unit Ground Rules

Appendix B
Planning Unit Ground Rules

December 20, 1999

The members of the Planning Unit for Water Resource Inventory Areas 27 and 28 adopt the following ground rules for the conduct of their business.

1. We will focus our discussions on the issues associated with developing a plan for the management and use of water resources. We will avoid debating issues beyond the scope of that effort.

2. We represent a broad range of interests, each having an interest in how our water resources are used and protected. We recognize the legitimacy of each other's interests and concerns in our efforts to forge an effective and viable management plan.

3. All participants will be treated with respect and dignity. We will not tolerate personal attacks directed at individuals and agencies.

4. We commit to understanding each other's interests and concerns. There should be no hidden agendas. We will openly and candidly sharing our concerns and interests and engage in thoughtful dialogue. We will listen carefully. We will ask questions for clarification. We will respect each other's right to disagree.

5. We commit not to characterize each other's motivations, values, or positions in any discussions that we may have with the press. We will not attribute specific statements or positions to a participant with their prior approval and we will seek such approval during the course of our meetings whenever possible. We commit to work out our differences at the table rather than in the press.

6. We commit to search for opportunities and creative solutions. We will focus on problem solving, rather than stating positions.

7. We commit to making decisions by consensus. Consensus does not require that all members endorse or agree with the proposal or decision, but at a minimum all members must be willing to accept the proposal or decision. If consensus cannot be reached, the participants will:

   a. Determine if the decision is critical to the group's work. If not, the group may decide to drop the decision or proposal. If yes, continue to work longer toward consensus.

   b. Consider appointing a subgroup to examine the issue and, if possible, submit a revised proposal to the full group for consensus consideration. Provide the subgroup a timeline to report back to the full planning unit.

   c. Consider adopting several alternatives or options for addressing an issue.

d. Consider the ranges of agreement in the attached Definition of Consensus.

8. We agree that this planning effort is a priority in terms of committing our time and resources. We agree that consistency in participation is critical. According, we commit to make every effort attend meetings of the planning unit. However, in recognition that events may periodically arise which prevent attendance, each participant may name an alternate to attend meetings on his or her behalf. The alternate will not simply be an observer, but will have the same authority to act as the principal participant. The participants shall be responsible for ensuring their alternate is informed and fully prepared to participate.

9. All participants accept the responsibility of keeping their associates, organization, or constituency informed of planning unit's progress and issues under discussion. Each participant also accepts the responsibility of representing the needs and interests of their associates, organization, or constituencies. Adequate time will be provided prior to major decisions to allow participants to consult with their associates, organization, or constituency. Strategic checkpoints will be established to allow participants to review progress made with their associates, organization or constituency and report back any concerns to the group. A participant may ask the group to reconsider any decisions within two months following the decision.

10. The use and protection of our water resources is an important public issue. Our meetings will be open to the public and we will make time available at each meeting for the members of the public to share their concerns, interests, and suggestions with us.

11. We agree that anyone may resign from the planning unit at anytime. If the reason for resignation stems from a concern with the work or conduct of the planning unit, the participant will advise the other participants of this concern and allow them to the opportunity to resolve the problem before resigning.

12. We will keep minutes of our meeting. The minutes shall summarize the discussions and document the decisions of the planning unit. They will not attribute statements to specific participants unless a participant advises the recorder that his or her statement is being made for the record. The source of background information or data used in discussions or decisions may be cited.

Appendix C
Operating Principles

Appendix C
Operating Principles

Definition of Consensus for WRIA 27/28						
Endorse	Endorse with a minor point of contention	Agree with reservation	Abstain	Stand aside	Formal disagreement but will go with the majority	Block
"I like it"	"Basically I like it"	"I can live with it"	"I have no opinion"	"I don't like it but I don't want to hold up the group"	"I want my disagreement to be noted in writing but I'll support the decision"	"I veto this proposal"

Consensus is defined in terms of agreement along a continuum. Team Members may register the degree of their agreement with the language in any of the first six columns.
(Adapted from: "Facilitator's Guide to Participatory Decision-Making," 1996)
The last (shaded) column on the right side of the continuum is *not* considered acceptable for consensus in this process.
However, anything to the left could be considered "agreement by consensus."

Appendix D
Water Rights Data

TABLE D-1
WATER RIGHTS SUMMARY

WRIA 27/28 LEVEL 1 TECHNICAL ASSESSMENT
FILE NO. 8491-001-00

Sub-Basin	Applications	Permits	Certificates	Claims
Kalama River	12	6	128	272
Lewis River	27	8	353	1,178
Middle Lewis River	0	0	30	26
Upper Lewis River	0	0	1	0
East Fork Lewis River	10	14	408	2,188
Salmon Creek	9	22	483	2,852
Burnt Bridge Creek	11	17	384	1,767
Lacamas Creek	10	2	187	1,234
Washougal River	14	7	276	690
Columbia River Tributaries	11	5	176	313

Notes
[1] All information is based on the Ecology WRATS database (August 23, 2000 version).

p:\00\finals\8491001\WaterRightsSummary\WaterRightsSummary.xls

TABLE D-2
ALLOCATED WATER RIGHTS

WRIA 27/28 LEVEL 1 TECHNICAL ASSESSMENT

FILE NO. 8491-001-00

Sub-Basin	Ground Water			Surface Water			
	Water Rights (Permits & Certificates)	Instantaneous (gpm)	Annual (acre-feet)	Water Rights (Permits & Certificates)	Instantaneous (gpm)	Annual (acre-feet)	Reservoir (acre-feet)
Kalama River	76	3,752	4,166	108	112	248	0
Lewis River	104	19,430	6,846	257	19,657	10,028	823,520
Middle Lewis River	9	637	492	21	9,413	47	740,000
Upper Lewis River	0	0	0	1	8	0	0
East Fork Lewis River	150	14,405	6,135	272	55	3,961	423
Salmon Creek	337	52,941	36,252	168	73	2,912	2.5
Burnt Bridge Creek	304	177,549	149,075	97	333	5,596	0
Lacamas Creek	118	31,020	33,245	71	289	45,100	7,599
Washougal River	48	22,598	29,144	235	123	902	141
Columbia River Tributaries	41	3,286	1,703	140	45	1,510	0

Notes

[1] The totals presented above are based on permits and certificates, and do not include applications or claims.

[2] All information is based on the Ecology WRATS datavase (August 23, 2000 version).

p:\00\finals\8491001\WaterRightsSummary\AllocatedWaterRights.xls

TABLE D-3

ADMINISTRATIVE CLOSURES OR RESTRICTIONS

WRIA 27/28 LEVEL 1 TECHNICAL ASSESSMENT

FILE NO. 8491-001-00

Stream	Location	Administrative Status
Clark County		
Burnt Bridge Creek	2N/1E-9	Closure
Cedar Creek	5N/1E-12	Closure
Chelatchie Creek	5N/1E-12	Closure
Cougar Creek	2N/4E-13	Low Flow (0.50 cfs)
Fifth Plain Creek	2N/3E-7	Closure
Gee Creek	1N/4E-11	Closure
Gibbons Creek	1N/4E-16	Closure
Jenny Creek	5N/1E-32	Closure
Lacamas Creek	2N/3E-9	Low Flow (6.0 cfs)
Unnamed Stream to East Fork of Lewis River	5N/1E-28	Low Flor (1/2 Low Flow)
Lockwood Creek	4N/1E-11	Closure
Mason Creek	4N/1E-11	Closure
Mill Creek	4N/2E-28	Low Flow (1.0 cfs)
Pup Creek	5N/2E-3	Closure
Rock Creek	4N/2E-11	Low Flow (0.50 cfs)
Unnamed Stream to Rock Creek	5N/3E-22	1/2 Low Flow
Salmon Creek	3N/1E-19	Closure
Shanghai Creek	7N/2W	Closure
Unnamed Stream to Washougal River	2N/4E-25	Low Flow (0.50 cfs)
Washougal River	2N/4E-27	Low Flow (175 cfs)
Weaver Creek	3N/2W-2	Closure
Whipple Creek	3N/1E-12	Closure
Cowlitz County		
Horseshoe Lake	5N/1W-25,26	Closure
	5N/1E-19,20	Closure
Kalama River	7N/1W-33	Low Flow (Nov-April-700 cfs) (April-May-700-325 cfs) (May-Sept-375 cfs) (Sept-Nov-325-700 cfs)
Skamania County		
Unnamed Stream (Spring Creek)	2N/6E-34	Adjudicated
West Fork Washougal River	2N/5E-29	Low Flow
Notes [1] Based on "Administrative Closures" list received from Ecology on January 5, 2001.		

p:\00\finals\8491001\WaterRightsSummary\AdminClosures.xls

TABLE D-4
PURPOSE OF WATER RIGHTS

KALAMA RIVER WATERSHED

WRIA 27/28 LEVEL 1 TECHNICAL ASSESSMENT

FILE NO. 8491-001-00

Purpose	**Ground Water**		**Surface Water**			**Total Allocations** [1,2]
	Instantaneous (gpm)	**Annual (acre-feet)**	**Instantaneous (cfs)**	**Annual (acre-feet)**	**Reservoir (acre-feet)**	
Domestic	383	124	20	81	0	99
Municipal	2,225	2,284	0	0	0	2
Commercial/Industrial	0	0	16	4	0	8
Irrigation	65	31	1	133	0	33
Stock Watering	0	0	0	4	0	12
Power	0	0	0	0	0	2
Fish Propagation	1,000	1,600	45	0	0	8
Wildlife Propogation	0	0	0	0	0	1
Fire Protection	0	0	5	1	0	20
Other	79	128	24	26	0	9

Notes

[1] Individual wate rights may have more than one purpose code.

[2] The totals presented above include permits and certificates, but do not include applications or claims.

[3] All information presented above is based on the Ecology WRATS database (August 23, 2000 version).

p:\00\finals\PurposeofWaterRights\KalamaRiver.xls

TABLE D-5
PURPOSE OF WATER RIGHTS

LEWIS RIVER WATERSHED

WRIA 27/28 LEVEL 1 TECHNICAL ASSESSMENT

FILE NO. 8491-001-00

Purpose	Ground Water Instantaneous (gpm)	Ground Water Annual (acre-feet)	Surface Water Instantaneous (cfs)	Surface Water Annual (acre-feet)	Surface Water Reservoir (acre-feet)	Total Allocations [1,2]
Domestic	3,784	641	4	151	0	216
Municipal	2,000	1,018	3	756	0	5
Commercial/Industrial	1,150	900	1	2	500	14
Irrigation	12,056	4,246	36	5,383	0	193
Stock Watering	0	40	2	28	0	43
Power	0	0	19,470	0	823,000	11
Fish Propagation	0	0	121	3,693	20	16
Wildlife Propagation	440	0	0	0	0	3
Fire Protection	0	0	0	1	0	18
Other	0	3	19	15	0	16

Notes

[1] Individual water rights may have more than one purpose code.

[2] The totals presented above include permits and certificates, but do not include applications or claims.

[3] All information presented aboce is based on the Ecology WRATS Database (August 23, 2000 version).

p:\00\finals\PurposeofWaterRights\LewisRiver.xls

TABLE D-6
PURPOSE OF WATER RIGHTS

MIDDLE LEWIS RIVER WATERSHED

WRIA 27/28 LEVEL 1 TECHNICAL ASSESSMENT

FILE NO. 8491-001-00

	Ground Water		Surface Water			
Purpose	**Instantaneous (gpm)**	**Annual (acre-feet)**	**Instantaneous (cfs)**	**Annual (acre-feet)**	**Reservoir (acre-feet)**	**Total Allocations [1,2]**
Domestic	637	492	1	47	0	26
Municipal	0	0	0	0	0	0
Commercial/Industrial	0	0	0	0	0	0
Irrigation	0	0	0	0	0	2
Stock Watering	0	0	0	0	0	0
Power	0	0	9,400	0	740,000	3
Fish Propagation	0	0	12	0	0	2
Wildlife Propagation	0	0	0	0	0	0
Fire Protection	0	0	0	0	0	4
Other	0	0	0	0	0	0

Notes

[1] Individual water rights may have more than one purpose code.

[2] The totals presented above include permits and certifications, but do not include applications or claims.

[3] All information presented above is based on the Ecology WRATS database (August 23, 2000 version).

p:\00\finals\PurposeofWaterRights\MiddleLewisRiver.xls

TABLE D-7
PURPOSE OF WATER RIGHTS

UPPER LEWIS RIVER WATERSHED

WRIA 27/28 LEVEL 1 TECHNICAL ASSESSMENT

FILE NO. 8491-001-00

Purpose	Ground Water Instantaneous (gpm)	Ground Water Annual (acre-feet)	Surface Water Instantaneous (cfs)	Surface Water Annual (acre-feet)	Surface Water Reservoir (acre-feet)	Total Allocations [1,2]
Domestic	0	0	0	0	0	0
Municipal	0	0	0	0	0	0
Commercial/Industrial	0	0	0	0	0	0
Irrigation	0	0	8	0	0	1
Stock Watering	0	0	0	0	0	0
Power	0	0	0	0	0	0
Fish Propagation	0	0	0	0	0	0
Wildlife Propagation	0	0	0	0	0	0
Fire Protection	0	0	0	0	0	0
Other	0	0	0	0	0	0

Notes

[1] Individual water rights may have more than one purpose code.

[2] The totals presented above include permits and certificates, but do not include applications or claims.

[3] All information presented above is based on the Ecology WRATS database (August 23, 2000 version).

p:\00\finals\PurposeofWaterRights\UpperLewisRiver.xls

TABLE D-8
PURPOSE OF WATER RIGHTS

E. FORK LEWIS RIVER WATERSHED

WRIA 27/28 LEVEL 1 TECHNICAL ASSESSMENT

FILE NO. 8491-001-00

	Ground Water		Surface Water			
Purpose	Instantaneous (gpm)	Annual (acre-feet)	Instantaneous (cfs)	Annual (acre-feet)	Reservoir (acre-feet)	Total Allocations[1,2]
Domestic	6,203	1,570	5	128	0	270
Municipal	2,710	1,418	0	0	0	10
Commercial/Industrial	819	233	7	51	0	17
Irrigation	4,393	2,436	32	3,725	372	247
Stock Watering	0	67	4	30	0	67
Power	0	0	2	0	0	5
Fish Propagation	250	407	1	0	0	12
Wildlife Propagation	10	0	0	0	0	0
Fire Protection	20	0	3	25	0	12
Other	0	4	0	2	52	10

Notes

[1] Individual water rights may have more than one purpose code.

[2] The totals presented above include permits and certificates, but do not include applications or claims.

[3] All information presented above is based on the Ecology WRATS database (August 23, 2000 version).

p:\00\finals\PurposeofWaterRights\E.ForkLewisRiver.xls

TABLE D-9
PURPOSE OF WATER RIGHTS

SALMON CREEK WATERSHED

WRIA 27/28 LEVEL 1 TECHNICAL ASSESSMENT

FILE NO. 8491-001-00

Purpose	Ground Water		Surface Water			Total Allocations [1,2]
	Instantaneous (gpm)	Annual (acre-feet)	Instantaneous (cfs)	Annual (acre-feet)	Reservoir (acre-feet)	
Domestic	20,926	11,766	18	54	0	298
Municipal	14,698	13,932	0	0	0	26
Commercial/Industrial	2,012	3,259	0	0	0	7
Irrigation	13,627	6,903	33	2,854	0	35
Stock Watering	268	135	0	4	0	55
Power	0	0	0	0	0	2
Fish Propagation	10	5	8	0	0	18
Wildlife Propagation	0	0	24	1,960	0	6
Other	850	192	25	1,960	0	10
Domestic	20,926	11,766	18	54	0	298

Notes

[1] Individual water rights may have more than one purpose code.

[2] The totals presented above include permits and certifications, but do not include applications or claims.

[3] All information presented above is based on the Ecology WRATS database (August 23, 2000 version).

p:\00\finals\PurposeofWaterRights\SalmonBurntBridgeCreek.xls

TABLE D-10
PURPOSE OF WATER RIGHTS

BURNT BRIDGE CREEK WATERSHED

WRIA 27/28 LEVEL 1 TECHNICAL ASSESSMENT

FILE NO. 8491-001-00

Purpose	Ground Water Instantaneous (gpm)	Ground Water Annual (acre-feet)	Surface Water Instantaneous (cfs)	Surface Water Annual (acre-feet)	Surface Water Reservoir (acre-feet)	Total Allocations [1,2]
Domestic	28,061	17,738	3	12	0	182
Municipal	70,725	44,608	4	2,635	0	31
Commercial/Industrial	54,695	78,728	3	369	0	52
Irrigation	14,403	4,898	3	77	0	234
Stock Watering	0	7	0	4	0	19
Power	0	0	0	0	0	2
Fish Propagation	2,300	240	6	0	0	15
Wildlife Propagation	0	0	11	2,500	0	1
Fire Protection	265	160	0.1	0	0	16
Other	6,850	2,661	300	0	0	26

Notes

[1] Individual water rights may have more than one purpose code.

[2] The totals presented above include permits and certifications, but do not include applications or claims.

[3] All information presented above is based on the Ecology WRATS database (August 23, 2000 version).

p:\00\finals\PurposeofWaterRights\SalmonBurntBridgeCreek.xls

TABLE D-11
PURPOSE OF WATER RIGHTS

LACAMAS RIVER WATERSHED

WRIA 27/28 LEVEL 1 TECHNICAL ASSESSMENT

FILE NO. 8491-001-00

Purpose	Ground Water Instantaneous (gpm)	Ground Water Annual (acre-feet)	Surface Water Instantaneous (cfs)	Surface Water Annual (acre-feet)	Surface Water Reservoir (acre-feet)	Total Allocations [1,2]
Domestic	5,683	1,053	1	20	0	108
Municipal	0	0	0	0	0	1
Commercial/Industrial	17,800	28,610	274	44,775	7,490	8
Irrigation	7,302	3,508	9	303	15	145
Stock Watering	0	45	0	2	0	24
Power	0	0	0	0	0	0
Fish Propagation	0	0	5	0	40	6
Wildlife Propagation	170	0	0	0	0	1
Fire Protection	0	0	0	0	0	3
Other	65	28	0	0	54	7

Notes

[1] Individual water rights may have more than one purpose code.

[2] The totals presented above include permits and certifications, but do not include applications or claims.

[3] All information presented above is based on the Ecology WRATS database (August 23, 2000 version).

p:\00\finals\PurposeofWaterRights\LacamasRiver.xls

TABLE D-12

PURPOSE OF WATER RIGHTS

WASHOUGAL RIVER WATERSHED

WRIA 27/28 LEVEL 1 TECHNICAL ASSESSMENT

FILE NO. 8491-001-00

Purpose	Ground Water		Surface Water			Total Allocations [1,2]
	Instantaneous (gpm)	Annual (acre-feet)	Instantaneous (cfs)	Annual (acre-feet)	Reservoir (acre-feet)	
Domestic	878	134	5	134	0	193
Municipal	7,665	7,135	4	0	0	10
Commercial/Industrial	14,000	21,770	0	0	0	4
Irrigation	55	101	7	748	0	131
Stock Watering	0	6	0	5	16	22
Power	0	0	24	0	0	11
Fish Propagation	0	0	82	16	23	17
Wildlife Propagation	0	0	0	0	0	3
Fire Protection	0	0	0	0	0	5
Other	0	0	1	0	102	5

Notes

[1] Individual water rights may have more than one purpose code.

[2] The totals presented above include permits and certificates, but do not include applications or claims.

[3] All information presented above is based on the Ecology WRATS database (August 23, 2000 version).

p:\00\finals\PurposeofWaterRights\WashougalRiver.xls

TABLE D-13

PURPOSE OF WATER RIGHTS

COLUMBIA RIVER TRIBUTARIES WATERSHED

WRIA 27/28 LEVEL 1 TECHNICAL ASSESSMENT

FILE NO. 8491-001-00

Purpose	Ground Water		Surface Water			Total Allocations [1,2]
	Instantaneous (gpm)	Annual (acre-feet)	Instantaneous (cfs)	Annual (acre-feet)	Reservoir (acre-feet)	
Domestic	808	280	4	137	0	146
Municipal	1,778	1,129	0	0	0	4
Commercial/Industrial	150	133	0	0	0	6
Irrigation	550	161	11	1,370	0	62
Stock Watering	0	0	0	3	0	16
Power	0	0	3	0	0	4
Fish Propagation	0	0	1	0	0	6
Wildlife Propagation	0	0	23	0	0	16
Fire Protection	0	0	0	0	0	12
Other	0	0	2	1	0	6

Notes

[1] Individual water rights may have more than one purpose code.

[2] The totals presented above include permits and certifications, but do not include applications or claims.

[3] All information presented above is based on the Ecology WRATS database (August 23, 2000 version).

p:\00\finals\PurposeofWaterRights\ColumbiaRiverTributaries.xls

Appendix E
Draft 2002/2004 List of Impaired Water Bodies in WRIAs 27 and 28

Draft 2002/2004 List of Impaired Water Bodies in WRIAs 27 and 28[1]

Listed Waterbody	# of Listed Segments	Parameter(s)[2] in Violation of Water Quality Standards	Assessment Category[3]	On the 1998 303(d) List
Kalama River Sub-basin				
Kalama River	1	Temp	5	Yes
Middle Lewis Sub-basin				
Clear Creek	1	Temp	5	No
Clearwater Creek	1	Temp	5	No
Lewis River	3	Total Dissolved Gas	5	No
Muddy River	2	Temp	5	No
Siouxon Creek	1	Temp	5	No
Swift Creek #2 Power Canal	1	Total Dissolved Gas	5	No
Upper Lewis Sub-basin				
Lewis River	2	Temp	5	No
Quartz Creek	2	Temp	5	No
Lewis Sub-basin				
Cedar Creek	1	FC	5	No
East Fork Lewis River Sub-basin				
Breeze Creek	1	FC	5	No
Copper Creek	1	Temp	5	No
East Fork Lewis River	9	Temp, FC	5	Yes
Gee Creek	2	FC	5	No
Lockwood Creek	1	FC	5	Yes
McCormick Creek	1	FC	5	Yes
Rock Creek	1	FC	5	No
Rock Creek North	1	FC	5	Yes
Rock Creek South	1	FC	5	Yes
Yacolt Creek	1	FC	5	Yes
Burnt Bridge Creek Sub-basin				
Burnt Bridge Creek	15	DO, Temp, FC	5	Yes
Vancouver Lake	3	FC, Total Phosphorus	5	No
Salmon Creek Sub-basin				
Cougar Canyon Creek[4]	3	FC	5, 4A	Yes
Curtin Creek[8]	3	DO, pH, FC	5, 4A	Yes
Lake River	5	Temp, FC, Sediment Bioassay	5	Yes
Mill Creek	1	FC	4A	Yes
Salmon Creek[5]	12	DO, pH, Temp, FC, Turb	5, 4A	Yes
Weaver (Woodin) Creek[6]	9	DO, pH, Ammonia-N, FC	5, 4A	Yes
Whipple Creek	1	FC	5	No
Lacamas Creek Sub-basin				
China Ditch	1	DO	5	Yes
China Lateral	2	DO, Temp	5	Yes
Dwyer Creek	1	DO	5	Yes
Fifth Plain Creek	5	DO, Temp	5	Yes
Lacamas Creek	10	DO, Temp, pH, FC	5	Yes
Lacamas Lake	10	Total Phosphorus	5	No
Matney Creek	3	DO, Temp, FC	5	Yes
Mill Ditch	2	DO, pH	5	Yes
Shanghai Creek	1	Temp	5	Yes
Washougal Sub-basin				
Washougal River	1	FC	5	No
Columbia River Tributaries Sub-basin				
Gibbons Creek Remnant Channel[7]	3	Chromium, FC	5, 4A	Yes

(1) From the 2002/2004 Water Quality Assessment; Department of Ecology, State of Washington. Ecology released a draft Assessment in February 2004, with public comments accepted through March 2004. Ecology will submit a revised version to the EPA for approval once revisions from the public comments are incorporated.

(2) Parameter Abbreviations: Temp (Temperature); FC (Fecal Coliform); DO (Dissolved Oxygen); Turb (Turbidity.

(3) Ecology categorizes impaired waterbodies as Category 5 (Needs a TMDL), Category 4A (Has a TMDL), Category 4B (Has a pollution control plan), and Category 4C (Impaired by a non-pollutant). This table includes all impaired listings except for Category 4C.

(4) One creek segment is listed as Category 5, the other two segments are listed as Category 4A.

(5) Category 5 listings include 1 segment for dissolved oxygen, 3 segments for pH, and 1 segment for temperature. Category 4A listings include 6 segments for fecal coliform and 1 segment for turbidty.

(6) Category 5 listings include 1 segment for dissolved oxygen and 1 segment for pH. Category 4A listings include 1 segment for Ammonia-A, 1 segment for dissolved oxygen, and 5 segments for fecal coliform.

(7) Category 5 listings include 1 segment for Chromium. Category 4A listings include 2 segments fecal coliform.

(8) Category 5 listings include 1 segment for DO and 1 segment for pH. Category 4A listings include 1 segment fecal coliform.

Appendix F
Target Flow Examples

Appendix F
Target Flow Examples

Proposed Target Flows and Management Points for East Fork Lewis River Subbasin

The target flow concept was described in Section 4. Target flows represent a realistic flow regime that may be achievable in most years by following selected management techniques over a long period of time. A flow regime consists of a range of flows that vary seasonally based on runoff and precipitation. Target flows should therefore be a range of flows that could typically be expected to occur, except in extended periods of dry weather or during time periods with excessive rainfall and/or snowmelt.

Two management points are recommended for monitoring in the East Fork Lewis River Subbasin (East Fork). One management point is the location of the existing USGS stream gage near Heisson, which is also referred to as (EFL_55), and is at approximately River Mile 20. This location was chosen because of the available data from this stream gage, which has been in continuous operation since 1930. An additional management point is recommended for the main stem of the East Fork in the vicinity of the Daybreak Bridge, which is also referred to as (EFL_40), and is at approximately River Mile 10. This location was selected for several reasons including:

- An additional point is needed downstream in the basin because the Heisson gage location is upstream of most of the water use in the East Fork Sub-basin
- The Daybreak site is upstream of the tidal and flood flow influence from the Columbia River, which extends up to approximately River Mile 7.5
- Modeling work was done by PWR, so simulated stream flow data and statistics are available at this site
- An IFIM study was done in 1999 in this vicinity

Unpublished analysis of data performed for Friends of the East Fork from 2000 to 2003 indicate that the East Fork Lewis River from the Heisson gage downstream to various locations, such as the Daybreak Bridge area, is a “losing reach”, at least during periods when flow is less than 200 cfs (Dyrland, 2003). This means that flows are actually lower at downstream locations than the flows at the Heisson gage. Some potential reasons that could cause this to occur include significant diversions of water between the upstream and downstream locations, or a surface water/ground water interaction which results in the surface water flowing from the bed of the stream into the underlying gravels. This anomaly has not been factored into the modeling work done by PWR, since subsurface conditions and surface water-ground water interactions were not explicitly modeled. The PWR work was based on surface conditions, drainage areas, and precipitation, and was calibrated to stream gage data in discreet locations in the basin. The model results indicate that stream flows at River Mile 10 are higher than at River 20, which would indicate that the stream reach is gaining.

Lower Range of Target Flows

The evaluation for the determination of the lower range of target flows to be selected is based on the actual data for the Heisson gauge and on the data developed by PWR from their modeling work for the Day Break Bridge site (PWR 2003). These values should be viewed as “interim” numbers for flow management purposes. The PWR simulation was not designed to address potential gains or losses to ground water, nor to account for surface water diversions by water users. Interim management numbers can be replaced by accurate gauging data, if a gauge is installed as recommended.

The average monthly flow values were used as the basis for calculating the 90%, 50%, and 10% exceedance values, with the 90% values being the lowest of the three numbers and the 10% values being the highest of the three numbers. For example, the 90% exceedance values mean that these average monthly flows could be expected to be equaled or exceeded 90% of the time. If the 90% values were to be used, this would be the lower end of this range of flows, and could approximate the expected low flows during each month of a low-flow year (e.g., one year out of ten). See Tables F-1 and F-2 and Exhibits 4-7 and F-1 which show the 90%, 50%, and 10% values for the two management points for the East Fork Sub-basin.

As discussed in Section 4.5.2, an IFIM study was conducted for a reach of the East Fork in the vicinity of the Daybreak Bridge. As a comparison of the 10%, 50%, and 90% monthly average flows shown in Exhibit F-1 for the Daybreak Bridge location, to the optimum flows determined by IFIM, it can be seen that in the lowest flow years (90% flows) the flows are less than the optimum Chinook spawning flows for nearly every month of the year (480-520 cfs). Even in the highest flow years, which are exceeded only in 10% of the years, there are two months, July and August, which have average monthly flows of 286 cfs and 203 cfs, respectively, which are well below the optimum flow for one life stage (steelhead juvenile), though these flows are in the range specified in the IFIM study for Chinook juvenile (see Exhibit 4-7)

This in essence shows that the optimum flows determined by the IFIM study are not achievable in most years, under existing flow conditions in many months of the year. This is particularly true for the low flow months of the year. The IFIM study also acknowledged that the normal streamflow may not achieve optimum levels.

Table F-1
East Fork Lewis River at Day Break Bridge (RM 10)
Average Monthly Percent Exeedance Flows[1] (cfs)

Month	90%	50%	10%
January	438	1,202	3,358
February	416	1,096	2,831
March	368	931	2,273
April	223	549	1,552
May	148	354	1,275
June	104	231	852
July[2]	**72**	**119**	**286**
August[2]	**49**	**77**	**203**
September[2]	**44**	**90**	**497**
October[2]	**51**	**238**	**1,228**
November	238	904	2,612
December	485	1,243	3,205

(1) Simulated by modeling flows at Day Break Bridge ~ River Mile 10 with a drainage area of 158.5 sq. mi. Values are the percent exceedance of monthly average flows for existing conditions modeled at EFL_40 (PWR 2003).

(2) Low flow months are highlighted for application of target flow approach.

Table F-2
East Fork Lewis River near Heisson (RM 20)
Average Monthly Percent Exeedance Flows[1] (cfs)

Month	90%	50%	10%
January	495	1402	2325
February	691	1229	2099
March	653	1061	1597
April	543	902	1296
May	311	557	840
June	163	311	570
July [2]	**80**	**133**	**205**
August [2]	**51**	**74**	**120**
September [2]	**51**	**79**	**198**
October [2]	**70**	**261**	**775**
November	296	1012	1886
December	704	1445	2371

(1) Based on data from USGS Gage No. 14222500 near Heisson ~River Mile 20.2 with a drainage area of 125 sq. mi. Values are the percent exceedance of monthly average flows.

(2) Low flow months are highlighted for application of target flow approach.

Exhibit F-1
Monthly Average Flow Statistics
East Fork Lewis River (~RM 10) - Simulated

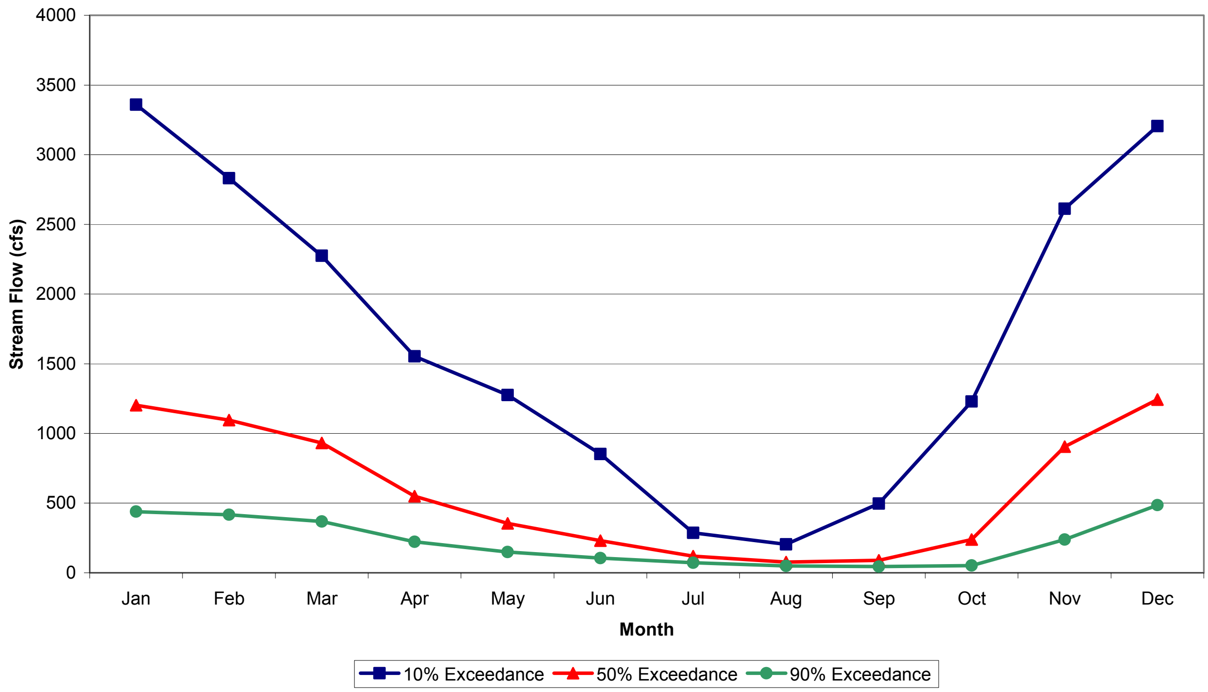
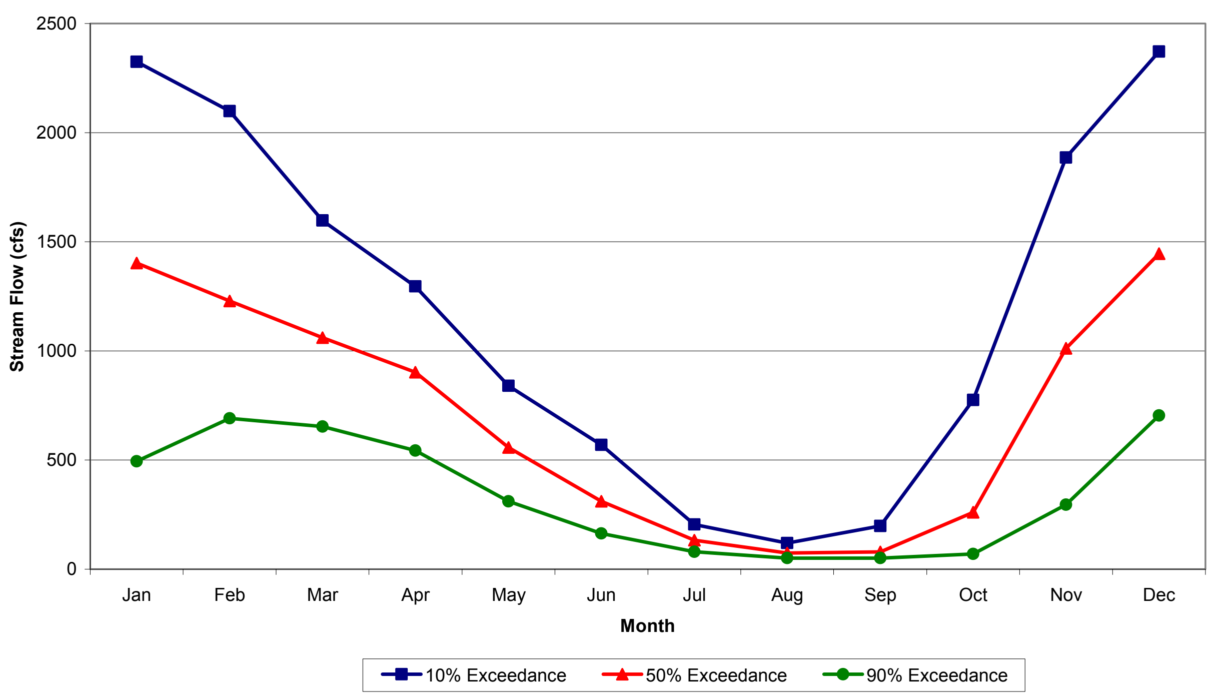


Exhibit F-2
Monthly Average Flow Statistics
East Fork Lewis River USGS Gauge 14222500 (1929-2002)



Although the 90% exceedance values are the flow levels that more closely reflect the lowest flow levels, the 50% and 10% values are also useful in that these numbers show the percentage of the time when more abundant flows occur. In addition to the importance of ensuring that the low range (90%) of flow levels are not reduced on a long-term basis, it is also important that the mid-high (50%-10%) range of flow levels not be significantly reduced, to protect fish habitat.

Recommendation:

For the main stem of the East Fork Lewis River, it is recommended that the available flow statistics for the 90%, 50%, and 10% exceedance levels serve as a basis for the target flow regime applying to the low-flow months. The suite of flow-management techniques discussed for the East Fork Lewis River watershed should be designed with the goal of protecting these flows from degradation; and if possible improving these flows. At this time, the Heisson Gauge is the only management point with adequate data to apply this recommendation. A proposed new gauging site at Daybreak Bridge should also be used as a management point, once a sufficient record has been developed at that site.

It should be noted that the flow statistics for the Daybreak Bridge were simulated based on drainage area and land use characteristics. These simulated flows may overstate actual flows, since diversions, ground water pumping and exchanges between surface and ground water below the Heisson gage are not accounted for. The target flow regime at the Daybreak Bridge site should be considered provisional, pending installation of a gage at that location and analysis of actual gage data.

Higher Range of Target Flows

The most reasonable statistics to use in the evaluation for determining the high end of the range for target flows are the 2-year and 10-year frequency flood, which have a 50% and 10% chance, respectively, of being equaled or exceeded in any given year. These provide more reliable metrics than the 100-year flood, which is difficult to estimate with high confidence. The 10-year flood should be viewed as a "surrogate" metric, for reducing potential damages from the 100-year flood. Unlike the low range for target flows, which is variable throughout the year based on typical runoff patterns, the high end of the range for target flows as the 10-year flood, is a single value throughout the year. Values for the 10-year flood are instantaneous peak flows and are calculated, based on existing gauging station records.

Based on the modeling work done by PWR, the 100-year, 10-year, and 2-year flood events at each of the two recommended management points in the East Fork Sub-basin have increased from pre-settlement conditions to the present time in the range of two to four percent. This amounts to an increase in flow from 239 to 336 cfs for the 10-year flood event. By recommending that the high end of the target flow range be maintained at the present day flows, this would halt the current trend of increasing flows for the 100-year, 10-year and 2-year flood events.

The calculated flows for the two recommended management points in the East Fork Subbasin in cubic feet per second (cfs) are shown in Table F-3:

Table F-3
Flood Statistics for East Fork Lewis River

Site	2-year	10-year	100-year
Heisson gage	7,756	12,530	18,001
Daybreak Bridge	8,366	13,718	19,815

Recommendation:

For the main stem of the East Fork Lewis River, it is recommended that the 2-year and 10-year flood events be used as metrics for high flow events. The suite of flow-management techniques discussed for the East Fork Lewis River watershed should be designed such that these flow statistics do not increase over time, and if possible are reduced over time. In addition, the duration of the highest flows should not increase. At this time, the Heisson Gauge is the only management point with adequate data to apply this recommendation. A proposed new gauging site at Daybreak Bridge should also be used as a management point, once a sufficient record has been developed at that site.

See note above regarding simulated flows at the Daybreak Bridge site.

Proposed Additional Gauging Sites for the East Fork Lewis River Subbasin

Policy SFP-1 (see Section 4.2) highlights the importance of maintaining existing stream gauges and installing new stream gauges to provide stream flow management data. There is only one stream gauge in the East Fork Subbasin, on the East Fork near Heisson. This gauge is located at River Mile 20.2 and just south of the community of Yacolt. This gauge has been in continuous operation since September 1929 for both daily flow and annual peak flow, and has a drainage area of 125 square miles. The total drainage area of the East Fork Subbasin is approximately 236 square miles, so this gauging station only provides flow measurements for approximately one half of the subbasin. Historically, this has always been the only stream gauge in the subbasin.

Recommendation:

It is recommended that the existing stream gauge at Heisson (RM 20.2) be maintained, and that one or more additional gauges be installed in the East Fork Lewis River Basin, to provide for more effective implementation of the flow management strategy and monitoring of results.

It is important that the existing stream gauge at Heisson be maintained, to continue providing long-term data on flows in this subbasin. In addition, if funding can be obtained it may be desirable to install additional gauges to enhance capabilities for monitoring and managing stream flow. This section describes some considerations in this regard for the East Fork subbasin. It should be noted that field work has not been performed to address access considerations or property ownership issues related to potential stream gauging sites.

Table F-4 summarizes candidate sites for installing new gauges in addition to maintaining the existing gauge. This includes the sites previously discussed for purposes of monitoring target flows, as well as additional sites that would be advantageous, if additional funding could be secured. If new stream gauges are installed in the East Fork Subbasin, consideration should also be given to whether existing weather stations for measuring precipitation and other weather variables are adequate to meet stream management needs.

Table F-4
Existing and Potential New Stream Gauges – East Fork Lewis River Subbasin

	Site	Potential Value	Priority	Notes
1.	Existing site on East Fork Lewis River near Heisson, R.M. 20.2	Mainstem flow levels (lower half of subbasin)	High	Takes advantage of previous data collected (1929 - present). Useful for monitoring effects in forested upper basin. Good for monitoring peak flows to provide flood warning. Not useful for monitoring effects downstream in more developed portion of basin.
2.	Daybreak Bridge/Park, RM 10.2	Provides management point lower in basin and near where IFIM studies conducted.	High	Narrow valley provides good gauging site. Location is upstream of much of developed portion of basin.
3.	Headwaters area	Would provide more focused data for evaluation of effects in smaller, forested watersheds.	Low - Medium	Could use staff gauges with periodic readings.
4.	Larger tributaries in more developed, portions of basin (e.g. Jenny Creek, Lockwood Creek, Mason Creek, Rock Creek [near S.R. 503], Yacolt Creek)	Would allow monitoring related to water use and land development, including changes in flow over time.	Low	Could use staff gauges with periodic readings.
5.	Additional Sites To Be determined for special studies (if applicable)	Evaluate effects of specific changes in land use conditions or mitigation measures. E.g. development or forest harvest.	TBD.	Depends on whether special studies are warranted.

(1) There are two Rock Creeks in this subbasin. One lies flows into the East Fork from the north side, and runs roughly parallel to S.R. 503. The other flows into the East Fork from the south side, and drains an area in the southern headwaters of the subbasin.

Proposed Target Flows and Management Points for Washougal River Subbasin

The target flow concept was described in Section 4.2. Target flows represent a realistic flow regime that may be achievable in most years by following selected management techniques over a long period of time. A flow regime consists of a range of flows that vary seasonally based on runoff and precipitation. Target flows should therefore be a range of flows that could typically be expected to occur, except in extended periods of dry weather or during time periods with excessive rainfall and/or snowmelt.

Two management points are recommended for monitoring in the Washougal River Subbasin. One management point is on the main stem of the Washougal River at the location of the former USGS stream gage near Washougal , which is also referred to as (WSH_20), and is at River Mile 9.2. This location was chosen primarily because of the available data from this former stream gage, which has the longest period of record in this sub-basin, and was in continuous operation from 1945-1981. An additional management point is recommended for the Little Washougal River near the confluence with the Washougal River, which is also referred to as (WSH_110). This location was selected for several reasons including:

- A USGS gage was in continuous operation at the location from 1952-1968, so there are several years of record for this tributary stream
- Modeling work was done by PWR, so simulated stream flow data and statistics are available
- There are some significant water diversions near the headwaters of this stream, so there is a potential for increasing the low flows if these diversions are either reduced or moved to other locations

Lower Range of Target Flows

The evaluation for the determination of the lower range of target flows selected is based on the data developed by PWR from their modeling work (PWR 2003). These values should be viewed as “interim” numbers for flow management purposes. The PWR simulation was not designed to address potential gains or losses to ground water, nor to account for surface water diversions by water users. Interim management numbers can be replaced by accurate gauging data, if a gauge is installed as recommended.

The average monthly flow values were used as the basis for calculating the 90%, 50%, and 10% exceedance values, with the 90% values being the lowest of the three numbers and the 10% values being the highest of the three numbers. For example, the 90% exceedance values mean that these average monthly flows could be expected to be equaled or exceeded 90% of the time. If the 90% values were to be used, this would be the lower end of this range of flows, and could approximate the expected low flows during each month of a low-flow year (e.g., one year out of ten). See Tables F-5 and F-6 and Exhibits F-3 and F-4 which show the 90%, 50%, and 10% values for the two management points for the Washougal Sub-basin.

As discussed in Section 4.6.2, an IFIM study was conducted for a reach of the Washougal in the vicinity of Hathaway Park. The modeled values of 10%, 50%, and 90% monthly average flows for the closest Washougal River gauge location shown in Table F-5 can be compared to the optimum flows determined by IFIM. Based on this comparison, in the lowest flow years (90% exceedance) the flows are less than the optimum Steelhead rearing flows of 500-600 cfs in nearly every month of the year. In the highest flow years (10% exceedance), average monthly flows during the months of July and August are 299 cfs and 230 cfs, respectively. Even these relatively high flows are much below the optimum flow for steelhead juveniles and Chinook spawning.

This in essence shows that the optimum flows determined by the IFIM study are in many months of the year, and particularly during the low flow months of the year, not achievable under existing flow conditions. The IFIM study also acknowledged that the normal streamflow may not achieve optimum levels.

Table F-5
Washougal River near Washougal (RM 9.2)
Average Monthly Percent Exceedance Flows(1) (cfs)

Month	90%	50%	10%
January	466	1501	2931
February	806	1547	2304
March	771	1242	2032
April	700	1042	1429
May	321	629	846
June	172	290	502
July (2)	**100**	**144**	**264**
August (2)	**67**	**91**	**153**
September (2)	**67**	**127**	**251**
October (2)	**97**	**446**	**1133**
November	684	1181	2439
December	902	1714	2793

(1) Flows near City of Washougal at USGS Gage No. 14143500 ~ River Mile 9.2 with a drainage area of 107 sq. mi. Values are the percent exceedance of monthly average flows from the period 1945 - 1981.

(2) Low flow months are highlighted for application of target flow approach.

Table F-6
Little Washougal River near Mouth
Average Monthly Percent Exceedance Flows(1) (cfs)

Month	90%	50%	10%
January	70	173	425
February	69	185	395
March	63	160	340
April	40	103	265
May	24	51	183
June	15	30	108
July(2)	**10**	**16**	**32**
August(2)	**7**	**10**	**21**
September(2)	**6**	**11**	**57**
October(2)	**7**	**33**	**169**
November	37	138	343
December	74	190	416

(1) Simulated by modeling flows near mouth with a drainage area of 24.3 sq. mi. Values are the percent exceedance of monthly average flows for existing conditions modeled at WSH_110 (PWR 2003).

(2) Low flow months are highlighted for application of target flow approach

Exhibit F-3
Average Monthly Flow Statistics
Washougal River USGS Gauge 14143500 (1944-1981)

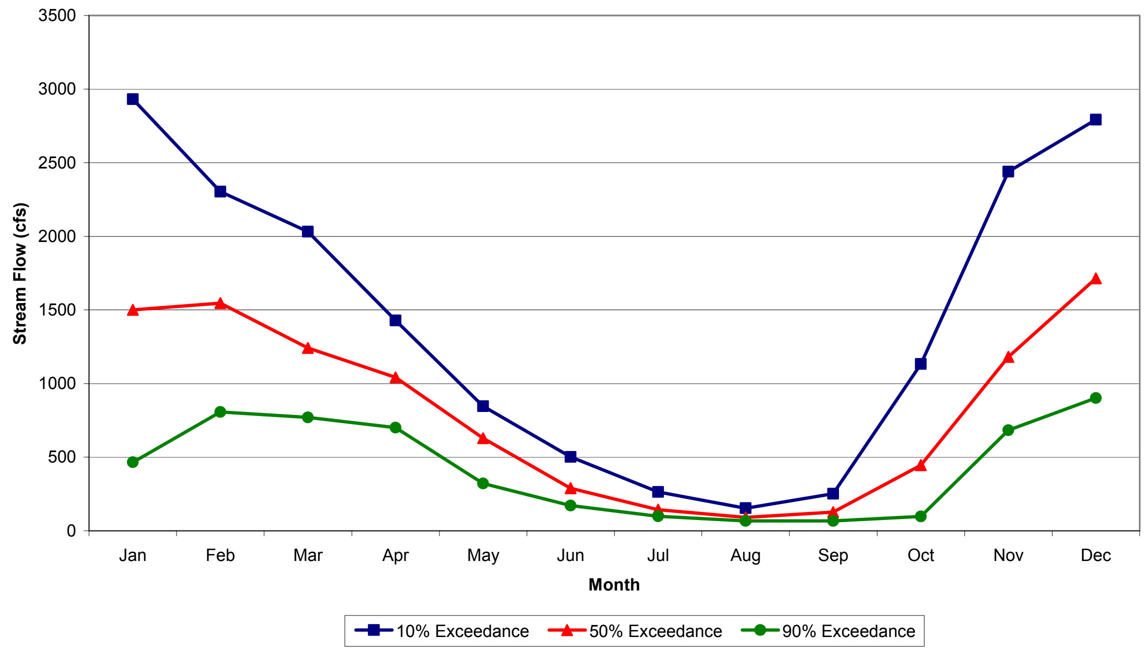
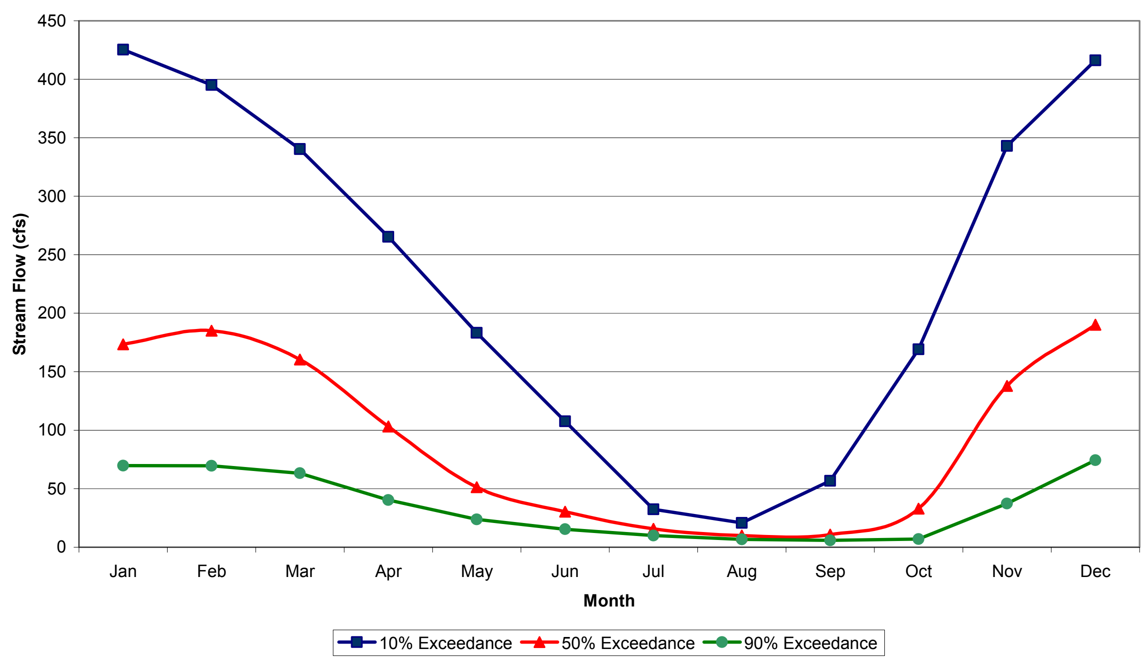


Exhibit F-4
Monthly Average Flow Statistics
Little Washougal River (~mouth) - Simulated



Although the 90% exceedance values are the flow levels that more closely reflect the lowest flow levels, the 50% and 10% values are also useful in that these numbers are also representative of the percentage of the time that certain flows might be expected to occur. In addition to the importance of ensuring that the low range (90%) of flow levels are not reduced on a long-term basis, it is also important that the mid-high (50%-10%) range of flow levels not be significantly altered on a long-term basis.

Recommendation:

For the main stem of the Washougal River and for the Little Washougal River, it is recommended that the available flow statistics for the 90%, 50%, and 10% exceedance levels serve as a basis for the target flow regime applying to the low-flow months. However, these flow statistics should be updated through installation of new stream gauges at the former gauging sites. The suite of flow-management techniques discussed for the Washougal River watershed should be designed with the goal of protecting these flows from degradation; and if possible improving these flows.

Higher Range of Target Flows

The most reasonable statistic to use in the evaluation for determining the high end of the range for target flows is the 10-year frequency flood, which has a 10% chance of being equaled or exceeded in any given year. This provides a more reliable metric than the 100-year flood, which is difficult to estimate with high confidence. The 10-year flood should be viewed as a “surrogate” metric, for reducing potential damages from the 100-year flood. Unlike the low range for target flows, which is variable throughout the year based on typical runoff patterns, the high end of the range for target flows as the 10-year flood, is a single value throughout the year. Values for the 10-year flood are instantaneous peak flows and are calculated, based on existing gauging station records.

Based on the modeling work done by PWR, the 100-year, 10-year, and 2-year flood events at each of the two recommended management points in the Washougal Sub-basin have had significant flow increases from pre-settlement conditions to the present time. Flows at the control point of the former gage location on the main stem have increased by nearly 350 cfs or nearly 4% for the 2-year flood event. The 10-year event has increased by 300 cfs or 2.4%, while the 100-year event has increased by 440 cfs or 2.1%. Larger percent increases have occurred at the Little Washougal control point where the 2-year event has increased by 6.4%, the 10-year event by 7.5%, and the 100-year event by 4.6%. By recommending that the high end of the target flow range be maintained at the present day flows, this would halt the current trend of increasing flows for the 100-year, 10-year and 2-year flood events.

The calculated flows for the two recommended management points in the Washougal Subbasin in cubic feet per second (cfs) are shown in Table F-7:

Table F-7 Flood Statistics for the Washougal River			
Site	100-year	10-year	2-year
Washougal Gauge	21,629	12,749	9,446
Little Washougal Gauge	2,469	1,501	1,072

> ***Recommendation:***
>
> For the main stem of the Washougal River, and the Little Washougal River, it is recommended that the 2-year and 10-year flood events be used as metrics for high flow events. However, these flow statistics should be updated through installation of new stream gauges at the former gauging sites. The suite of flow-management techniques discussed for the Washougal River Subbasin should be designed such that these flow statistics do not increase over time, and if possible are reduced over time. In addition, the duration of the highest flows should not increase.

Proposed Additional Gauging Sites for the Washougal River Subbasin

Policy SFP-1 (see Section 4-2) highlights the importance of maintaining existing stream gauges and installing new gauges to provide data for managing stream flow. There is currently only one stream gauge in the Washougal River Subbasin. This is a gauge operated by Clark County located on the Little Washougal River, about ½ mile upstream from its confluence with the Washougal's mainstem. In the past there was a USGS stream gauge located on the Washougal River, at RM 9.2, about three miles upstream of the mouth of the Little Washougal River. This gauge had a period of record from 1945-1981 for daily average flow and 1945-1996 for annual peak flow. A second gauge was located on the Little Washougal River about 1 mile upstream from its confluence with the Washougal River mainstem, with a period of record from 1951-1955 for daily flow and 1951-1968 for annual peak flow. In addition, there was a gauge on Canyon Creek, which flows into the Washougal River just upstream of the mouth of the West Fork Washougal River.

> ***Recommendation:***
>
> It is recommended that the former stream gauge on the Washougal River (RM 9.2) be replaced and the Clark County gauge on the Little Washougal River be maintained as a permanent installation recording continuous flow data, to provide for more effective implementation of the flow management strategy and monitoring of results.

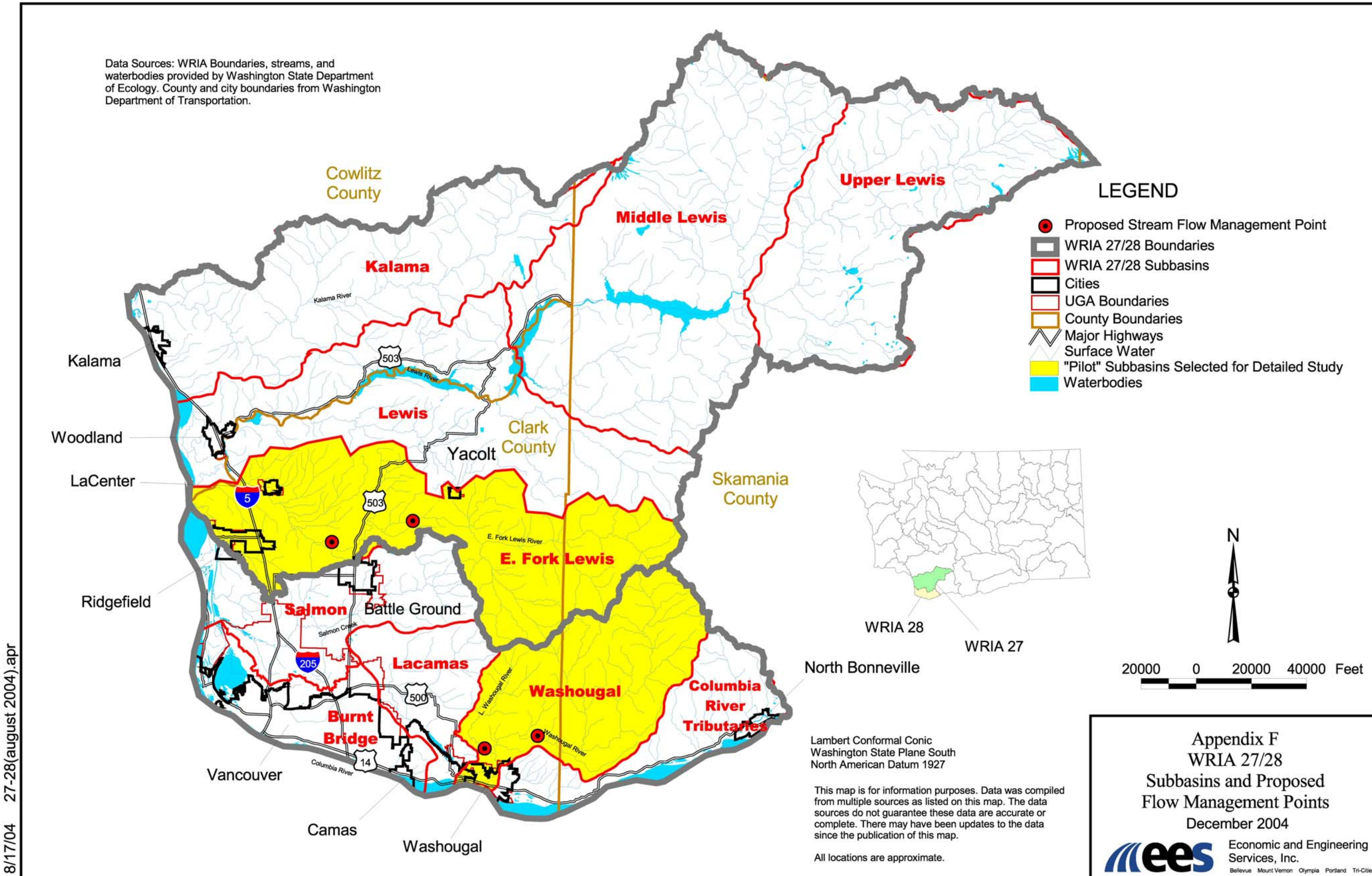
If funding can be obtained it may be desirable to install additional gauges to enhance capabilities for monitoring and managing stream flow. This section describes some considerations in this regard for the Washougal River subbasin. It should be noted that field work has not been performed to address access considerations or property ownership issues related to potential stream gauging sites.

Table F-8 summarizes candidate sites for installing new gauges in addition to maintaining the existing gauge. This includes the sites previously discussed for purposes of monitoring target flows, as well as additional sites that would be advantageous, if additional funding could be secured. If new stream gauges are installed in the Washougal River Subbasin, consideration should also be given to whether existing weather stations for measuring precipitation and other weather variables are adequate to meet stream management needs.

Table F-8
Potential New Stream Gauges – Washougal River Subbasin

	Candidate Site	Potential Value	Priority	Notes
1.	Former gauging site on Washougal R., R.M. 9.2	Mainstem flow levels (middle to lower portion of subbasin)	High	Takes advantage of previous data collected (1945-81).
2.	Former gauging site on Little Washougal	Monitor flows of a major tributary.	High	Build on high flow data collected during previous period of record (1951-55). Purposes may overlap somewhat with Site #2 above.
3.	Lower end of mainstem	Would record total flows for entire watershed	Medium	Downstream of a major tributary (Little Washougal R.). Would need to avoid influence from Columbia R. flow backup. Should also consider locating close to IFIM site (RM 3.5), especially if minimum instream flows established based on IFIM results.
4.	Upper end of mainstem, below northernmost cluster of tributaries (Silver Creek & others)	Monitor flows from forested headwaters; measure change due to forest practices. Predict peak flows.	Medium	Value for flood prediction limited, since flooding at downstream end related more to Columbia R. peak flows.
5.	Lower end of West Fork Washougal River	Monitor flows of a major tributary.	Low to medium	N/A
6.	Jones' and Boulder Creeks	Monitor flows as related to Camas diversions	Low to medium.	Necessary if "trigger flow" approach were used.
7.	Additional Sites To Be determined for special studies (if applicable)	Evaluate effects of specific changes in land use conditions or mitigation measures. E.g. development or forest harvest.	TBD.	Depends on whether special studies are warranted.

TBD = To be Determined
1. A gauge has recently been installed on Jones Creek.


Data Sources: WRIA Boundaries, streams, and waterbodies provided by Washington State Department of Ecology. County and city boundaries from Washington Department of Transportation.
Cowlitz County
Kalama
Middle Lewis
Upper Lewis
Lewis
Clark County
Skamania County
E. Fork Lewis
Salmon
Lacamas
Washougal
Burnt Bridge
Columbia River Tributaries
Kalama
Woodland
LaCenter
Ridgefield
Yacolt
Battle Ground
Vancouver
Camas
Washougal
North Bonneville
Kalama River
Lewis River
E. Fork Lewis River
Salmon Creek
L. Washougal River
Washougal River
Columbia River
5
205
503
500
14
LEGEND
Proposed Stream Flow Management Point
WRIA 27/28 Boundaries
WRIA 27/28 Subbasins
Cities
UGA Boundaries
County Boundaries
Major Highways
Surface Water
"Pilot" Subbasins Selected for Detailed Study
Waterbodies
WRIA 28
WRIA 27
N
20000 0 20000 40000 Feet
Lambert Conformal Conic
Washington State Plane South
North American Datum 1927
This map is for information purposes. Data was compiled from multiple sources as listed on this map. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this map.
All locations are approximate.
Appendix F
WRIA 27/28
Subbasins and Proposed
Flow Management Points
December 2004
Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities
8/17/04 27-28(august 2004).apr

Appendix G
Existing Surface Water Source Limitations

Appendix G
Existing Surface Water Source Limitations (SWSLs)

Table G-1
Summary of Existing SWSLs for the Kalama River Subbasin

Map Key	Stream Name	Description of Existing Closure or Low Flow
27-6	Kalama River	Low flow of 700 cfs from Nov-April; 700 to 375 cfs April-May; 375 cfs May-Sept; 375 to 700 cfs Sept-Nov. Within Section 33, Township 7 North, Range 1 West. This restriction has been in place on the Kalama River since the Department of Fisheries letter dated Sept 5, 1974.

Table G-2
Summary of Existing SWSLs for the North Fork Lewis River Subbasin

Map Key	Stream Name	Description of Existing Closure or Low Flow
27-7	Lewis River	Low flow of 1500 cfs for Sept 16-July 14; 1000 cfs from July 15-Sept 15. Within Section 4, Township 5 North, Range 2 East. This restriction has been in place on the Lewis River since the Department of Wildlife letter dated March 31, 1992.
27-1	Cedar Creek	Closure within Section 12, Township 5 North, Range 1 East. This restriction has been in place on Cedar Creek since the Department of Fisheries letters from 1945-1958.
27-2	Chelatchie Creek	Closure within Section 16, Township 5 North, Range 3 East. This restriction has been in place on Chelatchie Creek since the Department of Fisheries letter dated Jan 20, 1954.
27-4	Horseshoe Lake	Closure within Section 24, Township 5 N, Range 1 West
27-13	Pup Creek	Closure within Section 3, Township 5 North, Range 2 East. This restriction has been in place on Pup Creek since the Department of Fisheries letter dated Jan 20, 1954.

Table G-3
Summary of Existing SWSLs for the East Fork Lewis River Subbasin

Map Key	Stream Name	Description of Existing Closure or Low Flow
27-8	East Fork Lewis River	Low flow of 225 cfs (October 1 through June 30) and 150 cfs (July 1 through September 30), based on recommendations from the Department of Wildlife in March 1992 letter. (Section 17, T4N, R3E)
27-3	Gee Creek, tributary of Lewis River/Columbia River	Closure, based on recommendations from the Department of Fisheries by letters dated November 28, 1952 and April 12, 1967 (Section 11, T4N, R1W)
27-5	Jenny Creek, tributary of East Fork	Closure, based on recommendations from the Department of Fisheries by letters in February 1952 and September 1953. (Section 32, T5N, R1E)
27-10	Lockwood Creek, tributary of East Fork	Closure, based on recommendations from the Department of Fisheries by several letters from 1950 to 1961. (Section 11, T4N, R1E)
27-11	Mason Creek, tributary of East Fork	Closure, based on recommendations from the Department of Fisheries by letters in 1973 and 1974. (Section 14, T4N, R1E)
27-14	Rock Creek, tributary of East Fork	Low flow of 0.5 cfs, based on recommendations from the Department of Fisheries in February 1975 letter. (Section 11, T4N, R2E)
27-15	Unnamed stream, tributary of Rock Creek	One half of the low flow in the stream, based on recommendations from the Department of Fisheries in August 1955 letter. (Section 32, T5N, R3E)
27-9	Unnamed stream, tributary of East Fork	One half of the low flow in the stream, based on recommendations from the Department of Fisheries in February 1952 letter. (Section 28, T5N, R1E)
27-12	Unnamed stream (Mill Creek)	Low flow of 1.0 cfs, based on recommendations from the Department of Fisheries in November 1949. (Section 28, T4N, R2E)

Table G-4
Summary of Existing SWSLs for the Salmon Creek Subbasin

Map Key	Stream Name	Description of Existing Closure or Low Flow
28-7	Salmon Creek	Closure within Section 19, Township 3 North, Range 1 East. This restriction has been in place on Salmon Creek since the Department of Fisheries letter dated Nov 3, 1949.
28-13	Weaver Creek	Closure within Section 2, Township 3 North, Range 2 East. This restriction has been in place on Weaver Creek since the Salmon Creek closure because Weaver Creek is a tributary of Salmon Creek.
28-14	Whipple Creek	Closure within Section 12, Township 3 North, Range 1 West. This restriction has been in place on Whipple Creek since the Department of Game letter dated May 16, 1946.

Table G-5
Summary of Existing SWSLs
for the Burnt Bridge Creek Subbasin

Map Key	Stream Name	Description of Existing Closure or Low Flow
28-1	Burnt Bridge Creek	Closure within Section 9, Township 2 North, Range 1 East. This restriction has been in place on Burnt Bridge Creek since the Department of Fisheries letter dated March 29, 1949.

Table G-6
Summary of Existing SWSLs and Recommendations
for the Lacamas Creek Subbasin

Map Key	Stream Name	Description of Existing Closure or Low Flow
28-5	Lacamas Creek	Low flow 6.0 cfs within Section 9, Township 2 North, Range 3 East. This restriction has been in place on Lacamas Creek since the Department of Fisheries letter dated April 6, 1950.
28-3	Fifth Plain Creek	Closure within Section 7, Township 2 North, Range 3 East. This restriction has been in place on Fifth Plain Creek since the Department of Fisheries letter dated Nov 26, 1951.
28-8	Shanghai Creek	Closure within Section 6, Township 2 North, Range 3 East. This restriction has been in place on Shanghai Creek since the Department of Game letter dated Dec 20, 1966.

Table G-7
Summary of Existing SWSLs for the Washougal River Subbasin

Map Key	Stream Name	Description of Existing Closure or Low Flow
28-12	Washougal River	Low flow of 175 cfs within SW ¼ SE ¼ Section 27, Township 2 North, Range 4 East, which is near the mouth of Cougar Creek. This location is at the site of the discontinued USGS stream gauge No. 14143500. This restriction has been in place on the Washougal River since the Department of Wildlife letter dated July 24, 1987.
28-10	West Fork Washougal River	Low flow within Section 29, Township 2 North, Range 5 East, which is near the Skamania Hatchery and the mouth of the West Fork. This restriction has been in place on the W.F. Washougal River since the date of the Department of Game letters in August and September, 1973
28-11	Unnamed stream, tributary to Washougal River	Low flow of 0.50 cfs within Section 25, Township 2 North, Range 4 East, about two miles upstream of the mouth of Cougar Creek. This restriction has been in place on this unnamed stream since the Department of Fisheries letter dated January 14, 1953
28-2	Cougar Creek	Low flow of 0.50 cfs within Section 13, Township 2 North, Range 4 East, near the headwaters of Cougar Creek. This restriction has been in place on Cougar Creek since the Department of Fisheries letter, dated June 12, 1953.

Table G-8 Summary of Existing SWSLs and Recommendations for the Columbia River Tributaries Subbasin		
Map Key	**Stream Name**	**Description of Existing Closure or Low Flow**
28-4	Gibbons Creek	Closure within Section 16, Township 1 North, Range 4 East. This restriction has been in place on Gibbons Creek since the Department of Fisheries letter dated March 23, 1953.
28-6	Lawton Creek	Low flow of 3.0 cfs within Section 24, Township 1 North, Range 4 East. This restriction has been in place on Lawton Creek since the Department of Fisheries and Game letter.
28-9	Unnamed stream (Spring Creek)	Closure within Section 34, Township 2 North, Range 6 East. This restriction has been in place since the April 28, 1969 adjudication.

Appendix H
Proposed Elements of Stream Flow Protection Rule

Appendix H
Proposed Elements of Stream Flow Protection Rule

Policy SFP-2 in Section 4.4.1 states that the Department of Ecology (Ecology) should adopt State Rules (WACs) under the Instream Resources Protection Program to restrict issuance of new water rights in WRIAs 27 and 28. This appendix contains supporting materials for some of the major elements of the proposed rules.

The following items are included in this appendix:

- Core Issues for Integrating Stream Flow Protection and Water Supply Policies

This policy document highlights issues and explores solutions that achieve an appropriate balance between protecting stream flows and ensuring adequate water supplies for future uses. The following issues and their solutions are discussed:

I. Protecting Stream Flows
II. Domestic Wells
III. Water Supply Reservations for Municipal, Industrial, and other Purposes
IV. Off-setting and Mitigating Actions for Water Reservation Use
V. Extent of Tidal Reaches Excluded from Stream Closures
VI. Non-Reservation Water Right Applications
VII. Target Flows

- Table H-1 and Exhibits H-1 and H-2 Recommended Restrictions on Issuance of New Water Rights

This table and associated exhibits show the subbasins in each of the WRIAs, and describe the location of stream reaches by River Mile (RM), the proposed restrictions on the issuance of new water rights, and the basis of the proposed restrictions for each of the stream reaches. As additional information, the table also shows the locations where some of the major public water suppliers currently divert water.

- Table H-2 Water Right Reservation Summary

This table shows amounts of water proposed to be reserved for future water supply and other beneficial uses of water and stream flow depletion allowances by subbasin. Tables H-2a, H-2b, and H-2c contain supporting information for Table H-2. Also included are WDFW and Ecology flow recommendations to be reserved and the rationale for reserving these flow amounts for each subbasin in WRIAs 25 and 26 and WRIAs 27 and 28. Also included is a comment from Skamania County on the reservation quantities.

Estimated needs are presented for communities listed and other types of uses, from portions of the subbasins that have proposed stream flow restrictions. In order to make these amounts of water available for future water use in these subbasins with proposed streamflow restrictions, these amounts of water must be reserved for these uses. Parts III and IV of the Core Issues policy document describe this reservation process and the offsetting and mitigating actions required for water reservation use.

Future water uses that are projected for areas that are not within stream reaches with proposed stream flow restriction are not shown on this reservation table. Increased future water uses for these areas would not need to be reserved in these areas where there is no proposed stream flow restriction.

- Table H-3 Tidal Influence Locations to Establish Downstream Limit for Restrictions on New Water Rights

This table shows the locations of upstream limits of tidal influence for the Kalama, Lewis, East Fork Lewis, and Washougal rivers. These locations will be used in the decision-making process for future water right decisions by the Department of Ecology. It is intended that any future water rights that are issued in stream reaches that are downstream of these locations would not be subject to instream flows or closures. Upstream of these locations there will be stream flow restrictions as shown in Table H-1.

This table also shows the locations of major public water suppliers' existing withdrawal/diversion facilities to show whether or not future water rights obtained from these existing facilities would be subject to stream flow restrictions.

- Table H-4 Proposed Instream Flows

This table shows proposed instream flows on a monthly basis, the applicable stream reach, and the proposed location of the control station for three river systems in WRIAs 27/28, the Kalama River, the East Fork Lewis River and the Washougal River. These instream flows are proposed to support stream closures in these watersheds and will be used in processing applications for change or transfers of existing water rights and applications for new water rights limited to high-flow periods of the year. Blocks of water reserved for domestic, municipal, and other beneficial uses shall not be subject to instream flows or closures.

- Table H-5 Toe Width Recommended Flows

Table H-5 shows toe-width flows recommended by Washington Department of Fish and Wildlife and Washington Department of Ecology for tributary streams in WRIAs 27/28. Recommended toe-width flows are shown by fish species and lifestage, on a monthly basis. The "toe width" column lists distance from the toe of one streambank to the toe of the other streambank, as measured in the field. The "Fish Species" column identifies the key fish species present in each watercourse. The "toe-width spawning/rearing" column provides recommended flows, in cubic feet per second (cfs), for the species and life history stages listed. These recommended toe-width flows are derived from a mathematical equation, based on field studies, that relates toe-width measurements with water depths necessary for spawning and/or rearing. For the incubation lifestage, a number equivalent to 2/3 of the spawning flow number is used. The 2/3 spawning flow number provides approximately 1.0-1.5 feet of water over the spawning gravels. This table also depicts the recommended instream flows for priority fish species and lifestages, for each month of the year. The priority species/lifestage is commonly the one with the highest water needs during that particular month.

These toe-width flows will support stream closures in applicable watersheds, and will be used in processing applications for change or transfers of existing water rights and applications for new water rights limited to high-flow periods of the year. Blocks of water reserved for domestic, municipal, and other beneficial uses shall not be subject to instream flows or closures. Recommended toe-width flows do not affect existing water rights, including exempt domestic wells, and do not represent "target flows" as discussed in Chapter 4.

Core Issues for Integrating Stream Flow Protection and Water Supply Policies

This policy document is intended to highlight issues and explore solutions that achieve an appropriate balance between protecting stream flows and ensuring adequate water supplies. The following issues and their solutions are discussed:

I. Protecting Stream Flows
II. Domestic Wells
III. Water Supply Reservations for Municipal, Industrial, and other Purposes
IV. Off-setting and Mitigating Actions for Water Reservation Use
V. Extent of Tidal Reaches Excluded from Stream Closures
VI. Non-Reservation Water Right Applications
VII. Target Flows

I. Protecting Stream Flows

Issue: The Planning Unit has consistently viewed closures as a preferred mechanism for surface water protection; however Ecology has suggested that use of instream flow rules are preferred because numeric instream flows are more legally defensible and because instream flow rules establish a river right that adds flexibility to potential intra-basin transfers.

Solution**:** Merge aspects of closures and instream flows to utilize the best of each, while further integrating the water supply policy. Specific elements of a merged approach include:

- Ecology and Fish & Wildlife have recommended numeric stream flows in the Kalama, North Fork Lewis, East Fork Lewis, Salmon Creek and Washougal basins based on stream gage data and IFIM/Toe-width modeling & best available science;
- The Planning Unit recommends Ecology promulgate an administrative rule utilizing the numeric flows as a basis for year-round closures with certain exceptions. Exceptions include predefined blocks of water reserved for domestic wells, predefined blocks of water reserved for municipal and other purposes, and in certain cases, interruptible seasonal rights. The justification for year-round closure is the lack of adequate, long-term enforcement of instream flow rules and the hardship imposed by interruptible rights;

- Blocks of water reserved for domestic, municipal, and other purposes will not be subject to minimum instream flow conditions;
- The Planning Unit recommends interruptible rights be granted only in cases where a potential user can demonstrate a seasonal need for water and the use is likely not to interrupt habitat-forming flows;
- The Planning Unit recommends closure without numerical flows in other basins lacking sufficient stream gage data and IFIM analysis; and
- The Planning Unit recommends additional groundwater studies throughout the planning area to determine availability of groundwater that is not in continuity with surface water. This recommendation could help jurisdictions direct future growth into appropriate areas under the Growth Management Act or other planning processes.
- Some smaller streams and tributaries that drain directly to the Columbia River were not specifically analyzed in this watershed plan. The Planning Unit recommends that these streams not be closed, and that Ecology and Fish & Wildlife address these water bodies on a case-by-case basis in the future as applicants apply for new water rights. If, upon review, these streams are closed by administrative action, then it is recommended that a water right reservation should also be considered, to allow for domestic wells and potentially other uses. Such closures and recommendations would then be added to the formal rule at the next time the rule is updated.
- The Planning Unit recommends that a three-zone concept be considered for the East Fork Lewis and Washougal Rivers. While this concept should be explored further during the implementation phase, it would involve the definition of three zones for each river: 1) the tidal area, 2) reach just above the tidal area where a large reservation would have minimal impact to stream flow, and 3) upstream reaches with more restrictive limitations.

II. Domestic Wells

***Issue*:** The Planning Unit examined the impact from domestic wells through a pilot study in the Washougal basin. Based on study results and the social/economic significance of this use, the Planning Unit favors conditioning closures rules to provide for domestic wells that are exempt from requirements to apply for a permit under the State Ground Water Code (Chapter 90.44.050 RCW).

While excluded from the permit application process, domestic wells represent water rights that are junior to pre-existing senior rights within basins. Management of domestic wells is significant to the degree they may impair senior water rights or reduce instream flows to the detriment of fish or other wildlife species, especially in smaller tributaries at high development densities.

Ecology has argued that from a legal basis, domestic wells cannot be protected from a stream closure or interruptible water rights if they are in connectivity with surface water unless a reservation of water is defined within the rule. Therefore, the Planning Unit views the domestic well reservation as a protective measure for landowners to ensure domestic wells will continue to be allowed.

Solution: Accept Ecology's recommendation and develop a reservation or block of water for the exclusive use by domestic wells.

- The Planning Unit will recommend numerical reservations by subbasin for domestic wells. The numerical reservation should be large enough to ensure consistency with predicted land use over a twenty-year time horizon. Small tributaries and other flow sensitive areas should be protected from increased development densities by maintaining existing zoning levels;
- The Planning Unit recommends Ecology manage the accounting system to track the total number of domestic wells in comparison with the number allowed by the reservation.
- The Planning Unit recommends domestic wells target confined aquifers, whenever possible;
- The Planning Unit recommends that new domestic utilize water supplied by public purveyors whenever available;
- The Planning Unit recommends that domestic served by sewer systems also be served by public water systems to avoid the capture of water that otherwise would return to the basin.

III. Water Supply Reservations for Municipal, Industrial and Other Purposes

Issue: The Planning Unit recognizes increasing demand on public water supplies over the foreseeable future. It also recognizes the importance of protecting baseflow for fish and wildlife. While tension exists between these two sometimes conflicting needs, they are inextricably linked through the quality of life we enjoy and the economic vitality of the region.

For much of WRIA 27/28, the key to meeting demand is through the development of a regional water source in the shallow Sand and Gravel aquifer in the Vancouver Lake Lowlands. While the source holds promise, there are significant issues to be resolved and its development will take five to ten years and considerable capital. For several public purveyors, the regional source is a viable solution, but demand will exceed supply prior to its development. For other municipalities, a regional water source is not a viable option even when it becomes available. Most of their demand is currently met through groundwater sources, with some reliance on surface waters.

Solution: Protect baseflows by avoiding direct use of instream flows and groundwater that is in hydrologic connectivity with instream flows. Establish 'reservations' of water that may be used for municipal use if no other option is feasible. Use of reservations requires off-setting actions.

- Development of the Vancouver Lowlands regional water source (and potentially a second source in the Washougal/Camas vicinity) is a critical Planning Unit recommendation in the WRIAs 27 and 28 Management Plan;
- Municipalities striving to meet demand in the interim period prior to development of a regional source, or in cases where regional sources are not feasible, should develop deep groundwater sources that are not in connectivity with surface waters;
- In cases where it is not feasible to avoid the use of groundwater in connectivity with surface water, a reservation of water will be reserved in rule to meet demand. The water rights

applicant must evaluate all potential sources and demonstrate why use of the reservation is required;

- The reservation should indicate specific amounts of water by jurisdiction and basin. The jurisdiction may choose to allocate some or all of its reservation allocation to commercial or industrial use—this provision is intended to eliminate the need for commercial or industrial reservations in urban areas;
- Responsibility for analysis of available water sources lies with the water rights applicant;
- Application for the reservation will be reviewed, analyzed, and processed by Ecology in consultation by Fish & Wildlife; and
- Use of the reservation of water must be accompanied by a package of actions that off-set and mitigate for potential stream flow impairment (see Section IV below).

IV. Off-setting and Mitigating Actions for Water Reservation Use

***Issue*:** The Planning Unit's goal is to achieve a balance between the need for additional water supply and to protect baseflow. In cases where the water reservation is granted by Ecology, it is presumed that the use will impact baseflow. Since it is the goal of the Planning Unit to protect baseflow, it is important to recommend to Ecology a methodology to evaluate how these impacts can be eliminated or minimized.

***Solution*:** The Planning Unit recognizes the challenges public water purveyors face when trying to meet demand. Perfecting a water right is only one element; infrastructure costs in the form of equipment, distribution lines, and developing system redundancy represent significant resource needs. On the other hand, depletion of baseflow also has significant costs in terms of quality of life, liability under the Endangered Species Act, recreation, and watershed health. When the internal and external costs of baseflow reduction are factored into the equation, a regional water supply and deep groundwater sources become attractive over the long-term.

The Planning Unit recommends that Ecology (in conjunction with Fish & Wildlife) evaluate requests for reservation use by reviewing the applicant's analysis of other alternatives and by evaluating the applicant's proposal in terms of off-setting and mitigating actions.

- The Planning Unit recommends that Ecology develop clear guidance for mitigation. A starting point for such guidance may be found in an Ecology publication entitled "Mitigation Measures used in Water Right Permitting" dated April 2003.
- The Planning Unit recommends that where an applicant applies for a water right under a reservation, they be required to mitigate the predicted stream flow depletion to the maximum extent practicable through flow-related actions. Practicable is meant to include both economic and logistic considerations.
- No less than half of the predicted stream flow depletion (see Table H-2a) must be offset through the acquisition of active upstream water rights or other flow augmenting actions in the same subbasin upstream of the new proposed water right. The Planning Unit recognizes there may be occasional exceptions where offsetting one half of the predicted stream flow depletion fully or in part may be infeasible or cost-prohibitive. For example, the Kalama

River and upper North Fork Lewis River subbasins have been identified by the Planning Unit as areas where offsetting actions may be infeasible, due to the lack of upstream water rights that could be acquired as a mitigation action. In these limited cases, acquisition of offsetting active water rights or flow augmentation actions shall be implemented to the extent feasible. Any remaining offset requirement shall be mitigated through other habitat actions designed to offset the effects of the stream flow depletion not being offset. In no case shall the amount of stream flow depletion from new water rights issued under this policy exceed the quantity shown in Table H-2a, under the column heading “Net Stream flow Depletion Allowance”.

- The Planning Unit recommends that Ecology consider other mitigating actions to address impacts that cannot be practicably off-set (no more than half) through water-for-water actions. This includes the restoration of wetlands and side-channels that increase stream storage capacity;
- The Planning Unit recommends that Ecology consider habitat restoration actions other than the restoration of wetlands and side-channels using the following criteria:
    - habitat actions should focus upon projects that improve stream conditions impaired by flow (e.g., projects that improve width to depth relationships or improve landscape-level hydrologic processes, etc.);
    - habitat actions should address threats and limiting factors through priority actions identified in the Lower Columbia Salmon Recovery Plan;
    - habitat actions should be evaluated within the context of when baseflow impacts will occur and the expected timeframe of habitat project benefits;
- The Planning Unit recommends that Ecology (and Fish & Wildlife) consider cost to the applicant in terms of other supply alternatives, water supply total project cost, and the cost of the off-setting and mitigating actions. These costs should be evaluated within the context of other fish recovery actions that may be needed to compensate for impairment to streamflow; and
- The Planning Unit recommends that Ecology consider the applicant’s request to access the reservation of water relative to its intended use and timeframe. Several public purveyors have interim needs while a regional water source is developed. The Planning Unit supports an interim use of the reservation, especially as the certainty of a regional source increases <u>and</u> the reservation is retired after this interim use, or its use is diminished to fill a water system redundancy (backup) need. Ecology should consider a diminished use in terms of its predicted frequency of use and impact on fish habitat.
- The Planning Unit recommends that Ecology consider allowing small community water systems to contribute money into a pooled mitigation fund, in lieu of implementing specific mitigation actions. Money could then be accumulated from small systems over time to support larger and more beneficial mitigation projects. Details regarding this concept should be examined during the implementation phase. Such details will include what entity manages the mitigation fund, the dollar amount to be contributed, etc.
- The Planning Unit recommends that Ecology consider allowing water users to “bank” mitigation credits for use in the future. In this way a community could implement mitigation

activities prior to the need for accessing water rights contained in a reservation. Details regarding this concept should be examined during the implementation phase.

- The Planning Unit intends that domestic wells, including those serving multiple houses, be exempt from mitigation requirements.

V. Extent of Tidal Reaches Excluded from Stream Closures

Issue**:** The Planning Unit supports the use of the tidally-influenced area of the North Fork Lewis basin for meeting new water demands. Tidal influence on each of these basins is dynamic and changes daily and seasonally. Some points within the tidal area are affected throughout the day, while other points may be affected only for minutes.

To accomplish the intent of using tidally-influenced areas effectively and within the context of minimizing impairment to fish and wildlife habitat, the Planning Unit has identified the location where stream closure will take effect upstream and remain open downstream.

Solution**:** Identify the point where tidal influence extends at mean daily low tide and the point at mean daily high tide. As an initial point of reference, determine the mid-point between the mean daily low tide and the mean daily high tide. Analyze the mid-point relative to potential impacts to fish habitat and impacts to existing community public water systems.

- Columbia River tide data was researched, reviewed, and analyzed relative to stream gradient for each of the identified basins. Recommendations were developed and presented to Fish and Wildlife for evaluation of habitat conditions in tidal reaches. Recommended locations along with other key points including cities or known well fields (i.e., Pioneer well fields) were developed in table format.
- The Planning Unit, including Ecology and Fish & Wildlife, reviewed the results of the research and formulated a basin-by-basin recommendation for the lower-most limit to protective rule language (See Table H-3).

On the East Fork Lewis River, Washougal River, and possibly the Kalama River, additional work may be done to determine whether a reach at the lower end of the closed area could be subject to less restrictive limitations, without compromising habitat quality. This concept will need further work during the implementation phase.

VI. Non-Reservation Water Right Applications

Issue**:** Over time in closed basins, Ecology will receive applications for water rights that cannot be met through sources that are not in connectivity with surface waters and the applicant is not eligible to access a reservation of water. In these cases, Ecology may grant a water right that is off-set by the retirement of an upstream active water right.

VII. Target Flows

Issue**:** The Planning Unit has consistently supported the notion of non-regulatory 'target flows' to help set goals for stream flow management actions. Target flows (goals) can be set either to protect existing conditions and/or to *enhance* current conditions.

Solution*:* Define target flows in a qualitative manner that reflects the value of protecting and enhancing flow conditions in selected watersheds. State that the target is to at a minimum maintain flows at the numerical levels described in the Plan for selected streams and to improve flows where feasible through a range of management techniques including management of land use as well as water use.

Table H-1
Recommended Restrictions on Issuance of New Water Rights WRIAs 27 and 28

Location	Restrictions on New Water Rights[1]	Water Supply Reservations	Notes
Kalama River Subbasin			
Kalama River mainstem	Closed to new water rights with exceptions as described in Policy SFP-2 and Core Issues document. In addition, minimum flows established as listed in Table H-4. Purpose of minimum flows is to guide decisions on transfers of existing rights.	City of Kalama General categories as part of overall Kalama River Subbasin reservations See Table H-2 for more information	High importance for fish recovery goals (Rated Tier 1 and 2 in LCFRB Recovery Plan documents)[2] City of Kalama water intake structure located in this reach at ~ RM 2.7 (below Modrow Bridge)
Tributaries to Kalama River	Same as mainstem	No specific communities. General categories as part of overall Kalama River Subbasin reservations See Table H-2 for more information	
All other tributaries to Columbia River[3]	No special restrictions in tidally influenced reaches. Above tidally influenced areas, subject to future closures based on case-by-case decisions. Location of tidal influence to be determined through case-by case determinations on future applications.	None	
North Fork Lewis River Subbasins			
Lewis River Mainstem tidal reach (mouth to RM 7.1)	No special restrictions. State Water Code applies.	Not applicable since this reach is not closed to new water rights	Water supply intake for Woodland may be in this reach
Tributaries to Lewis River tidal reach[3]	No special restrictions in tidally influenced reaches. Above tidally influenced areas, subject to future closures based on case-by-case decisions. Location of tidal influence to be determined through case-by case determinations on future applications.	General categories as part of overall Lewis River Subbasin reservations See Table H-2 for more information	
Lewis River mainstem from tidal reach to Merwin Dam	Closed to new water rights with exceptions as described in Policy SFP-2 and Core Issues document.	General categories as part of overall Lewis River Subbasin reservations See Table H-2 for more information	Flows in this reach are largely governed by reaches from hydroelectric facilities under FERC license conditions
Tributaries to Lewis River from tidal reach to Merwin Dam	Closed to new water rights with exceptions as described in Policy SFP-2 and Core Issues document.	General categories as part of overall Lewis River Subbasin reservations See Table H-2 for more information	

Table H-1 (cont.)
Recommended Restrictions on Issuance of New Water Rights WRIAs 27 and 28

Location	Restrictions on New Water Rights[1]	Water Supply Reservations	Notes
Horseshoe Lake	Closed to new water rights with exceptions as described in Policy SFP-2 and Core Issues document.	General categories as part of overall Lewis River Subbasin reservations See Table H-2 for more information	Existing administrative closure. See Table G-2 and Exhibit 4-1
Cedar Creek Chelatchie Creek Pup Creek	Closed to new water rights with exceptions as described in Policy SFP-2 and Core Issues document.	General categories as part of overall Lewis River Subbasin reservations See Table H-2 for more information	Existing administrative closure. See Table G-2 and Exhibit 4-1
Mainstem Lewis River and reservoirs from Merwin Dam to upstream of Swift Reservoir	No special restrictions. State water code applies	Not applicable since this reach is not closed to new water rights.	Flows in this reach are largely governed by reaches from hydroelectric facilities under FERC license conditions
Other tributaries to Lewis River and reservoirs	No special restrictions. State water code applies	Not applicable since this reach is not closed to new water rights.	
Mainstem Lewis River from upstream end of Swift Reservoir to headwaters and all tributaries	Closed to new water rights with exceptions as described in Policy SFP-2 and Core Issues document.	General categories as part of overall Lewis River Subbasin reservations See Table H-2 for more information	High importance for fish recovery goals (Rated Tier 1 and 2 in LCFRB Recovery Plan documents) [2]
Gee Creek and tributaries	Closed to new water rights with exceptions as described in Policy SFP-2 and Core Issues document	None	Existing administrative closure. See Table G-2 and Exhibit 4-1
All other tributaries to Columbia River	No special restrictions in tidally influenced reaches. Above tidally influenced areas, subject to future closures based on case-by-case decisions. Location of tidal influence to be determined through case-by case determinations on future applications.	None	

Table H-1 (cont.)
Recommended Restrictions on Issuance of New Water Rights WRIAs 27 and 28

Location	Restrictions on New Water Rights[1]	Water Supply Reservations	Notes
East Fork Lewis River Subbasin			
East Fork Lewis River mainstem	Closed to new water rights with exceptions as described in Policy SFP-2 and Core Issues document. In addition, minimum flows established as listed in Table H-4. Purpose of minimum flows is to guide decisions on transfers of existing rights and allocations during high-flow season.	Clark Public Utilities (Pioneer Wellfield) General categories as part of overall East Fork Lewis River Subbasin reservations See Table H-2 for more information	High importance for fish recovery goals (Rated Tier 1 and 2 in LCFRB Recovery Plan documents) [2] Existing administrative low flow by Ecology. See Table G-3 and Exhibit 4-1
Tributaries to East Fork Lewis River	Same as mainstem	No specific communities. General categories as part of overall East Fork River Subbasin reservations See Table H-2 for more information	High importance for fish recovery goals (Rated Tier 1 and 2 in LCFRB Recovery Plan documents) [2] Existing administrative low flow and closures by Ecology. See Table G-3 and Exhibit 4-1
All other tributaries to Columbia River[3]	No special restrictions in tidally influenced reaches. Above tidally influenced areas, subject to future closures based on case-by-case decisions. Location of tidal influence to be determined through case-by case determinations on future applications.		
Salmon Creek Subbasin			
Salmon Creek tidal reach and all tributaries to Salmon Creek tidal reach[3]	No special restrictions in tidally influenced reaches. Above tidally influenced areas, subject to future closures based on case-by-case decisions. Location of tidal influence to be determined through case-by case determinations on future applications.	Not applicable since this reach is not closed to new water rights.	
Salmon Creek and all tributaries to Salmon Creek upstream of tidal reach	Closed to new water rights with exceptions described in Policy SFP-2 and Core Issues document	City of Battle Ground General categories as part of overall Salmon Creek Subbasin reservations. See Table H-2 for more information.	Existing administrative closure by Ecology. See Table G-2 and Exhibit 4-2

Table H-1 (cont.)
Recommended Restrictions on Issuance of New Water Rights WRIAs 27 and 28

Location	Restrictions on New Water Rights(1)	Water Supply Reservations	Notes
Whipple Creek tidal reach and all tributaries to Whipple Creek tidal reach(3)	No special restrictions in tidally influenced reaches. Above tidally influenced areas, subject to future closures based on case-by-case decisions. Location of tidal influence to be determined through case-by case determinations on future applications.	Not applicable since this reach is not closed to new water rights.	
Whipple Creek and all tributaries to Whipple Creek upstream of tidal reach	Closed to new water rights with exceptions described in Policy SFP-2 and Core Issues document	City of Battle Ground General categories as part of overall Salmon Creek Subbasin reservations. See Table H-2 for more information.	Existing administrative closure by Ecology. See Table G-2 and Exhibit 4-2
All other tributaries to Columbia River(3)	No special restrictions in tidally influenced reaches. Above tidally influenced areas, subject to future closures based on case-by-case decisions. Location of tidal influence to be determined through case-by case determinations on future applications.	None	
Burnt Bridge Creek Subbasin			
Burnt Bridge Creek tidal reach and all tributaries to Burnt Bridge Creek tidal reach(3)	No special restrictions in tidally influenced reaches. Above tidally influenced areas, subject to future closures based on case-by-case decisions. Location of tidal influence to be determined through case-by case determinations on future applications.	Not applicable since this reach is not closed to new water rights.	
Burnt Bridge Creek and all tributaries to Burnt Bridge Creek upstream of tidal reach	Closed to new water rights with exceptions described in Policy SFP-2 and Core Issues document	General categories as part of overall Burnt Bridge Creek Subbasin reservations. See Table H-2 for more information.	Existing administrative closure by Ecology. See Table G-2 and Exhibit 4-2
Other waterbodies in the subbasin	No special restrictions		

Table H-1 (cont.)
Recommended Restrictions on Issuance of New Water Rights WRIAs 27 and 28

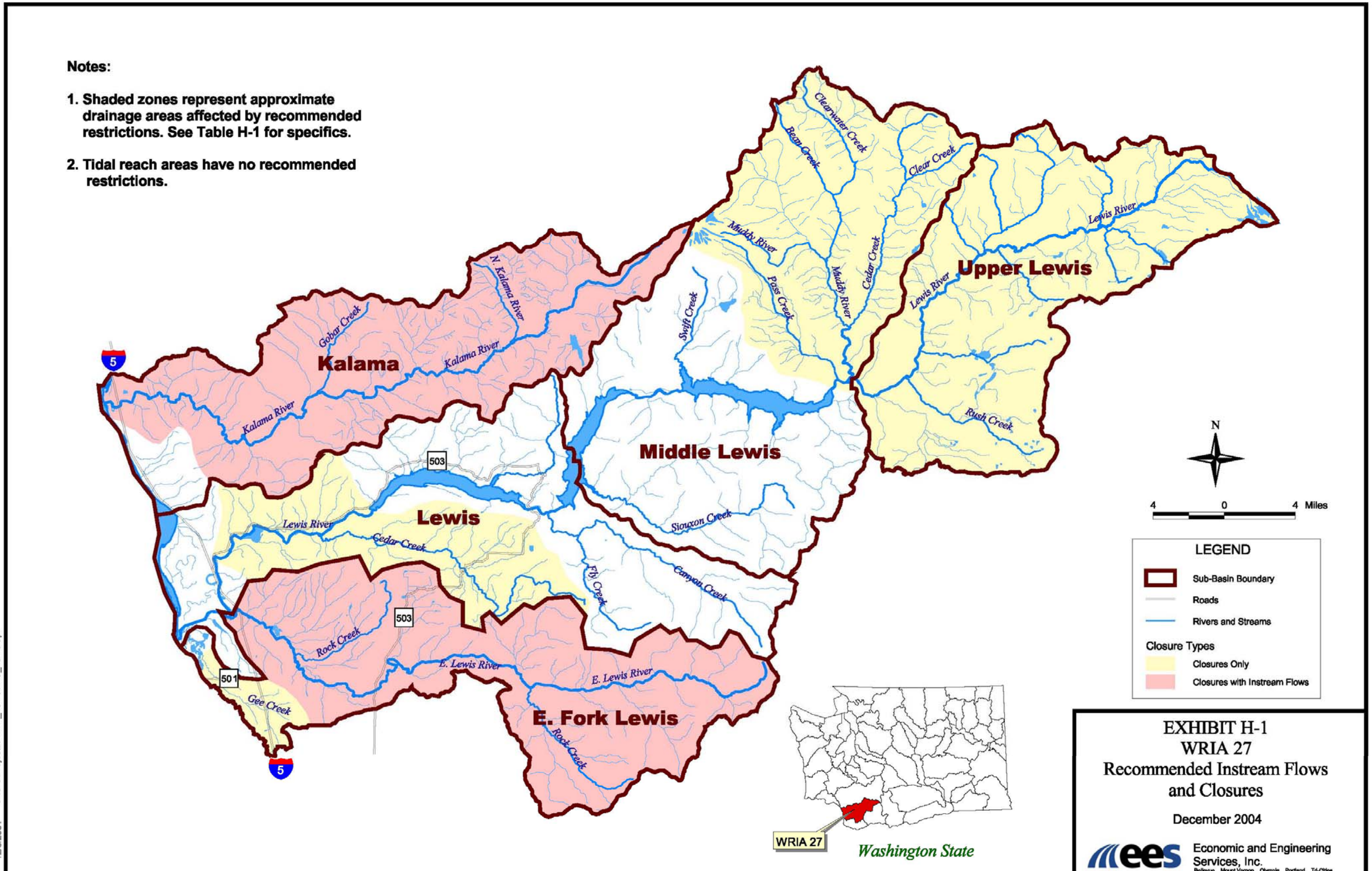
Location	Restrictions on New Water Rights[1]	Water Supply Reservations	Notes
Lacamas Creek Subbasin			
Lacamas Creek and all tributaries to Lacamas Creek	Closed to new water rights with exceptions described in Policy SFP-2 and Core Issues document	Camas and Clark Public Utilities General categories as part of overall Lacamas Creek Subbasin reservations. See Table H-2 for more information.	Existing administrative low flows and closures by Ecology. See Table G-7 and Exhibit 4-2
Washougal River Subbasin			
Washougal River mainstem	Closed to new water rights with exceptions as described in Policy SFP-2 and Core Issues document. In addition, minimum flows established as listed in Table H-4. Purpose of minimum flows is to guide decisions on transfers of existing rights and allocations during the high-flow season.	City of Washougal, City of Camas General categories as part of overall Washougal River Subbasin reservations See Table H-2 for more information	High importance for fish recovery goals (Rated Tier 1 and 2 in LCFRB Recovery Plan documents)[2]
Tributaries to Washougal River	Same as mainstem		City of Camas intakes on Jones and Boulder Creeks (existing rights not affected)
Columbia River Tributaries Subbasin			
Columbia River tributaries tidal reaches and their tributaries' tidal reaches[3]	No special restrictions. State water code applies. No special restrictions in tidally influenced reaches. Above tidally influenced areas, subject to future closures based on case-by-case decisions. Location of tidal influence to be determined through case-by case determinations on future applications.	Not applicable since this reach is not closed to new water rights	No major public water supplies in this reach.
Columbia River tributaries and their tributaries above tidal reach	Closed to new water rights with exceptions as described in Policy SFP-2 and Core Issues document.	General categories as part of overall Columbia River tributaries Subbasin reservations See Table H-2 for more information	High importance for fish recovery goals (Rated Tier 1 and 2 in LCFRB Recovery Plan documents)[2] Existing administrative closures by Ecology on Gibbons Creek, Lawton Creek, and Spring Creek

RM=River Mile

(1) Restrictions would not apply to existing water rights, new individual domestic wells, or selected additional uses as described in the watershed management plan.

(2) LCFRB's 2004 Interim Habitat Strategy ranks streams reaches throughout the region in four "Tiers". Tiers are based on a combination of a.) priority of each fish population for restoration and b.) potential for preservation or restoration or stream reaches. For purposes of the table above, it is assumed that all Tier 1 and Tier 2 reaches should have restrictions on issuance of new rights.

(3) It is expected that the stream reach downstream of the tidal influence location (TBD) would be open to appropriation with no restrictions. This location may be a very short reach of stream upstream of the mouth. These locations would be determined on a case-by-case basis as future water right applications are filed on these streams


Notes:
1. Shaded zones represent approximate drainage areas affected by recommended restrictions. See Table H-1 for specifics.
2. Tidal reach areas have no recommended restrictions.
Kalama
Lewis
Middle Lewis
Upper Lewis
E. Fork Lewis
Kalama River
N. Kalama River
Gobar Creek
Lewis River
Cedar Creek
Rock Creek
E. Lewis River
Gee Creek
Fly Creek
Canyon Creek
Siouxon Creek
Swift Creek
Muddy River
Pass Creek
Cedar Creek
Clearwater Creek
Bean Creek
Clear Creek
Rush Creek
5
503
501
N
4 0 4 Miles
LEGEND
Sub-Basin Boundary
Roads
Rivers and Streams
Closure Types
Closures Only
Closures with Instream Flows
WRIA 27
Washington State
EXHIBIT H-1
WRIA 27
Recommended Instream Flows and Closures
December 2004
ees
Economic and Engineering Services, Inc.
12/6/2004 C:\GIS\Projects\WRIA_25-28\wria_25-28.apr

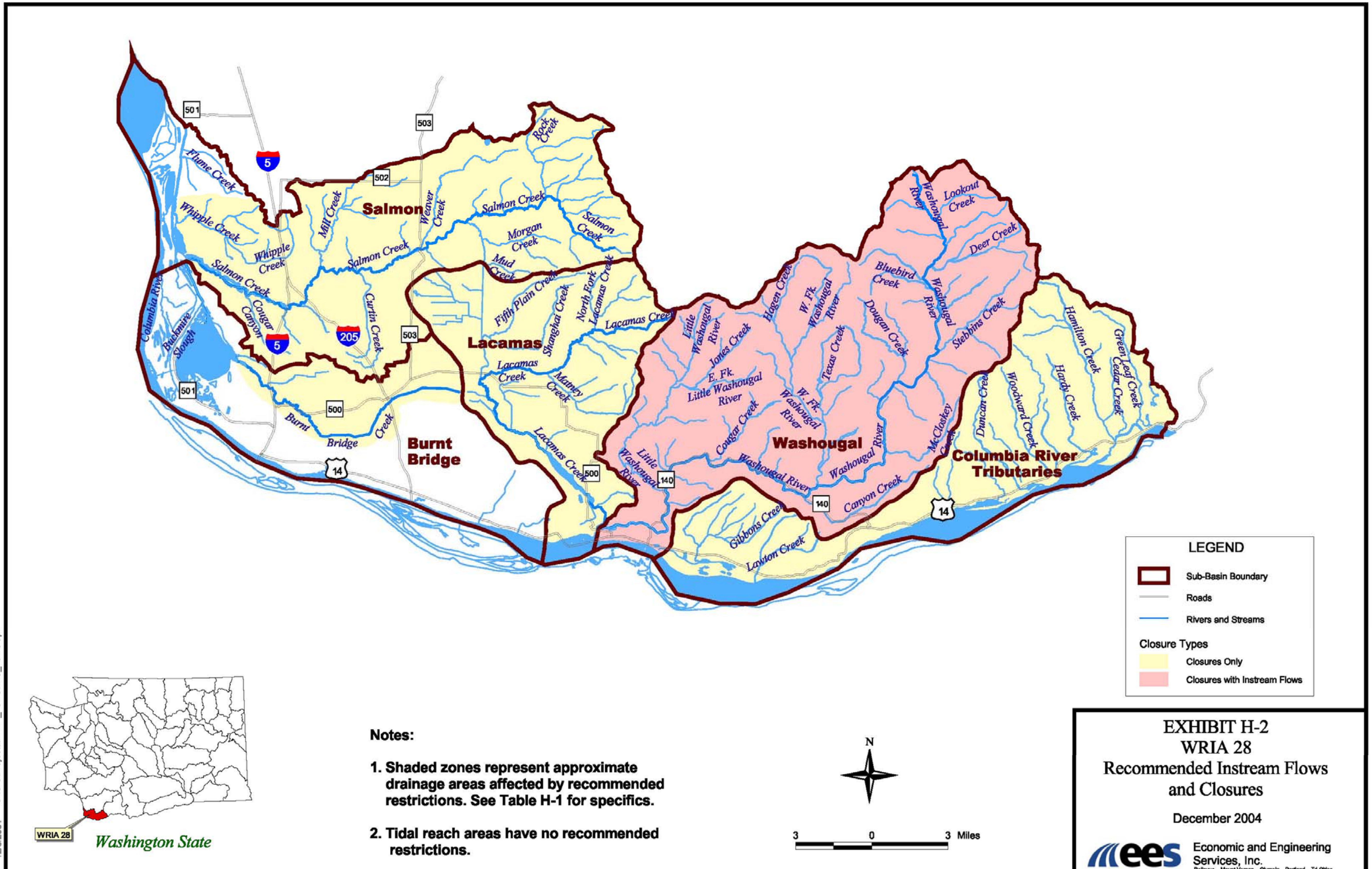


EXHIBIT H-2
WRIA 28
Recommended Instream Flows and Closures
December 2004
Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities
LEGEND
Sub-Basin Boundary
Roads
Rivers and Streams
Closure Types
Closures Only
Closures with Instream Flows
Notes:
1. Shaded zones represent approximate drainage areas affected by recommended restrictions. See Table H-1 for specifics.
2. Tidal reach areas have no recommended restrictions.
N
3 0 3 Miles
Washington State
WRIA 28
12/6/2004 C:\GIS\Projects\WRIA_25-28\wria_25-28.apr
Salmon
Lacamas
Burnt Bridge
Washougal
Columbia River Tributaries
Flume Creek
Whipple Creek
Salmon Creek
Cougar Canyon
Columbia River
Buckmire Slough
Mill Creek
Weaver Creek
Curtin Creek
Morgan Creek
Mud Creek
Rock Creek
Fifth Plain Creek
Shanghai Creek
North Fork Lacamas Creek
Lacamas Creek
Matney Creek
Burnt Bridge Creek
Little Washougal River
Jones Creek
E. Fk. Little Washougal River
Hagen Creek
W. Fk. Washougal River
Texas Creek
Cougar Creek
Washougal River
Bluebird Creek
Dougan Creek
Lookout Creek
Deer Creek
Stebbins Creek
McCloskey Creek
Canyon Creek
Gibbons Creek
Lawton Creek
Duncan Creek
Woodward Creek
Hardy Creek
Hamilton Creek
Green Leaf Creek
Cedar Creek
501
502
503
500
140
14
5
205

Table H-2
Water Right Reservation Summary for WRIAs 27/28

Water User [1]	Net Stream flow Depletion Allowance After Mitigation (cfs) [2]
Kalama River Subbasin [5]	
Kalama	1.92
Small Systems and Domestic Wells	0.35
Subbasin Total	**2.26**
North Fork Lewis Subbasin	
Cowlitz County Portion	
Small Systems and Domestic Wells	0.26
Clark County Portion	
Small Systems and Domestic Wells	0.49
Skamania County Portion	
Domestic Wells	0.40
Small Systems	0.40
Commercial	0.21 [6]
Subbasin Total	**1.76**
East Fork Lewis Subbasin [5]	
Clark County Portion	
CPU, Battle Ground, and Ridgefield [4]	2.20
Small Systems and Domestic Wells	0.66
Skamania County Portion	
Small Systems and Domestic Wells	0.00
Subbasin Total	**2.85**
Salmon Creek Subbasin	
CPU, Battle Ground, and Ridgefield [4]	0.13
Small Systems and Domestic Wells	0.12
Subbasin Total	**0.24**
Burnt Bridge Creek Subbasin	
Vancouver	0.02
Small Systems and Domestic Wells	0.00
Subbasin Total	**0.02**
Lacamas Creek Subbasin	
Camas	0.50
CPU	0.30
Small Systems and Domestic Wells	0.36
Subbasin Total	**1.16**
Washougal River Subbasin [5]	
Clark County Portion	
Washougal	0.00 [3]
Small Systems and Domestic Wells	0.36
Skamania County Portion	
Small Systems and Domestic Wells	0.74 [7]
Subbasin Total	**1.10**
Columbia River Tributaries Subbasin	
Clark County Portion	
Small Systems and Domestic Wells	0.22
Skamania County Portion	
Small Systems and Domestic Wells	0.22
Subbasin Total	**0.44**

Notes:

(1) Categories of water users include:
Large Public Water Systems, which are listed individually.
Small Systems, which refers to Public Water Systems not listed individually and required to apply for a water rights permit.
Domestic Wells, including those serving multiple homes but exempt from the requirement to apply for a water right permit.
Other Beneficial Uses, such as self-supplied industrial uses.

(2) Calculated based upon an estimate of additional water rights needed to meet water demands through 2020. Incorporates the effects of offsetting and mitigation activities. The allowance applies only to mainstem flows; it is not intended to allow for extensive dewatering of smaller water bodies.

(3) Current water rights are sufficient to meet needs through year 2020. Therefore no reservation is established.

(4) Wells serving CPU, Battle Ground, and Ridgefield may draw partly from the East Fork Lewis River Subbasin and partly from the Salmon Creek Subbasin. Therefore, the stream flow depletion is split between these subbasins, based on information provided by CPU.

(5) In the lower reaches of this subbasin, there may be opportunity to increase reservation amounts, pending further study to refine understanding of flow impacts.

(6) Withdrawal impacts shall be limited to the mainstem North Fork Lewis River above Swift Reservoir only.

(7) During future plan review, the size of this reservation will be reconsidered in light of Skamania County's request for 1.15 cfs needed to accommodate approximately 3109 homes.

Table H-2a
Water Right Reservation Calculations for WRIAs 27/28

	Anticipated Needs [1]			Stream flow Depletion Without Mitigation (cfs) [3]	Offset/ Mitigation Requirement (cfs) [4]	Net Stream flow Depletion After Mitigation (cfs) [5]
	No. of "Blocks" [2]	Qa (afy)	Qi (cfs)			
***Kalama River Subbasin*[9]**						
Kalama	NA	290	3.83	1.92	0.00	**1.92**
Small Community Water Systems - Cowlitz Co.	1	100	0.37	0.37	0.19	**0.19**
Domestic Wells - Cowlitz Co.	NA	141	0.52	0.16	0.00	**0.16**
Subbasin Total						**2.26**
North Fork Lewis River Subbasin						
Small Community Water Systems - Cowlitz Co.	1	100	0.37	0.37	0.19	**0.19**
Small Community Water Systems - Clark Co.	2	200	0.75	0.75	0.37	**0.37**
Small Community Water Systems - Skamania Co.[10]	NA	NA	NA	0.40	0.00	**0.40**
Domestic Wells - Cowlitz Co.	NA	61	0.22	0.07	0.00	**0.07**
Domestic Wells - Clark Co.	NA	105	0.39	0.12	0.00	**0.12**
Domestic Wells - Skamania Co. [10]	NA	NA	NA	0.40	0.00	**0.40**
Commercial - Skamania County[10] [12]	NA	NA	NA	0.21	0.00	**0.21**
Ridgefield	(Not applicable, due to location in tidally influenced area. [8]					
Subbasin Total						**1.76**
***East Fork Lewis River Subbasin*[9]**						
CPU, Battle Ground and Ridgefield[6]	NA	5,000	15.00	4.40	2.20	**2.20**
Small Community Water Systems - Clark Co.	1	100	0.37	0.37	0.19	**0.19**
Small Community Water Systems - Skamania Co.	0	0	0.00	0.00	0.00	**0.00**
Domestic Wells - Clark Co.	NA	421	1.55	0.47	0.00	**0.47**
Domestic Wells - Skamania Co.	NA	15	0.05	0.02	0.00	**TBD**
Subbasin Total						**2.85**
Salmon Creek Subbasin						
CPU, Battle Ground and Ridgefield[6]	NA	1,050	2.45	0.25	0.13	**0.13**
Small Community Water Systems - Clark Co.	0	0	0.00	0.00	0.00	**0.00**
Domestic Wells - Clark Co.	NA	105	0.39	0.12	0.00	**0.12**
Subbasin Total						**0.24**

Table H-2a (cont.)
Water Right Reservation Calculations for WRIAs 27/28

	Anticipated Needs [1]			Stream flow Depletion Without Mitigation (cfs) [3]	Offset/ Mitigation Requirement (cfs) [4]	Net Stream flow Depletion After Mitigation (cfs) [5]
	No. of "Blocks" [2]	Qa (afy)	Qi (cfs)			
Burnt Bridge Creek Subbasin						
Vancouver						**0.02**
Small Community Water Systems - Clark Co.	0	0	0.00	0.00	0.00	**0.00**
Domestic Wells - Clark Co.	NA	NA	NA	0.00	0.00	**0.00**
Subbasin Total						**0.02**
Lacamas Creek Subbasin						
Camas[7]	NA	3,240	6.01	1.00	0.50	**0.50**
Clark Public Utilities (CPU)	NA	1,973	3.63	0.60	0.30	**0.30**
Small Community Water Systems - Clark Co.	1	100	0.37	0.37	0.19	**0.19**
Domestic Wells - Clark Co.	NA	158	0.58	0.17	0.00	**0.17**
Subbasin Total						**1.16**
***Washougal River Subbasin*[9]**						
Washougal	NA	0	0.00	0.00	0.00	**0.00**
Small Community Water Systems - Clark Co.	1	100	0.37	0.37	0.19	**0.19**
Small Community Water Systems - Skamania Co.[10][11]	NA	NA	NA	0.20	0.10	**0.10**
Domestic Wells - Clark Co.	NA	158	0.58	0.17	0.00	**0.17**
Domestic Wells - Skamania Co. [10][11]	NA	NA	NA	0.64	0.00	**0.64**
Subbasin Total						**1.10**
Columbia River Tributaries Subbasin						
Small Community Water Systems - Clark Co.	0.55	55	0.21	0.21	0.10	**0.10**
Small Community Water Systems - Skamania Co.	0.55	55	0.21	0.21	0.10	**0.10**
Domestic Wells - Clark Co.	NA	105	0.39	0.12	0.00	**0.12**
Domestic Wells - Skamania Co.	NA	25	0.08	0.12	0.00	**0.12**
Subbasin Total						**0.44**

Notes:
Qa = Annual Allotment; Qi = Instantaneous Quantity; afy = acre-feet per year; cfs = cubic feet per second; NA = Not Applicable

(1) Anticipated needs are calculated in the following ways for three different types of water users: Large Public Water Systems - Needs are based upon deficiencies in existing water rights to meet water demand growth projected to 2020 (except Kalama - 50 year need was used).
Small Community Water Systems - Needs are noted in terms of "blocks" of water. The number of blocks assigned to each subbasin is based upon the general likelihood of future water demand growth by these types of consumers in that area (e.g., there will likely be more such growth in the Washougal River Subbasin than in the Burnt Bridge Creek Subbasin, due to the ability of larger purveyors to meet future needs in the latter.)
Domestic Wells - Needs are based upon estimated growth in the number of domestic wells by 2020.

(2) "1 ""block"" = 100 afy water right on a Qa basis (or approx. 90,000 gallons per day on an average day basis)
= 0.37 cfs water right, on a Qi basis (assuming a maximum day:average day peaking factor of 2.0, and an instantaneous:maximum day peaking factor of 1.33)"

(3) The Stream flow Depletion without Mitigation refers to the total amount of stream flow reduction that would occur within the subbasin as a result of pumping or diversion, if there were no mitigation offset. In some cases, this quantity is equal to the anticipated need (Qi). In other cases, this quantity is lower, recognizing that a portion or all of the need may be met using groundwater supplies. In these cases, the impacts to streams may be lower than the amount of water withdrawn from the aquifer. For domestic wells, the depletion amount is calculated as 30% of the anticipated need, taking into account that an estimated 70% of water pumped from such wells is returned to stream flows via septic system returns.

(4) Refers to the requirement of water users to offset 50 percent of their future water uses that are guaranteed within the context of this reservation. Does not apply to Domestic Wells.

(5) Calculated as the Stream flow Depletion minus the Offset/Mitigation Requirement. This allowance applies only to impacts upon mainstem flows; it is not intended to allow for extensive dewatering of smaller water bodies. Water right applicants must provide further evidence regarding potential impacts to smaller tributary creeks resulting from new or expanded water resource development. Allowances are to be considered available only for the category to which they are assigned. However, every 10 years, Ecology and local parties should review the status and use of the allowances and may shift allowance quantities between categories to better address needs, so long as the subbasin total allowance does not change.

(6) Wells serving CPU, Battle Ground and Ridgefield may draw partly from the East Fork Lewis River Subbasin, and partly from the Salmon Creek Subbasin. Therefore the stream flow depletion is split between these subbasins, based on information provided by CPU.

(7) The majority of the City of Camas is located within the Lacamas Creek Subbasin, though portions are also located within the Burnt Bridge Creek and Washougal River Subbasins. The City's water sources are located within both the Lacamas Creek and Washougal River Subbasins. Therefore, the stream flow depletion for Camas applies to both subbasins (i.e., total stream flows in both subbasins collectively are not to be reduced by more than the amount indicated for the City).

(8) Not applicable, due to location in tidally influenced area.

(9) In the lower reaches of this subbasin, there may be opportunity to increase reservation amounts, pending further study to refine understanding of flow impacts.

(10) Revised water demand projections were determined during the 2005/2006 watershed plan remand process based on projected build-out in relation to current minimum lot sizes and anticipated growth needs, and are not reflected in previous assessments and growth projections.

(11) During future plan review, the size of this reservation will be reconsidered in light of Skamania County’s request for 1.15 cfs needed to accommodate approximately 3109 homes.

(12) Withdrawal impacts shall be limited to the mainstem North Fork Lewis River above Swift Reservoir only.

Table H-2b
WRIAs 27/28
Analysis of Projected Water Demands and Water Rights to 2020

Community	Existing Water Rights (1)		Water Demands				Additional Water Rights Needed to Support 2020 Demands		
			Year 2000 (2)		Year 2020 (2)				
	Qa	Qi	Annual	Max Inst. (3)	Annual	Max Inst. (3)	Qa		Qi (6)
	(afy)	(cfs)	(afy)	(cfs)	(afy)	(cfs)	(afy)(4)	(cfs)(5)	(cfs)
Kalama	2,284	4.96	881	3.00	1,647	5.62	0	0.00	0.67
Battle Ground	3,119	6.68	1,244	4.30	3,901	13.47	782	1.08	6.79
Ridgefield	681	3.67	594	2.19	4,151	15.31	3,470	4.80	11.64
Clark Public Utilities - Salmon Creek Area (7)	NA	NA	NA	NA	NA	NA	1,050	1.45	2.45
Clark Public Utilities - Pioneer Area (7)	NA	NA	NA	NA	NA	NA	5,000	6.91	15.00
Clark Public Utilities - Upper Lacamas Creek Area (7)	NA	NA	NA	NA	NA	NA	1,973	2.73	3.63
Camas	6,300	23.49	4,013	15.50	9,540	29.49	3,240	4.48	6.01
Washougal	3,786	17.48	1,759	6.57	3,139	12.32	0	0.00	0.00

Notes:
(1) From Watershed Plan, Appendix E (April 2004). Includes quantities associated only with water right certificates and permits, except for Camas, which also includes quantities associated with claims.
(2) From Watershed Plan, Table 3-1 (April 2004).
(3) Maximum Instantaneous Demand calculated as Maximum Day Demand (in mgd) X 1.55 (to convert to cfs) X 24/18 (assuming source pump(s) and/or diversion(s) operate 18 hours a day).
(4) Calculated as 2020 Annual Demand (afy) - Qa (afy).
(5) The result of the above calculation converted to cfs.
(6) Calculated as 2020 Max Inst Demand (cfs) - Qi (cfs).
(7) Based on filed water right application information.

Table H-2c
WRIAs 27/28
Analysis of Projected Water Demands for Domestic Wells to 2020

Subbasin [1]	Year 2000 [2]			Year 2020 [2]			Increases from 2000 to 2020 [3]				
	Population	ADD [6] (mgd)	MDD [7] (mgd)	Population	ADD [6] (mgd)	MDD [7] (mgd)	Population	ADD [6] (mgd)	Qa [4] (afy)	MDD [7] (mgd)	Qi [5] (cfs)
Kalama River (Cowlitz Co)	3,618	0.36	0.72	4,873	0.49	0.97	1,255	0.13	141	0.25	0.52
North Fork Lewis River (Cowlitz Co)	1,550	0.16	0.31	2,088	0.21	0.42	538	0.05	61	0.11	0.22
North Fork Lewis River (Clark Co)	2,716	0.27	0.54	3,657	0.37	0.73	942	0.09	105	0.19	0.39
North Fork Lewis River (Skamania Co)[9]	144	0.01	0.03	NA	NA	NA	NA	NA	NA	NA	NA
East Fork Lewis River (Clark Co)	10,862	1.09	2.17	14,630	1.46	2.92	3,768	0.38	421	0.75	1.55
East Fork Lewis River (Skamania Co)	217	0.02	0.04	340	0.03	0.07	123	0.01	15	0.02	0.05
Salmon Creek (Clark Co)	2,716	0.27	0.54	3,657	0.37	0.73	942	0.09	105	0.19	0.39
Burnt Bridge Creek (Clark Co) [8]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lacamas Creek (Clark Co)	4,073	0.41	0.81	5,486	0.55	1.10	1,413	0.14	158	0.28	0.58
Washougal River (Clark Co)	4,073	0.41	0.81	5,486	0.55	1.10	1,413	0.14	158	0.28	0.58
Washougal River (Skamania Co)[9]	722	0.07	0.15	NA	NA	NA	NA	NA	NA	NA	NA
Columbia River Trib. (Clark Co)	2,716	0.27	0.54	3,657	0.37	0.73	942	0.09	105	0.19	0.39
Columbia River Trib. (Skamania Co)	361	0.04	0.07	567	0.06	0.11	206	0.02	25	0.04	0.08

Notes:

ADD = Average Day Demand; MDD - Maximum Day Demand; mgd = million gallons per day; afy = acre-feet per year; cfs = cubic feet per second; NA = Not Applicable

(1) The following assumptions regarding numbers of domestic wells are used in this analysis:

Cowlitz County - 70% of domestic wells are in Kalama River Subbasin; 30% are in North Fork Lewis River Subbasin

Clark County - 40% of domestic wells are in East Fork Lewis River Subbasin; 15% are in Lacamas Creek Subbasin; 15% are in Washougal River Subbasin; 10% are in North Fork Lewis River Subbasin; 10% are in Salmon Creek Subbasin; 10% are in Columbia River Trib.

Skamania County - 50% of domestic wells are in Washougal River Subbasin; 25% are in Columbia River Trib.; 15% are in East Fork Lewis River Subbasin; 10% are in North Fork Lewis River Subbasin (Note: This considers only those domestic wells located in the portions of the counties that are within WRIAs 27/28.)

(2) From Watershed Plan, Table 3-1. County-wide numbers apportioned to subbasins according to the assumptions under Note 1.

(3) Year 2020 value minus Year 2000 value.

(4) Qa (Annual Allotment) = ADD *1,121 (conversion from mgd to afy)

(5) Qi (Instantaneous Quantity) = MDD (in mgd) X 1.55 (to convert to cfs) X 24/18 (assuming source pump(s) and/or diversion(s) operate 18 hours a day).

(6) ADD is based on a water-use factor of 100 gallons per day per person, based on Clark Public Utilities data.

(7) MDD is based on a MDD:ADD ratio of 2:1.

(8) It is assumed that there will be no increase in domestic wells in the Burnt Bridge Creek Subbasin. Future water needs will be met by public water systems (e.g., Clark Public Utilities and Vancouver).

(9) Revised water demand projections were determined during the 2005/2006 watershed plan remand process based on projected build-out in relation to current minimum lot sizes and anticipated growth demands, and are not reflected in previous assessments and growth projections.

Rationale for WDFW-WDOE recommendations for flow reserves in WRIAs 25-28
Hal Beecher, WDFW
4 October 2004

WDFW and Ecology have worked to identify and protect instream flows to protect instream resources, including fish. For streams where we had IFIM/PHABSIM study results, we used those results for recommending instream flows. In other streams we used the toe-of-bank width ("toe-width") method.

If we had hydrological information, we used that to keep our recommendations consistent with hydrology, particularly during low flow in late summer and early fall (salmon and steelhead juvenile rearing and Chinook salmon spawning). We limit our instream flow recommendations to flows that are hydrologically realistic – they occur frequently enough (every few generations) for long enough (roughly a week) that they would have real benefit to the long-term survival of a population of fish. Thus we would expect these flows, though higher than normal, to benefit fish populations when the flows occur.

Late summer – early fall low flows limit fish habitat - Our concerns with the ceiling on our instream flow recommendations during low flow emphasize the importance of low flows as a limiting factor for fish. For both coho salmon and steelhead we have evidence that more flow during summer low flow results in better production of these fish. Conversely, less flow results in less production. Further reduction of flow in late summer and early fall can be expected to adversely impact production of these fish.

The magnitude of impact of flow reduction on fish is best estimated using the method used to recommend instream flows. In the case of IFIM/PHABSIM, the model produces an index, weighted usable area (WUA), for habitat at each flow of interest. The toe-width method does not produce an index for assessing habitat loss with flow. For sites with IFIM/PHABSIM studies, we can interpolate changes of WUA with change in flow and compare it to rates of change of flow; the two are similar in the range of flows occurring during the driest years at the dry season (late summer-early fall).

During late summer-early fall, we recommend instream flows to protect the full natural potential for fish habitat. This results in recommending flows that preclude additional out-of-stream water appropriation (new water rights) – i.e., closure.

Flow reserves – We recognize that protecting fish habitat through instream flows and closures may involve some compromise; flow reserves are such a compromise. How much water can be exempt from instream flows while still fulfilling the purpose of instream flows?

We considered the case of driest streams at the low flow season, the time when flows are the greatest stressor for fish. At such a season, it is difficult to say that any flow reduction is acceptable, but we evaluated several habitat or flow reductions. Habitat reductions of 50%, 25%, 10%, and 5% were considered too extreme under already severe conditions. Reductions of 1-2% were considered tolerable, although it does represent a real loss of fish, including ESA-listed species, and is only tolerable if additional flow protection (adoption and implementation of instream flows and closures) goes with it.

To determine an acceptable flow reserve, we determined flows that equate to 1-2% reductions in WUA for juvenile steelhead and Chinook salmon spawning at the 90% exceedence flows in September-October. Thus we are looking at the very dry conditions (9 out of 10 are as wet or wetter for that date) at the driest season. For fish (or any other water user) this is the most stressful condition. Because some streams did not have WUA (i.e., no IFIM/PHABSIM studies), we considered how flow might be used as a surrogate for the habitat index (WUA). At several study sites the relationship between WUA and flow was nearly linear, so we used flow as a surrogate for habitat where no IFIM/PHABSIM study was conducted; we used a 1-2% reduction in flow from the 90% exceedence flow at the low flow season as the reserve recommendation.

In small streams, we recommended no reserve. These small streams are too sensitive to flow reduction.

Summary – For late summer instream flow recommendations we focus on the wettest conditions to allow fish to benefit from relatively wetter conditions when they occur. For flow reserves, we focus on the driest late summer flows to assess worst-case (for fish) habitat impacts of exempting withdrawals from instream flows and closures.

Recommended flow reserves – The following table is excerpted and annotated from Steve Manlow's September 23 memo.

WRIA 25/26

Stream	Flow equating to 2% loss	Flow equating to 1% loss	Recommendation for flow reserve
Gray's River (RM 11)	1.0 cfs	0.5 cfs	0.5 cfs = 1% of 90% exceedence flow
Elochoman River (RM 4.5)	0.5 cfs	0.25 cfs	0.25 cfs = 1% of 90% exceedence flow
Skamakowa, Abernathy, Germany, Mill, & Coal creeks		< 0.05 cfs	0.0 cfs – these streams are too small to be subjected to additional withdrawal – NO RESERVE
Cowlitz River at Randle (RM 102.9)	11.2 cfs	5.6 cfs	5.6 cfs = 1% of 90% exceedence flow
Cispus River near Randle (RM 15.8)	6.4 cfs	3.2 cfs	3.2 cfs = 1% of 90% exceedence flow
Tilton River (RM 7.1)	1.3 cfs	0.6 cfs	0.6 cfs = 1% of 90% exceedence flow
Cowlitz River at Mayfield Dam (RM 50.6)	40.0 cfs (includes 11.2 from upper Cowlitz, Cispus, and Tilton, above)	20.0 cfs (includes 5.6 from upper Cowlitz, Cispus, and Tilton, above)	20.0 cfs = 1% of expected low flow under FERC license
Toutle River (RM 6.5)	5.8 cfs	2.9 cfs	2.9 cfs = 1% of 90% exceedence flow
Lower Cowlitz River at Castle Rock (RM 71.3)	45.8 cfs (includes 40 cfs from upstream on Cowlitz and from Toutle)	22.9 cfs (includes 20 cfs from upstream on Cowlitz and from Toutle)	22.9 cfs = 1% of 90% exceedence flow
Coweeman River (RM 7.0)	0.6 cfs	0.3 cfs	0.3 cfs = 1% of 90% exceedence flow

WRIA 27/28

Stream	Flow equating to 2% loss	Flow equating to 1% loss	Recommendation
Kalama River (RM 4.3-5.2)* **PHABSIM**	7.2 cfs for steelhead juveniles at 200 cfs 7.8 cfs for Chinook spawning at 200 cfs	3.6 cfs for steelhead juveniles at 200 cfs 3.9 cfs for Chinook spawning at 200 cfs	3.6 cfs
North Fork Lewis River at Ariel (RM 19.5)	24.0 cfs	12.0 cfs	12.0 cfs = 1% of expected lowest flow (subject to revision pending outcome of relicensing)
East Fork Lewis River (RM 10.8)* **PHABSIM**	1.4 cfs for steelhead juveniles at 40 cfs 0.6cfs for Chinook spawning at 40 cfs	0.7 cfs for juvenile steehead rearing at 40 cfs 0.3 cfs for Chinook spawning at 40 cfs	0.6 cfs
Salmon, Burnt Bridge, and LaCamas Creeks		< 0.02 cfs	0.0 cfs – these streams are too small and too heavily impacted to be subjected to additional withdrawal – NO RESERVE
Washougal River (RM 3.5)* **PHABSIM**	1.1 cfs for steelhead juveniles at 60 cfs 0.57 cfs for Chinook spawning at 60 cfs	0.55 cfs for steelhead juveniles at 60 cfs 0.28 cfs for Chinook spawning at 60 cfs	0.6 cfs
Columbia River Tributaries			0.0 cfs - these streams are too small to be subjected to additional withdrawal – NO RESERVE

Table H-3
Tidal Influence Locations to Establish Downstream Limit for Restrictions on New Water Rights

River	Tidal Influence Location	Major Public Water Supplier Location	Rationale
WRIA 27			
Kalama	Mouth (RM 0.0)	Kalama water intake structure downstream of Modrow Road bridge (~RM 2.7)	Available adult holding pools near I-5 are reduced substantially with changes in tide and river flow; habitat availability and access in sloughs and side channels downstream to mouth is reduced with tidal and river fluctuations; existing fish passage problems exist during low-flow/low tide conditions at river mouth, resulting in adult and juvenile stranding.
North Fork Lewis	Just upstream of City of Woodland existing water intake structure (RM 7.1)	Woodland water intake structure in floodwall vicinity (~RM 7)	Mainstem spawning habitat occurs upstream of this point, with only occasional documentation below this point; available rearing habitat is not noticeably reduced with changing tidal elevations below this point because of channel shape, flow volume, and confinement; no known passage problems.
East Fork Lewis	Mouth (RM 0.0)	***Surface Water*** No major public water supplies from East Fork. ***Groundwater*** Pioneer wells south of East Fork between RM 3 and RM 8	Tidal influence zone is extensive (up to Mason Creek), but withdrawals would have localized effects because of stream depth, low gradient, channel characteristics, and distance from the North Fork Lewis River; during low flow/low tide conditions, wetted channel width is significantly reduced (by approximately one half to two-thirds)near I-5; rearing habitat availability in sloughs, side channels, and associated wetlands would be reduced with withdrawals; summer temperature problems (70 degrees F below Mason Creek) in tidally influenced zone would be exacerbated with reduced flow conditions.
WRIA 28			
Washougal	Mouth (RM 0.0)	***Surface Water*** No major public water supplies from lower Washougal. ***Groundwater*** Numerous wells owned by Washougal, Camas and CPU in vicinity of lower Washougal	Fish passage problems are well documented during low flow/low tide conditions; south Island channel just upstream of RM 0.1 is dewatered during low flow/low tide, and flows in north Island channel are insufficient for adult passage; available adult holding pools on lower river are reduced substantially with changes in tide and river flows; habitat availability and access in sloughs and side channels is reduced with tidal and river fluctuations; summer temperature problems (above 70 degrees F) in tidally influenced zone would be exacerbated with reduced flow conditions.

Table H-4
Proposed Instream Flows for WRIAs 27 and 28

Stream Reach	Proposed Instream Flows (cfs)[1]		Control Station
Kalama River	Oct 1-Dec 31	1,050	Control Station for proposed instream flows to be located at about RM 4, with exact point to be determined
Mainstem mouth to headwaters and all tributaries in this reach	Jan 1 - May 31	950	
	Jun 1-Jun 30	900	
	Jul 1-Jul 31	616	
	Aug 1-Aug 15	434	
	Aug 16-Aug 31	400	
	Sep 1-30	589	
North Fork Lewis River[2]	Oct 1 – Oct 15	1200	Control Station is the USGS gauge (#14220500), at RM 19.
Mainstem mouth to Merwin Dam at Ariel	Oct 16 – Oct 31	2500	
	Nov 1 – Dec 15	4200	
	Dec 16 – Mar 1	2000	
	Mar 2 – Mar 15	2200	
	Mar 16 – Mar 30	2500	
	Mar 31 – Jun 30	2700	
	Jul 1 – Jul 10	2300	
	Jul 11 – Jul 20	1900	
	Jul 21 – Jul 30	1500	
	Jul 31 – Sept 30	1200	
East Fork Lewis River	Oct 1- Dec 31	500	Control Station for proposed instream flows to be located near Daybreak Park at about RM 11, with exact point to be determined
Mainstem RM X to headwaters and all tributaries in this reach.	Jan 1–Feb 28	500	
	Mar 1-May 31	460	
	Jun 1-Jun 30	420	
	Jul 1-Jul 31	233	
	Aug 1-31	122	
	Sep 1-Sep 15	175	
	Sep 16-30	295	
Washougal River	Oct 1-Dec 31	425	Control Station for proposed instream flows to be located at Hathaway Park at IFIM Site (about RM 3.5)
Mainstem mouth to headwaters and all tributaries in this reach	Jan 1 -Feb 28	425	
	Mar 1-May 31	375	
	Jun 1-Jun 30	525	
	Jul 1-Jul 31	240	
	Aug 1-31	168	
	Sep 1-Sep 15	264	
	Sep 16-30	425	

(1) Instream flows are proposed to support stream closures and will be used in processing applications for changes or transfers of existing water rights. Blocks of water reserved for domestic, municipal, and other beneficial uses shall not be subject to instream flows or closures.

(2) North Fork Lewis River flows are derived from the Federal Energy Regulatory Commission (FERC) relicensing process and do not represent instream flows, and may be subject to change as provided by FERC requirements.

Table H-5a
Toe Width Recommended Flows for WRIA 27 Streams[2]

Stream Name	Toe-Width (feet)	Fish Species	Toe-Width Spawning/Rearing Flows in cfs [1]	Instream Flows in cfs and Fish Species and Lifestage Priorities listed by Month											
				Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Cedar Creek (near Lewis River Hatchery)	**53.3**	spring chinook, coho, chum and winter steelhead	chinook spawn 188, coho/chum spawn 101, steel spawn 156, steel rear 46	125	156	156	156	156	104	104	46	188	188	188	125
				chinook incubat	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	chinook spawn	chinook spawn	chinook spawn	chinook incubat
Gee Creek (@ Ridgefield, HWY 501 crossing)	**17.3**	coho, winter steelhead	coho spawn 23, steel spawn 42, steel rear 9	23	42	42	42	42	28	28	9	9	23	23	23
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Canyon Creek (@ NE Healy Rd)	**68.3**	rainbow trout	trout spawn 208, trout rear 66	66	66	208	208	208	139	139	66	66	66	66	66
				trout rear	trout rear	trout spawn	trout spawn	trout spawn	trout incubat	trout incubat	trout rear	trout rear	trout rear	trout rear	trout rear
Speelyai Creek (@HWY 503)	**49.7**	chinook, coho, steelhead	chinook spawn 172, coho spawn 91, steel spawn 143, steel rear 42	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cougar Creek (@ HWY 503)	**43.5**	chinook, coho, steelhead	chinook spawn 146, coho spawn 77, steel spawn 123, steel rear 34	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Jenny Creek (@ Pacific HWY/Clark Co. Rd)	**15.0**	coho, winter steelhead	coho spawn 19, steel spawn 36, steel rear 8	19	36	36	36	36	24	24	8	8	19	19	19
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
McCormick Creek (@ 11th Ave. crossing)	**12.3**	coho, winter steelhead	coho spawn 15, steel spawn 28, steel rear 6	15	28	28	28	28	28	28	6	6	15	15	15
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Brezee Creek (@ La Center, Co. Rd 42 crossing)	**16.0**	coho, winter steelhead	coho spawn 21, steel spawn 39, steel rear 8	31	39	39	39	39	39	39	8	8	21	21	21
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Lockwood Creek (@ Co. Rd 42)	**21.3**	coho, winter steelhead	coho spawn 30, steel spawn 54, steel rear 13	30	54	54	54	54	36	36	13	13	30	30	30
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn

Table H-5a (cont.)
Toe Width Recommended Flows for WRIA 27 Streams(2)

Stream Name	Toe-Width (feet)	Fish Species	Toe-Width Spawning/Rearing Flows in cfs (1)	Instream Flows in cfs and Fish Species and Lifestage Priorities listed by Month											
				Jan	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Mason Creek (@ J.A. Moore Rd crossing)	**17.3**	coho, winter steelhead	coho spawn 23, steel spawn 42, steel rear 9	23	42	42	42	42	28	28	9	9	23	23	23
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Yacolt Creek (@ confluence at Moulton Falls)	**35.5**	coho, winter steelhead	coho spawn 59, steel spawn 97 steel rear 26	59	97	97	97	97	66	66	26	26	59	59	59
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Rock Creek (#1) (1/2 mi. south of Dole)	**42.7**	coho, winter steelhead	coho spawn 75, steel spawn 121, steel rear 34	75	121	121	121	121	80	80	34	34	75	75	75
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Rock Creek (#2) (@ 319th St. Bridge off HWY 503)	**17.5**	coho, winter steelhead	coho spawn 23, steel spawn 43, steel rear 10	23	43	43	43	43	29	29	10	10	23	23	23
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn

WRIA 27: Spawning periods: spring chinook (only in Cedar Creek)=Aug-Sept, fall chinook=Sept-Nov., chum=Oct-Dec, coho=Oct-Jan, winter steelhead=Feb-May, summer steelhead Jan.-May

Table H-5a (cont.)
Toe-Width Recommended Flows for WRIA 28

Stream Name	Toe-Width (feet)	Fish Species	Toe-Width Spawning/Rearing Flows in cfs [1]	Instream Flows in cfs and Fish Species and Lifestage Priorities listed by Month											
				Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Weaver Creek (@ 199th Rd crossing)	**10.3**	coho, winter steelhead	coho spawn 12, steel spawn 23, steel rear 4	12	23	23	23	23	15	15	4	4	12	12	12
				coho spawn	steel spawn	Steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Gibbons Creek (@ Frontage Rd crossing)	**19.5**	coho, winter steelhead	coho spawn 27, steel spawn 49, steel rear 11	27	49	49	49	49	33	33	11	11	27	27	27
				coho spawn	steel spawn	Steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Whipple Creek (@ 179th st. crossing)	**20.3**	coho, winter steelhead	coho spawn 28, steel spawn 51, steel rear 12	28	51	51	51	51	34	34	12	12	28	28	28
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Mill Creek (@ North Salmon Creek Rd)	**19.8**	coho, winter steelhead	coho spawn 27, steel spawn 50, steel rear 11	27	50	50	50	50	33	33	11	11	27	27	27
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Morgan Creek (@ 182nd St. crossing)	**14.0**	coho, winter steelhead	coho spawn 17, steel spawn 33, steel rear 7	17	33	33	33	33	22	22	7	7	17	17	17
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Rock Creek (near 213th Rd)	**24.3**	coho, winter steelhead	coho spawn 36, steel spawn 63, steel rear 15	36	63	63	63	63	42	42	15	15	36	36	36
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Little Washougal River (@ Washougal River Road)	**54.3**	fall chinook, coho, winter and summer steelhead	chinook spawn 193, coho spawn 103, steel spawn 160, steel rear 48	193	193	160	160	160	107	107	48	193	193	193	193
				chinook spawn	chinook spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	chinook spawn	chinook spawn	chinook spawn	chinook spawn
W.F. Washougal River (@ Skamania Hatchery)	**57.0**	fall chinook, coho, winter and summer steelhead	chinook spawn 205, coho spawn 110, steel spawn 169, steel rear 51	205	205	169	169	169	112	112	51	205	205	205	205
				chinook spawn	chinook spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	chinook spawn	chinook spawn	chinook spawn	chinook spawn

Table H-5a (cont.)
Toe-Width Recommended Flows for WRIA 28

Stream Name	Toe-Width (feet)	Fish Species	Toe-Width Spawning/Rearing Flows in cfs (1)	Instream Flows in cfs and Fish Species and Lifestage Priorities listed by Month											
				Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Lawton Creek (@ HWY 14 crossing)	**18.0**	coho, winter steelhead	coho spawn 24, steel spawn 44, steel rear 10	24	44	44	44	44	29	29	10	10	24	24	24
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Duncan Creek (@ HWY 14 crossing)	**16.0**	coho, chum, and winter steelhead	coho/chum spawn 21, steel spawn 39, steel rear 8	21	39	39	39	39	26	26	8	8	21	21	21
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	chum spawn	chum spawn	chum spawn
Woodward Creek (@ Beacon Rock State Park Rd crossing	**27.5**	coho, winter steelhead	coho spawn 42, steel spawn 72, steel rear 18	42	72	72	72	72	48	48	18	18	42	42	42
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn
Hardy Creek (@ HWY 14 crossing)	**26.3**	coho, chum, and winter steelhead	coho/chum spawn 40, steel spawn 69, steel rear 17	40	69	69	69	69	46	46	17	17	40	40	40
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	chum spawn	chum spawn	chum spawn
Hamilton Creek (near North Bonneville)	**41.5**	coho, chum, and winter steelhead	coho/chum spawn 72, steel spawn 117, steel rear 33	72	117	117	117	117	78	78	33	33	72	72	72
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	chum spawn	chum spawn	chum spawn
Greenleaf Creek (@ Cascade Drive crossing)	**21.7**	coho, winter steelhead	coho spawn 31, steel spawn 55, steel rear 13	31	55	55	55	55	37	37	13	13	31	31	31
				coho spawn	steel spawn	steel spawn	steel spawn	steel spawn	steel incubat	steel incubat	steel rear	steel rear	coho spawn	coho spawn	coho spawn

WRIA 28: Spawning periods: fall chinook=Sept-Feb, (only in Little and WF Washougal) chum=Oct-Dec, coho=Oct-Jan, winter steelhead=Feb-May, summer steelhead Jan.-May (only in Little and WF Washougal)

(1) Numbers have been rounded down to the nearest whole number.

(2) See pages H-2 and H-3 for information on table interpretation.

Appendix I
Water Supply Management Techniques

Appendix I
Water Supply Management Techniques

This appendix provides a comparison between six water supply management strategies: development of new surface and ground water sources; water conservation; water reclamation and reuse; water transfers; aquifer storage and recovery; and surface water storage. The benefits and constraints of each strategy are discussed, and their general effectiveness for providing water supplies and managing stream flows in WRIAs 27 and 28 is characterized.

1. New Water Supply Development

Description

This strategy involves development of additional future supplies from either surface or ground water. The majority of growth in WRIAs 27 and 28 is anticipated to occur in the municipal water use category. Throughout the basin, municipal purveyors rely almost exclusively upon ground water supplies. The only exceptions to this are the Cities of Kalama and Woodland, which use Ranney Wells, and the City of Camas, which obtains a portion of its supply from two creeks.

Effectiveness and Feasibility

The development of additional surface water supplies to meet municipal demands has been previously explored by some purveyors. The results of such analyses have indicated that new surface water diversions are much more costly than additional development of ground water. This, in conjunction with the fact that there is an abundance of high quality ground water that has been well characterized throughout the area, has led purveyors to focus upon ground water as they consider new supply development.

This strategy is currently viewed as the most effective and feasible option to meet future water demands in WRIAs 27 and 28. Municipal water purveyors relying upon ground water aquifers are already planning to expand use of those resources to meet future needs. The most cost-effective solution for new small public water systems is typically the installation of new wells. Similarly, water for new individual rural homes will most likely be withdrawn from private wells.

The primary challenge faced by those desiring to develop additional supplies is obtaining water rights. Although it is possible to obtain new rights in WRIAs 27 and 28, the process can be lengthy and expensive, due to the current backlog of water right applications at the Department of Ecology (Ecology) and the need to thoroughly evaluate potential impacts to other water right holders and competing interests. Although the water right application process may be challenging, it is still considered more favorable than the other options discussed below.

As with all of the strategies discussed in this chapter, environmental factors must be addressed when planning for this water supply alternative. One specific issue of importance relative to development of additional ground water supplies is hydraulic continuity, which refers to the interaction between ground water and surface water bodies. Depending on the unique circumstances associated with the hydrogeology of a basin, increased ground water pumping rates can cause decreases in flows of nearby streams at some places and some times. Ecology requires that this potential effect be considered when evaluating new source development.

2. Water Conservation

Description

Water conservation refers to the beneficial reduction of water use, loss, or waste. Conservation measures can be implemented within the municipal, industrial, and agricultural sectors.

In the municipal context, water conservation consists of a range of activities involving both water systems and their customers. At the customer end, "demand-management" programs use elements such as public information to encourage customers to manage their water use; installing high-efficiency plumbing fixtures and appliances; and using rate structures to provide economic incentives for water-use efficiency. These programs typically target certain types of water use that are particularly large for a given community, such as residential indoor uses, residential outdoor uses, non-residential indoor uses, and non-residential outdoor uses. With respect to the public water system itself, conservation involves improving the efficiency of water system operation, by minimizing losses and managing system uses such as flushing of water mains, draining storage reservoirs for maintenance, and finding and repairing leaks in water mains. Water systems must submit a water conservation plan outlining measures to be implemented, as a condition for approval of Water System Plans and issuance of new water right permits.

The importance of water conservation in the municipal sector has recently been reaffirmed with the passage of House Bill 1338 during the 2003 legislative session. Section 7 of this law authorizes Ecology to establish water efficiency requirements, to be applied to all municipal water purveyors. By December 31, 2005, Ecology is to have adopted rules that outline conservation planning requirements, develop water distribution system leakage standards, and establish minimum conservation performance reporting requirements. These rules will likely be based in large part upon existing mechanisms, such as those in use by DOH in relation to water system planning. The new rules are anticipated to strengthen conservation requirements and thereby reduce the need for development of additional water supplies to meet future demands. The entire text of HB 1338, Section 7 is provided as Appendix __.

In the industrial context, water conservation consists of a range of activities based on the size and type of industry. Because of the large volumes associated with these users, opportunities often exist to conserve significant quantities of water. On a daily basis, industrial facilities may use on the order of hundreds of thousands to millions of gallons of water. Industries have various incentives to initiate a water conservation program, such as reducing operating and wastewater treatment costs, reducing energy consumption, reducing demand relative to the available supply or water right, or in order to take advantage of financial incentive programs offered by municipal water suppliers. Larger industries often have in-house engineering capability to identify opportunities to save water.

In the agricultural context, water conservation involves different technologies and approaches, in comparison with the municipal sector. Efficiency measures at the individual farm level would typically be implemented by the landowner and/or agricultural producer raising a crop or producing livestock. Examples of on-farm measures, such as may be implemented within WRIAs 27 and 28, are:

- Replacement of unpressurized irrigation systems with pressurized spray systems, microspray or drip systems;
- Use of soil moisture sensors to optimize water applications;
- Refinement of irrigation scheduling to optimize water-use efficiency; and,
- On-farm ponds or pump-back systems to capture and reuse tailwater.

There are no irrigation districts in WRIAs 27 and 28, and farm operations that are present do not have extensive canal systems. Therefore, water-use efficiency measures typical of irrigation district conveyance systems are not applicable in this region.

Effectiveness and Feasibility

In any community, water conservation can be viewed as a continuum, from less aggressive and less costly programs; to more aggressive and more expensive programs. Some water conservation measures have already been implemented within WRIAs 27 and 28. The major public water systems throughout the basin have conducted public outreach and education efforts. In addition, some systems have instituted fixture retrofits (showerheads and toilets) and implemented leak detection and repair programs. There is potential for additional water savings to be realized through conservation at the major public water system level, due to the substantial amount of growth associated with this sector over the next 20 years and the fact that there are some conservation strategies that have not yet been employed, or have been applied only in limited areas. However, these may come at a higher cost.

Some of the factors involved in evaluating the applicability of water conservation efforts in a given community are:

- Relationship between the cost per unit volume of water saved via conservation, compared with the cost per unit volume of water obtained by other supply strategies.
- Policy choices that may encourage conservation even in the absence of a cost-effectiveness benefit.

- Level of interest and support for conservation among the general public.

Water conservation has also been utilized in the industrial sector in WRIAs 27 and 28. Some process efficiencies have been implemented at industrial facilities within the basin; however, additional opportunities exist due to the large volumes of water involved and the existence of various incentives such as reductions in overhead costs and energy consumption. In many cases, industrial process efficiencies may be coupled with water recycling efforts, as described in the next section.

A portion of the WRIA 27/28 population relies upon individual, private wells for water supply. Some existing water conservation efforts, such as Clark Public Utilities' public outreach and fixture retrofit programs, have introduced water savings opportunities to this sector in limited areas. Additional gains are possible with the development of programs specifically targeting this group of water users. Such programs are uncommon, due to the lack of a governmental entity (state or local) that is responsible for promoting water conservation within this particular water use category.

Water conservation in the irrigated agriculture sector has not been explored in depth at this time for WRIAs 27 and 28, due to the relatively small amount of water used for this purpose, as opposed to the amount used by other user categories (see Chapter 3).

3. Water Reclamation and Reuse

Description

Water reclamation and reuse refers to the capture, treatment, and reuse of wastewater, typically for non-potable purposes. By using this as a source of water, the need for water from natural sources can be reduced. Wastewater reuse can apply both to municipal wastewater systems and the wastewater systems associated with individual industrial facilities. Typical applications of reclaimed municipal wastewater include landscape and golf course irrigation. Industrial wastewater reuse often takes the form of water recycling, where used process water is captured, treated if necessary, and used again in the same process or for a different purpose altogether.

Effectiveness and Feasibility

Municipal wastewater reuse is not an attractive water supply strategy for WRIAs 27 and 28 in the near future, in relation to other water supply alternatives. This is due primarily to the high implementation costs of municipal wastewater reuse projects, the abundance of groundwater supplies in the basin, and a general lack of acceptance of reclaimed water, among the public at large. Policy decisions and shifts in public perception would be needed to create a climate in which municipal wastewater reuse is viewed as a means by which water resources may be better utilized in the basin in the future.

Water reuse and recycling in the industrial sector is currently much more feasible than in the municipal sector for WRIAs 27 and 28, due to lower costs (relative to implementation of municipal reuse projects), fewer public concerns (as the public is less likely to come into contact with industrial reuse water), and the desire by some industries to promote an environmental ethic. Many water-intensive industries in the basin have already implemented water recycling processes, typically driven by water withdrawal or wastewater discharge permit constraints. Additional future water savings are anticipated in the industrial sector, as water recycling systems become more common and less costly.

4. Water Transfers

Description

This strategy involves changing an existing water right to meet needs associated with a different use or a different location than originally defined in the water right. Transfers (also known as water right changes) do not increase the overall amount of water being used in a basin; rather, they modify where and how the water is used.

Common types of changes involve the transfer of water from agricultural or commercial/industrial usage to municipal consumption. Such transfers have been increasingly used throughout the western states over the past 10 to 15 years. The reasons for this include:

- Rapid population growth in many areas, leading to a high demand for municipal water supplies;
- Quantities of water that appear relatively small in the irrigation or industrial context can have a significant impact on the ability to meet growing demands in the municipal context; and,
- These two together can lead to high prices for water transferred to municipal use, and this provides a strong incentive for irrigators and industries to transfer water to serve municipal needs.

Under State law, a water right holder may also transfer an existing water right to the State of Washington, to be held in reserve in the state's trust water rights program. Such reserved rights may be used by Ecology for instream flows or other beneficial uses.

Effectiveness and Feasibility

The attractiveness of transfers as a water supply management option in WRIAs 27 and 28 varies between the different types of transfers discussed above. Transfers of water rights from agricultural to municipal usage are not as feasible in WRIAs 27 and 28 as they could be in other, more irrigation-intensive areas of the state. Agricultural water use accounts for less than 10% of the total water used in WRIAs 27 and 28. Many existing agricultural water rights are typically not of enough size or in an appropriate location for use by municipal water consumers in the basin.

However, transfers of industrial water rights to use for municipal purposes do have potential in WRIAs 27 and 28, due to the existence of some substantial industrial water rights associated in some cases with the same sources of supply (e.g., aquifers) already used by municipal water purveyors. In a situation where an industrial water user scales back production, leaving a portion of its water right unused, that amount of water could be sold or leased to a public water system for municipal purposes. Such arrangements have already been explored by some industries and water purveyors in the basin.

Similar to the water rights constraint noted for new source development, the processing of water right transfers can be lengthy and involve evaluation to ensure other water right holders are not impaired by the transfer and to guarantee that competing interests are considered. Recent changes in State law have addressed this issue in part by allowing water right change applications to be processed on a different schedule than that used for reviewing applications for new water rights. In addition, water conservancy boards have been given the authority to process change applications (with Ecology retaining the authority to issue final determinations), in order to make the process more efficient. However, this option is not available to applicants within WRIAs 27 and 28, as no conservancy boards exist in the basin.

5. Aquifer Storage and Recovery

Description

In areas where water availability is limited on a seasonal basis, excess water can be injected into ground water aquifers during wet periods and then withdrawn during dry periods to aid in meeting water demands. This process, known as Aquifer Storage and Recovery (ASR), serves to optimize the use of existing water resources, especially in areas dependent primarily upon surface water supplies.

Effectiveness and Feasibility

ASR is currently not an attractive water supply option in WRIAs 27 and 28. Some water purveyors have previously explored ASR and determined it not to be feasible. In general, ASR is not attractive relative to other alternatives, due to the fact that existing ground water supplies are abundant and do not require augmentation to support further development. Furthermore, ASR implementation costs can be quite high.

There are many other issues surrounding ASR. For example, the viability of ASR requires that the organization storing water underground have a reasonable assurance that other users will not deplete the resource, and that water rights will permit withdrawals when needed. There are also uncertainties in ground water quality resulting from mixing injected water with water already present in the aquifer.

6. Surface Water Storage

Description

Similar to ASR in its overall objective, surface water storage (i.e., impoundments and reservoirs) is often used where surface water supplies are limited on a seasonable basis.

During wet periods, when excessive flows are present, water is captured and retained for use later during drier periods.

Effectiveness and Feasibility

Surface water storage is currently not an attractive water supply option in WRIAs 27 and 28. The categories of water users for which the majority of growth is anticipated in WRIAs 27 and 28 rely primarily upon ground water supplies. Due to the abundance of ground water supplies, water providers in these categories have little desire to transition to surface water to meet future needs. Clark Public Utilities has reviewed the potential for utilizing existing storage facilities in the Lewis River Basin and constructing a pipeline to deliver supplies to its service area. This approach was found to be too costly in comparison with other water supply options. Under federal regulations, surface water requires more extensive and costly treatment, compared with ground water. Pipelines are required to convey water from storage sites to users. For these reasons, the cost of implementation, technical complexity, legal considerations, permitting requirements, and environmental concerns (e.g., impacts to instream flows) associated with surface water storage projects pose substantial challenges.

Appendix J
Key Issues and Existing Plans for Major Municipal Water Providers

Appendix J
Key Issues and Existing Plans for Major Municipal Water Providers

This appendix summarizes key information for the eight largest municipal water providers in WRIAs 27/28:

- City of Battle Ground
- City of Camas
- Clark Public Utilities
- City of Kalama
- City of Ridgefield
- City of Vancouver
- City of Washougal
- City of Woodland

For each water system, a description of the purveyor's water supplies and demands are presented, followed by a discussion of the purveyor's planned strategy to meet future demand needs. The water system profiles are presented according to the size of the communities served, from the largest to the smallest

City of Vancouver

Water System Description

The City of Vancouver (City) supplied water to a population of approximately 194,000 people in 2000, or roughly 60 percent of the total Clark County population. The City completed an update of its Comprehensive Water Plan in 2003. Information in this section was compiled from the plan and interviews with City staff.

The City's sources of supply are comprised of 36 wells located at 11 water stations throughout the City. The wells withdraw water from the Orchards (unconsolidated sedimentary rock) aquifer system, the Troutdale gravel aquifer, and the Sandy River Mudstone aquifer. The reliable well capacity of the City well sources is approximately 28.75 million gallons per day (mgd) on an average annual basis. The peak reliable pumping capacity of the sources totals 48,950 gallons per minute (gpm), or approximately 70.5 mgd.

The City's water customers are located within its approximately 30,000-acre City Limits, as well as in roughly 15,000 acres of unincorporated Clark County. Based on projections developed by the Southwest Washington Regional Transportation Council, which are in turn based upon State Office of Financial Management forecasts, the City's water service area population is expected to increase to approximately 273,000 by year 2023. This growth represents an annual growth rate of 1.5 percent.

Year 2000 water demand was on the order of 25 mgd on an annual average basis. Maximum day demand in year 2000 was approximately 48 mgd. Roughly 25 percent of the City's water usage is by commercial and industrial customers. Large water consumers include Frito Lay, SEH America, and Great Western Malting. According to the forecast presented in the Comprehensive Water Plan, water demands are anticipated to increase to approximately 35 mgd on an annual basis by year 2023. The corresponding maximum day demand forecast for year 2023 is 68 mgd.

The City has implemented a conservation program, the key elements of which include public education, leak detection and pipe replacement, and a uniform rate structure. The City of Vancouver Water Resource Education Center was opened in 1996, providing a focused major public outreach program to teach citizens to use water wisely. In addition, the City reuses wastewater treatment plant effluent for in-plant purposes, thereby reducing the need for potable water at the two City wastewater treatment facilities.

Strategies for Serving Future Growth in Vancouver

Via its long-range planning activities, the City of Vancouver has been proactive in taking steps to ensure that water demands will be met as growth continues. In addition to managing its existing supplies in light of anticipated increases in demand, the City has also identified and evaluated various alternative supply options. The two primary supply options identified for meeting future needs are described below:

- ***Columbia River Alluvium.*** This option would involve the development of a wellfield to the west of Vancouver Lake. Based upon previous studies, this aquifer has the potential to yield an extremely plentiful water supply. Based on well drilling in the area by the Columbia Resource Company, wells in this aquifer would likely be drilled to a depth of 200-300 feet. It has been estimated that three initial new wells could produce 4,000-6,000 gpm. Further investigative studies could begin in late 2003.
- ***Sandy River Mudstone Aquifer.*** There is substantial storage volume associated with this aquifer, from which the City already withdraws a portion of its supply. Limits to this supply need to be defined. The aquifer is used by the Cities of Portland and Vancouver, as well as Clark Public Utilities and SEH America, and is currently being studied by all of these users. No new supplies will be developed from this source until further characterization of the aquifer is completed. It should be noted that as a part of its evaluation of the aquifer system, the City of Portland is conducting a study of aquifer storage and recovery, introducing winter water from its Bull Run supply into the aquifer for potential withdrawal during summer months.

Among these two options, the City views development of a wellfield near Vancouver Lake as the preferred future supply alternative, due to evidence of abundant supply and minimal water quality concerns. It is envisioned that this source would be used to supply all demands associated with growth beyond approximately 2010, the time when reliable supplies are anticipated to be fully utilized. This new supply would also provide an additional level of redundancy to the existing system. The City has entered into discussions with the Port of Vancouver for purchase of a 20-acre site to the west of the lake for development of new wells. The primary challenge facing the City with regard to this option appears to be satisfying land use and environmental concerns in order to proceed with wellfield development. A secondary issue is related to water rights. Currently, the total primary rights held by the City are 50,227 acre-feet per year, or 44.84

mgd on an average daily basis. This is adequate to support the future demands forecast for the City beyond 2023. However, the City will need to engage in the process of transferring a portion of its existing water rights to this new source. Depending on the amount of total demand developed in the future, additional water rights may need to be purchased or acquired via application to support growth.

Clark Public Utilities

Water System Description

Clark Public Utilities (CPU) supplies water to a population of approximately 77,000 people in 2000, or roughly 20 percent of the total Clark County population. CPU completed an update of its Water System Plan in 2001. Information in this section was compiled from the updated plan and interviews with CPU staff.

CPU’s sources of supply consist of 33 groundwater wells located throughout CPU’s service area. The wells withdraw water from three distinct underground aquifers. The majority of CPU’s water is pumped from wells which withdraw water from the Upper Troutdale and the Sand & Gravel Aquifers. Other wells withdraw water from the Lower Troutdale Aquifer and from Pleistocene alluvial deposits. The typical flow from CPU’s well sources is approximately 18,624 gallons per minute (gpm). The peak reliable pumping capacity of the sources during maximum demand days totals 20,694 gallons per minute (gpm).

CPU’s water system serves the unincorporated, urban (i.e., La Center and Yacolt), and rural areas of Clark County north and northeast of the City of Vancouver, except for the cities of Battle Ground, Ridgefield, Camas, and Washougal. CPU is also the designated satellite system management agency for Clark County. As such, CPU’s service area includes satellite systems, such as Amboy. Based upon State Office of Financial Management forecasts, CPU’s water service area population is expected to increase to approximately 114,000 by 2020. This represents an annual growth rate of roughly 2.0 percent.

Year 2000 water demand, excluding the demands associated with Yacolt and the satellite systems, was 9.51 million gallons per day (mgd) on an annual average basis. Maximum daily demand was approximately 21.50 mgd. According to the demand forecast presented in the 2001 Water System Plan, water demands are anticipated to increase to approximately 14.19 mgd on an annual basis by year 2020. The corresponding maximum day demand forecast for year 2020 is 28.19.

CPU has implemented various conservation strategies. Since the late 1980’s, a fixture retrofit program has resulted in the installation of low-flow showerheads and toilets in approximately 80,000 homes throughout the County. Additionally, CPU provides public educational materials regarding water conservation and has a program by which it systematically identifies and replaces leaking water mains. CPU is also considering implementing a home conservation audit program to approximately half of its customers, utilizing Bonneville Power Administration funding. Another conservation element being evaluated is the use of summer conservation rates for discouraging high irrigation use.

CPU implements water reuse in the form of utilizing cooling water from its natural-gas power generator for irrigating parks and supplying water to a duck flyway. Furthermore, there are plans to utilize a portion of this water to provide heat to a utility warehouse building.

Strategies for Serving Future Growth in CPU Service Area

Comparison of projected demands with existing source capacities indicates that CPU's average daily demand will likely exceed the utility's primary annual water rights by year 2006. Forecast maximum day demands are expected to exceed CPU's total instantaneous water rights by 2020. Recognizing the need for additional water supply in the future, CPU has identified and evaluated 14 groundwater and 11 surface water supply options in various areas throughout the County. This detailed evaluation resulted in the identification of two preferred areas where CPU is looking to develop additional sources of supply to meet future needs imposed by growth. These alternatives are listed below.

- ***Sand and Gravel Aquifer in the Pioneer Area.*** The sand and gravel aquifer in the Pioneer area has a limited supply capacity, but is near a high growth area, and could serve growth in the immediate vicinity.
- ***Columbia River Alluvium.*** This option would involve the development of a wellfield to the southeast of Vancouver Lake.

Both of these options are included in CPU's water supply strategy for the future, which is summarized below:

1. ***Short-Term.*** Some of CPU's existing shallow wells in the Salmon Creek Basin are susceptible to contamination and are limited in their productivity due to the potential of being in hydraulic continuity with Salmon Creek. In order to utilize the authorized groundwater withdrawal in this area in a manner that reduces the potential for adverse impacts to surface water supplies, CPU plans to replace these shallow wells with new wells in the near vicinity. This action is not anticipated to result in an increase in the amount of water withdrawn by CPU in the Salmon Creek Basin.
2. ***Mid-Term.*** One of the high-growth portions of CPU's service area is the Pioneer area. In order to meet some of the near-term water demands in this area, additional wells are envisioned for the Sand & Gravel Aquifer in this vicinity. Two applications have been filed with the Department of Ecology requesting additional water rights to support the expansion of this source of supply. Expected capacity for source development in the Pioneer area is roughly 7 mgd.
3. ***Long-Term.*** The primary source of supply envisioned to meet the majority of CPU's increased demand in the future is the development of a wellfield immediately southeast of Vancouver Lake. Although preliminary testing of the Columbia River Alluvium in this area indicates that removal of organic contaminants and manganese will likely be required, the source is believed to contain ample supply to meet the

needs of growing Clark County. CPU plans to employ a strategy of purchasing other existing water rights in addition to obtaining new rights to support the development of this source. Initial discussions have been held with industrial water rights holders in the area, investigating the potential for purchase of groundwater rights. An application for an additional 37 mgd has already been filed. The first phase of this source development (an initial 7 mgd) is anticipated to be completed by 2005. As a long-term strategy, this new wellfield is envisioned to become CPU's primary source of supply to meet all demands, with its other existing wells utilized as peaking sources.

The primary water resource issue presently faced by CPU is the uncertainty in obtaining sufficient water rights to support the primary element of its future water supply strategy. The utility is engaged in activities to facilitate the process (e.g., evaluating purchases and submitting applications), but the climate surrounding water rights in Washington will continue to make this a significant challenge.

In addition to focusing upon these new supplies, CPU has also directed substantial resources at the management of existing supplies. Acknowledging the need to manage the water resources of the Salmon Creek Basin, in which many of CPU's sources are located, the utility has entered into a joint agreement with the Department of Ecology and Clark County. As a part of this agreement, a Water Resource Plan was developed, outlining a management strategy for this area. CPU, with input from the other agencies, has prepared annual technical evaluations, determining the amount of groundwater available from the basin, instream flow needs, and options for mitigating the impacts associated with development in the basin. CPU is committed to maintaining an effective management strategy for the Salmon Creek Basin.

City of Camas

Water System Description

The City of Camas (City) supplied water to a population of approximately 12,500 people in Clark County in 2000. The City completed an update of its Water System Comprehensive Plan in 2002. Information in this section was compiled from the updated plan and interviews with City staff.

The City's sources of supply are comprised of nine groundwater wells and two surface water sources. Eight of the wells are located in the downtown area, while the ninth well is located on NW 38th Avenue. The total capacity associated with the wells is 9,050 gpm. The two surface water sources are Jones and Boulder Creeks, which have been providing the City with water since the early 1900's. The City's surface water treatment plant has a rated capacity of 1,200 gpm. However, the sources provide only 1,050 gpm under normal operation, while capacity during dry summer months can be as low as 500 gpm. The City relies primarily upon its groundwater supplies, with surface water accounting for about one-third of total production. Three emergency interties with the City of Washougal provide additional supply reliability for the City.

The City's water customers are located within its 6,200-acre UGA boundary, as well as in approximately 7,700 acres of land outside of the UGA. Based on projections in the 1999 Clark County Monitoring Report, which are in turn based upon State Office of Financial Management forecasts, the City's water service area population is expected to increase to approximately 30,859 by year 2020. This represents an annual growth rate of approximately 4 percent.

Year 2002 water demand was on the order of 3.9 mgd on an annual average basis. Maximum daily demand was approximately 8.0 mgd. Roughly 50 percent of the City's water usage is by industrial customers. Large water consumers include Wafertech Industries, Georgia Pacific, Linear Technologies, and Hewlett Packard (which is located within the City of Vancouver UGA). A range of demand forecasts is provided in the City's 2002 Water System Comprehensive Plan. The range is based upon varied levels of plant expansion by Wafertech, the City's largest customer. The "mid-range" demand projection, which accounts for Wafertech's full use of its existing plant and the addition of a second plant, indicates that water demands are anticipated to increase to approximately 8.51 mgd on an annual basis by year 2020. The corresponding maximum day demand forecast for year 2020 is 14.27.

The City is implementing a conservation program, the key elements of which include dissemination of public educational materials, implementation of a centralized, computerized irrigation system for City parks utilizing a timer and climate control, and the use of voluntary water use audits for both industrial and residential customers. A recent emphasis has been placed upon the industrial water use audit program. Industrial customers have been contacted and encouraged to take advantage of the no-cost, voluntary program.

Strategies for Serving Future Growth in Camas

Comparison of projected demands (based on the mid-range forecast) with existing source capacities indicates that the City's average daily demand will likely exceed the City's primary annual water rights by year 2006. This situation may occur sooner, if industrial growth happens at a quicker pace than anticipated. Recognizing its need for additional water supply in the future, the City has identified and evaluated various supply options. In assessing future supply options, the City has noted certain limitations associated with its existing supplies. These are described below.

- ***Groundwater Under the Influence of Surface Water.*** In March of 2001, the City's Well No. 4, near the Washougal River, was classified as a groundwater source under the influence of surface water (GWI). The City discontinued use of the well and is searching for an appropriate replacement well in the vicinity to which the well's water rights could be transferred. In the event that a suitable replacement well is not identified, the City will likely install filtration facilities at Well No. 4. Other nearby City wells (Nos. 7 and 8) have also been tested and determined not to be GWI. Well Nos. 1, 2, and 3 are currently being replaced and will be tested due to their proximity to the Washougal River.

- ***Limited Surface Water Supplies.*** As mentioned above, Jones and Boulder Creeks have extremely limited production during dry summer months. The City recognizes the need for a better understanding of these creeks and their local ecosystem. Therefore, since 2002, the City has budgeted resources toward the study and management of the Jones and Boulder Creek watersheds. Recent efforts include coordination with the Washington State Department of Fish and Wildlife to design more fish friendly intakes on both creeks. The City has also applied to the Washington State Department of Ecology for funds to install new intakes and water measuring devices.

Having assessed its existing sources of supply and considered alternative sources, the City has developed a multi-faceted approach for meeting future needs. Key elements are described below:

- ***Maximize Capacities of Existing Sources and Water Rights.*** This involves the replacement of Well Nos. 1, 2 and 3, upgrades to Well Nos. 4 and 6, and development of a management strategy for its surface water supplies, as discussed above. Making full use of existing water rights is the first step the City intends to take in meeting future demands. Improvements to Well No. 6 were completed in 2001, and the replacement of Well Nos. 1, 2, and 3 will be completed by late 2003.
- ***Additional Groundwater Sources.*** The City is actively exploring new well sites on the east side of the Washougal River and to the west (as a part of the West Camas Test Drilling Program). Development of these sites would require additional water rights.
- ***Development of a Non-Potable Supply.*** This potential option involves the use of Columbia River water for non-potable industrial and irrigation purposes. Such a project would require a separate transmission and treatment system. Again, additional water rights would be needed.
- ***Sharing of Resources with Adjacent Purveyor.*** The City is exploring the feasibility of developing a joint supply with the City of Washougal. This option is in the initial discussion phase.

A key issue related to each element of the City's future water supply strategy is water rights. While the City plans on maximizing the use of its existing water rights, it is clear that additional rights, either purchased or obtained through application, are needed for the City to meet the demands imposed by future growth. This issue will continue to pose the greatest challenge in the City's water supply future.

City of Battle Ground

Water System Description

The City of Battle Ground (City) supplied water to a population of approximately 9,000 people in Clark County in 2000. The City completed an update of its Water System Plan in 1998. Information in this section was compiled from that plan and interviews with City staff.

The City's sources of supply consist of 7 groundwater wells. The wells withdraw water from the Upper Troutdale Aquifer and the deeper Sand & Gravel Aquifer. The total withdrawal volumes associated with the City's water rights are 3,119 acre-feet/year on an annual basis and 3,000 gallons per minute (gpm) on an instantaneous basis. The operational flow from the City's well sources is approximately 1,060 gpm. The total capacity of the wells is 2,600 gallons per minute (gpm). In addition to these well supplies, the City has three interties with Clark Public Utilities (CPU). These interties are used only in the following situations: 1) for assistance in meeting some peak demands, 2) while the City's wells are out of operation for maintenance, and 3) for emergency purposes.

The City's water system currently serves primarily residential customers in the City limits, but is planning to expand to serve portions of the City's Urban Growth Area and Urban Reserve Areas. Based upon the relatively high growth experienced by the City in recent years, the City has adopted a 6.2 percent annual growth rate for planning purposes through the year 2014. At this rate, the City's water service area population is expected to increase to approximately 22,500 by 2014. Extrapolation of this growth results in an anticipated population of roughly 29,000 by 2020.

Year 1997 water demand was on the order of 0.73 million gallons per day (mgd) on an average daily basis. Maximum day demand was approximately 1.25 mgd. According to the forecast growth in population, water demands are anticipated to increase to approximately 3.48 mgd on an average daily basis by year 2020. The corresponding maximum day demand forecast for year 2020 is 6.52 mgd.

The City's conservation program consists primarily of a leak control program which provides funds for the identification and replacement of leaking portions of water mains on an annual basis. The City is also exploring the potential to participate in a regional program with other water purveyors to distribute educational flyers.

Strategies for Serving Future Growth in Battle Ground

Comparison of projected demands with existing source capacities indicates that the City's existing sources of supply and water rights are not adequate to accommodate the significant growth anticipated for its service area. Recognizing the need for additional water supply in the future, the City has identified multiple additional water supply options. The components of the City's water supply strategy, along with their associated challenges, are listed below:

- ***Development of Additional wells.*** The City plans to maximize the use of its existing water rights by developing new wells. The siting of the first of these additional wells is anticipated to be completed by the end of 2003. This new well (Well No. 9) will likely be designed to provide 500-1,000 gpm of additional water supply. Due to water quality issues, new wells in the Battle Ground area will likely require treatment for the removal of iron and manganese.

- ***Accumulation of Agricultural Water Rights.*** As the City grows and annexes additional lands, it is anticipated that some existing agricultural water rights will be gained. These rights may be transferred to new or existing wells in order to bolster water supplies. The lack of certainty regarding timing of future annexations provides a challenge for planning on the integration of these water rights into the City's water supply scheme.

Resolution of these issues is needed to ensure the City is capable of providing for future water demands.

City of Washougal

Water System Description

The City of Washougal (City) supplied water to a population of approximately 9,000 people in Clark County in 2000. The City completed an update of its Water System Plan in January 2002. Information in this section was compiled from the draft plan and interviews with City staff. The City's receives its water supply from 5 wells that withdraw water from the shallow alluvial aquifer upon which the City is located. The City has worked with the Department of Health to determine if any of the existing sources may be considered ground water under the influence of surface water (GWI). Thus far, although the wells are shallow (i.e., approximately 100 feet deep), analysis has shown that the wells are not GWI.

The firm yield of the City's supply is approximately 2.74 million gallons per day (mgd) during the months of November-March and 3.96 mgd during the months of April-October. The water rights associated with this source total 3,786 acre-feet/year on an annual withdrawal basis and 7,850 gallons per minute (gpm) on an instantaneous basis. In addition to its 5 active wells, the City maintains 2 standby wells and has an emergency intertie with the City of Camas.

The City provides water to customers located within city limits, as well as to customers located within the City's UGA and Urban Reserve. Based on historical growth patterns for the City's water service area, the service area population is expected to increase to approximately 17,808 people by 2021.

Year 2000 average daily water production was on the order of 1.57 mgd, while maximum day production was approximately 3.18 mgd. Roughly 50 percent of the City's water usage is by residential customers. The City's largest water user is the woolen mill, which represents approximately 10 percent of the total system demand. Other industrial customers account for about 19 percent of total water usage. The water demand forecast in the City's water system plan indicates that water production is anticipated to increase to approximately 2.80 mgd on an average daily basis by year 2020. The corresponding maximum day production forecast for year 2020 is 5.96 mgd.

The City has implemented a conservation program, key elements of which include the dissemination of public educational materials and a rate structure that charges a higher amount for volumes used in excess of a base monthly volume.

Strategies for Serving Future Growth in Washougal

Based on current demand projections, the City requires additional sources of supply to meet future needs. As a part of its planning process, the City has identified the following alternatives for addressing water demands associated with future growth:

- Install an additional large capacity well
- Increase capacity of existing wells
- Return abandoned wells to service

The City's current future supply strategy consists of maximizing the use of its existing wells and water rights, as well as installing a new large capacity well in the center of town. There are some inconsistencies in the City's water rights regarding the total amount of instantaneous withdrawal appropriated. Legal clarification of this issue will allow the City to plan in more detail as it develops additional supplies.

The new well envisioned by the City would be located in town, between the Washougal and Columbia Rivers. Being installed here, the well would be at some distance from the rivers; thus, likely avoiding any concern with GWI issues. The City is working to secure the necessary permits to install the new well, which would have a capacity of approximately 1,000 gpm, by 2005. An additional larger capacity well (3,000-5,000 gpm) may be considered closer to 2020.

The key challenge facing the City relative to water supply is clarifying its existing water rights and securing additional water rights if needed. Resolution of these issues is critical for the City to provide for future water demands beyond 2020.

City of Woodland

Water System Description

The City of Woodland (City) supplied water to a population of approximately 4,000 people in Cowlitz and Clark Counties in 2000. The City developed an update of its Water System Plan in 1995. Information in this section was compiled from that plan, as well as from the Pre-Design Report for the City of Woodland Water Treatment Plant (1997), and interviews with City staff during the spring of 2002. The City's single source of supply is a Ranney Well collector that withdraws water adjacent to the Lewis River. The water rights associated with this source total 756 acre-feet/year on an annual withdrawal basis and 1,400 gallons per minute (gpm) on an instantaneous basis. Since 1999, the City has operated a filtration/disinfection water treatment plant that addresses Surface Water Treatment Rule (SWTR) requirements as well as reducing aesthetic problems associated with dissolved iron concentrations in the raw water supply.

The City provides water to customers located within city limits, as well as to customers located outside of the City but within the Urban Growth Boundary. Based on historical growth patterns for the City's water service area (i.e., an average annual growth rate of 2.9 percent), the service area population is expected to increase to approximately 6,900 people by 2020.

Year 2000 average daily water production was on the order of 0.72 mgd, while maximum day production was approximately 1.59 mgd. Approximately half of the City's water usage is by commercial and industrial customers. Large non-residential water consumers include Northwest Pet, Hamilton Materials and Columbia River Carbonates, Brock's Oak Tree Restaurant, Save On Foods, Safeway, and Loomis. The water demand forecast in the City's water treatment plant pre-design report indicates that water production is anticipated to increase to approximately 1.139 mgd on an average daily basis by year 2016. The corresponding maximum day production forecast for year 2016 is 2.51 mgd. Utilizing the historic average annual growth rate of 2.9 percent, this demand forecast may be extrapolated to average and maximum day demands of 1.28 mgd and 2.81 mgd, respectively, by 2020.

The City has implemented a conservation program, key elements of which include the dissemination of public educational materials and a low-flow fixture replacement program.

Strategies for Serving Future Growth in Woodland

With an historic and projected average annual growth rate of 2.9 percent, the City of Woodland is planning on experiencing substantial growth over the next 20 years. While keeping its source of supply options open, the City's preferred plan to meet the water demands associated with future development is to expand its use of the Lewis River Ranney Well. While the new treatment plant has been designed to accommodate this growth in demand, the City faces the challenge of obtaining adequate water rights to support its growth. Comparison of the City's projected water demands with its existing water rights reveals that average daily demands are near the full amount associated with the City's annual water right. Furthermore, the City's instantaneous water right will likely be exceeded by maximum day demands by 2010. To address this situation, the City has filed two applications for new water rights with the Department of Ecology (Ecology). The first application, which was originally filed in 1995 and has been confirmed by Ecology, requests that the City's annual withdrawal be increased to 1,200 acre-feet/year. A more recent application was filed in 2001 and requests an increase in the City's allowed instantaneous withdrawal from 1,400 gpm to 2,100 gpm. Resolution of these water right applications is needed to ensure the City is capable of providing for future water demands.

City of Kalama

Water System Description

The City of Kalama (City) supplied water to a population of approximately 3,000 people in Cowlitz County in 2000. The City completed an update of its Water System Plan in early 2002. Information in this section was compiled from the draft plan and interviews with City staff. The City's single source of supply is a Ranney Well collector that withdraws water adjacent to the Kalama River. The water rights associated with this source total 2,284 acre-feet/year on an annual withdrawal basis and 2,225 gallons per minute (gpm) on an instantaneous basis. Due to a 1998 DOH determination that the Ranney Well is a groundwater under the influence of surface water (GWI) source, the City has constructed a diatomaceous earth water filtration plant. The new plant, operational as of the end of June 2002, is designed with an initial capacity of 1,800 gpm, expandable to 2,700 gpm in the future. In addition to filtration, the City also chlorinates, fluoridates, and adjusts the pH of water from the Ranney Well.

The City provides water to customers located within city limits, as well as to customers located outside of the City. Based on historical growth patterns for the City's water service area (i.e., average annual growth rates of 2.4 percent within the City and 4.0 percent outside the City), the service area population is expected to increase to approximately 7,160 people by 2021.

Year 2000 average daily water production was on the order of 0.786 mgd, while maximum day production was approximately 1.451 mgd. Roughly 55 percent of the City's water usage is by industrial customers, primarily located at the Port of Kalama. Large water consumers include IMSA Coated Steel Corporation, Novian, Chemtrade, RSG, Kalama Export, United Harvest and Gram Lumber. The water demand forecast in the City's water system plan indicates that water production is anticipated to increase to approximately 1.516 mgd on an average daily basis by year 2021. The corresponding maximum day production forecast for year 2021 is 2.805 mgd.

The City has implemented a conservation program, a key element of which is the dissemination of public educational materials via newsletters and a web-site.

Strategies for Serving Future Growth in Kalama

As mentioned above, the City's new water treatment plant is designed such that it may be expanded by an additional 900 gpm in the future to meet needs imposed by growth. Based on current demand projections, such expansion may be necessary by 2016. In order for the City to expand its treatment plant and continue to utilize the Ranney Well as its sole water supply, an additional 475 gpm of instantaneous water rights will be needed in the future. The City has adequate annual and instantaneous water rights to meet projected demands through 2021; however, the existing instantaneous water right will be less than the expanded treatment capacity by that time. The City is planning for the additional treatment capacity, and associated water rights, in order to account for the potential of the Port of Kalama's water use increasing substantially if a new large industrial user locates at the Port. If such industrial growth does not occur, the treatment plant capacity and water rights will serve to accommodate future growth beyond 2021.

The key challenge facing the City relative to water supply is securing additional water rights to accompany the planned treatment plant expansion. The City has filed an application for new water rights associated with its existing Ranney Well withdrawal. This will continue to figure prominently in the ability of the City to provide for future water demands beyond 2021.

City of Ridgefield

Water System Description

The City of Ridgefield (City) supplied water to a population of approximately 2,000 people in Clark County in 2000. Information in this section was compiled from the City's April 1996 Water System Plan. The City provides water to customers located within Ridgefield City Limits, which has recently increased in size due to annexation of lands.

For its core system, the City receives its water supply from 3 active wells and 2 standby wells located in Abrams Park, near Gee Creek. The wells are screened at depths of approximately 160 to 200 feet within the Troutdale aquifer. The total supply capacity of the City's 3 primary wells is 900 gallons per minute (gpm). Water rights for all City sources total 681 acre-feet/year on an annual withdrawal basis and 1,650 gpm on an instantaneous basis. The City has recently developed an intertie with Clark Public Utilities on the east side of the City's system. In the near term, this intertie is intended only to support fire flow needs. However, wholesale purchases from CPU via the intertie are a supply option for the future.

Based on recent growth patterns for the City's water service area and considering the size of the potential build-out area, the service area population is expected to increase to approximately 15,000 people by 2020.

Year 2000 average daily water production was estimated to be on the order of 0.53 mgd, while maximum day production was estimated at approximately 1.06 mgd. Roughly 90 percent of the City's water usage is by residential customers. Some commercial and industrial customers account for the balance of the water demand. Given the population projection described above, the water demand forecast for the City is anticipated to increase to approximately 3.7 mgd on an average daily basis by year 2020. The corresponding maximum day production forecast for year 2020 is 7.4 mgd.

The City has implemented a conservation program, key elements of which include demand metering, dissemination of public educational materials, and a rate structure that encourages efficient use of water.

The City supports the work of the Gee Creek Restoration Committee, efforts of which are guided by Clark County for the purposes of reducing negative impacts to Gee Creek (e.g., high flows and water quality concerns) due to stormwater runoff.

Strategies for Serving Future Growth in Ridgefield

Based on current demand projections, the City requires additional sources of supply to meet future needs. The City's current future supply strategy consists of maximizing the use of its existing wells, as well as installing multiple new wells over the course of the next 12 years. These wells will likely be developed in the Troutdale aquifer, similar in depth and capacity to the other existing wells.

The key challenge facing the City relative to water supply is securing additional water rights for these new sources of supply. Resolution of this issue is critical for the City to provide for future water demands through 2020.

Appendix K
Water Quality Monitoring Activities in WRIAs 27 and 28

Appendix K
Water Quality Monitoring Activities in WRIAs 27 and 28

Agency	WRIA	Watershed	Site No.	Monitoring Location	Lat/Long-TRS	Parameters	Yrs. Monitored	Test Frequency	Monitoring Objectives	Funding Sources	Data Mngt/ QA/QC
State											
Ecology [4]	27	Kalama River	27B070	Kalama River near Kalama	lat.46.0475, long.122.8361	Cond, FC, NH3-N, NO2-NO3, OPDIS, Oxygen, pH, Press, TSS, Temp, TPP, TPN, Turb.	72,73,76,77,80-92,95-02	Monthly (Long-term)	Statewide and regional assessment	Dept. of Ecology	Per Ecology Standards [1]
Ecology [4]	27	North Fork Lewis River	27E070	Cedar Creek near Etna	lat.45.93605, long.122.6179	same as above	95	Monthly (Basin)	same as above	same as above	same as above
Ecology [4]	27	North Fork Lewis River	27C080	North Fork Lewis River @ Co Rd 16	lat.45.90583, long.122.7361	same as above	92	Monthly (Basin)	same as above	same as above	same as above
Ecology [4]	27	East Fork Lewis River	27D090	East Fork Lewis River near Dollar Corner	lat.45.81472, long.122.5906	same as above	77-92,95-02	Monthly (Long-term)	same as above	same as above	same as above
Ecology [4]	27	Lake River	27F070	Gee Creek @ Ridgefield	lat.45.81892, long.122.7377	same as above	95	Monthly (Basin)	same as above	same as above	same as above
Ecology [4]	28	Lake River	28F070	Lake River near Ridgefield	lat.45.8075, long.122.7392	same as above	92	same as above	same as above	same as above	same as above
Ecology [4]	28	Washougal River	28B110	Washougal River below Canyon Creek	lat.45.60722, long.122.2303	same as above	95,98,00	same as above	same as above	same as above	same as above
Ecology [4]	28	Washougal River	28B070	Washougal River @ Washougal	lat.45.58639, long.122.3528	same as above	69,70,72,73,76,77,92	same as above	same as above	same as above	same as above
Ecology [4]	28	Columbia River Tributaries	28H070	Campen Creek	lat.45.5775, long.122.3142	same as above	02	same as above	same as above	same as above	same as above
Ecology [4]	28	Columbia River Tributaries	28G070	Gibbons Creek	lat.45.575, long.122.3142	same as above	92,02	same as above	same as above	same as above	same as above
Federal											
USFS [5]	27	North Fork Lewis	-	Lewis River above Quartz Creek	NA	Temp	01	Every 30 mins. - June-Sept.	Compliance w/ Clean Water Act and Northwest Forest Plan	US Forest Service	NA
USFS [5]	27	North Fork Lewis	-	Quartz Creek above Platnum Creek	NA	same as above	99-01	same as above	same as above	same as above	NA
USFS [5]	27	North Fork Lewis	-	Quartz Creek below Platnum Creek	NA	same as above	77-88, 82, 84, 88, 97-01	same as above	same as above	same as above	NA
USFS [5]	27	North Fork Lewis	-	North Fork Lewis River above Curly Creek	NA	same as above	75-88, 91, 96-00	same as above	same as above	same as above	NA
USFS [5]	27	North Fork Lewis	-	North Fork Lewis River above Big Creek	NA	same as above	01	same as above	same as above	same as above	NA
USFS [5]	27	North Fork Lewis	-	Big Creek tributary above Scookum Meadows	NA	same as above	01	same as above	same as above	same as above	NA
USFS [5]	27	North Fork Lewis	-	Big Creek @ Gaging Station	NA	same as above	01	same as above	same as above	same as above	NA
USFS [5]	27	North Fork Lewis	-	Muddy River above Clear Creek	NA	same as above	91, 96-01	same as above	same as above	same as above	NA
USFS [5]	27	North Fork Lewis	-	Clearwater Creek 8 mi. above Muddy River	NA	same as above	98-99, 01	same as above	same as above	same as above	NA

Appendix K (cont.) Water Quality Monitoring Activities in WRIAs 27 and 28											
Agency	**WRIA**	**Watershed**	**Site No.**	**Monitoring Location**	**Lat/Long-TRS**	**Parameters**	**Yrs. Monitored**	**Test Frequency**	**Monitoring Objectives**	**Funding Sources**	**Data Mngt/ QA/QC**
USFS [5]	27	North Fork Lewis	-	Clearwater Creek near confluence above Muddy River	NA	same as above	96-98	same as above	same as above	same as above	NA
USFS [5]	27	North Fork Lewis	-	Muddy River below Clear Creek confluence	NA	same as above	91, 97-01	same as above	same as above	same as above	NA
USFS [5]	27	North Fork Lewis	-	Canyon Creek above Jakes Creek	NA	same as above	01	same as above	same as above	same as above	NA
USFS [5]	27	North Fork Lewis	-	Canyon Creek above Big Rock Creek	NA	same as above	01	same as above	same as above	same as above	NA
USFS [5]	27	East Fork Lewis River	-	East Fork Lewis River above Green Fork Creek	NA	same as above	99-01	same as above	same as above	same as above	NA
USFS [5]	27	East Fork Lewis River	-	Green Fork Creek one mile above East Fork Lewis River	NA	same as above	01	same as above	same as above	same as above	NA
USFS [5]	27	East Fork Lewis River	-	Green Fork Creek 0.5 mile above East Fork Lewis River	NA	same as above	97-98, 00	same as above	same as above	same as above	NA
USFS [5]	27	East Fork Lewis River	-	East Fork Lewis River below Green Fork Creek	NA	same as above	01	same as above	same as above	same as above	NA
USFS [5]	27	East Fork Lewis River	-	East Fork Lewis River below Little Creek	NA	same as above	01	same as above	same as above	same as above	NA
USFS [5]	27	East Fork Lewis River	-	East Fork Lewis River above Slide Creek	NA		01	same as above	same as above	same as above	NA
USFS [5]	27	East Fork Lewis River	-	Slide Creek 0.25 mi. above East Fork Lewis River	NA	same as above	01	same as above	same as above	same as above	NA
USFS [5]	27	East Fork Lewis River	-	East Fork Lewis Rive below Sunset Falls campground	NA	same as above	01	same as above	same as above	same as above	NA
USFS [5]	27	East Fork Lewis River	-	Copper Creek above Bolin Creek	NA	same as above	77-81, 96-01	same as above	same as above	same as above	NA
USFS [5]	27	East Fork Lewis River	-	East Fork Lewis River above Niccolls Creek	NA	same as above	97, 99-01	same as above	same as above	same as above	NA
Local											
Clark Co. [6]	27	North Fork Lewis River	CHL010	Chelatchie Creek upstream of SR 503	T5N R3E S16	Cond, FC, DO, pH, Temp, Turb, E.coli, TP, NH3-N, NO2-NO3, TSS	01-	Monthly (Started October 2001)	Long term index, Trend	Clark County stormwater fees	Level 4 - per Ecology standards
Clark Co. [6]	27	East Fork Lewis River	RCN050	Rock Creek North upstream of Gabriel Road	T4N R2E S02	same as above	01-	same as above	Long term index, Trend	same as above	same as above
Clark Co. [6]	27	East Fork Lewis River	EF1	McCormick Creek @ NW Lacenter Rd	T4N R1E S09	Temp, pH, DO, Turb, FC, NH3-N, TSS, NO2-NO3, TP	91-92	Monthly	East Fork Lewis Watershed Plan	Centennial Grant	same as above

Appendix K (cont.)

Water Quality Monitoring Activities in WRIAs 27 and 28

Agency	WRIA	Watershed	Site No.	Monitoring Location	Lat/Long-TRS	Parameters	Yrs. Monitored	Test Frequency	Monitoring Objectives	Funding Sources	Data Mngt/ QA/QC
Clark Co. [6]	27	East Fork Lewis River	EF2	East Fork Lewis River @ Pollock Rd	T4N R1E S03	same as above	91-92	same as above	same as above	same as above	same as above
Clark Co. [6]	27	East Fork Lewis River	EF3	Lockwood Creek @ NE Lockwood Creek Rd	T4N R1E S01	same as above	91-92	same as above	same as above	same as above	same as above
Clark Co. [6]	27	East Fork Lewis River	EF4	Mason Creek @ J.A. Moore Rd	T4N R1E S13	same as above	91-92	same as above	same as above	same as above	same as above
Clark Co. [6]	27	East Fork Lewis River	EF5	East Fork Lewis @ Day Break Rd	T4N R2E S20	same as above	91-92	same as above	same as above	same as above	same as above
Clark Co. [6]	27	East Fork Lewis River	EF6	Rock Creek North @ Rock Creek Rd	T4N R2E S02	same as above	91-92	same as above	same as above	same as above	same as above
Clark Co. [6]	27	East Fork Lewis River	EF7	East Fork Lewis River @ Moulton Falls	T4N R3E S13	same as above	91-92	same as above	same as above	same as above	same as above
Clark Co. [6]	27	East Fork Lewis River	EF8	Yacolt Creek @ NE Railroad Ave	T4N R3E S12	same as above	91-92	same as above	same as above	same as above	same as above
Clark Co. [6]	27	East Fork Lewis River	EF9	Rock Creek South @ Dole Valley Rd	T3N R4E S05	same as above	91-92	same as above	same as above	same as above	same as above
Clark Co. [6]	27	East Fork Lewis River	BRZ010	Breeze Cr upstream of LaCenter Btms bridge	T4N R1E S03	Cond, FC, DO, pH, Temp, Turb, E.coli, TP, NH3-N, NO2-NO3, TSS	01-	Monthly (Started October 2001)	Long term index, Trend	Clark County stormwater fees	same as above
Clark Co. [6]	28	Gee Creek	GEE050	Gee Cr dnstrm of Royle Road	T4N R1E S29	same as above	01-	same as above	same as above	same as above	same as above
Clark Co. [6]	28	Whipple Creek	WPL050	Whipple Cr upstream of NW 179th Street	T3N R1E S08	same as above	01-	same as above	same as above	same as above	same as above
Clark Co. [6]	28	Salmon Creek	CGR050	Cougar Cr dnstrm of NW 99th Street	T2N R1E S34	same as above	01 only	same as above	same as above	same as above	same as above
Clark Co. [6]	28	Salmon Creek	MIL010	Mill Cr upstream of Salmon Creek Avenue	T3N R1E S24	same as above	01-	same as above	same as above	same as above	same as above
Clark Co. [6]	28	Salmon Creek	CUR020	Curtin Cr dnstrm of NE 139th Street	T3N R2E S20	same as above	01-	same as above	same as above	same as above	same as above
Clark Co. [6]	28	Salmon Creek	CGR020	Cougar Cr upstream of NW 119th Street	T3N R1E S33	same as above	02-	same as above	same as above	same as above	same as above

Appendix K (cont.) Water Quality Monitoring Activities in WRIAs 27 and 28											
Agency	**WRIA**	**Watershed**	**Site No.**	**Monitoring Location**	**Lat/Long-TRS**	**Parameters**	**Yrs. Monitored**	**Test Frequency**	**Monitoring Objectives**	**Funding Sources**	**Data Mngt/ QA/QC**
Clark Co. [6]	28	Lacamas Creek	MAT010	Matney Cr upstream of NE 68th Street	T2N R3E S09	same as above	01-	same as above	same as above	same as above	same as above
Clark Co. [6]	28	Lacamas Creek	C1	Lacamas Creek upstream of Matney Creek	T2N R3E S09	same as above	83-92	~monthly	Lacamas Lake Monitoring	DOE Centennial Clean Water Fund	Addressed in Lacamas Lake Restoration Program
Clark Co. [6]	28	Lacamas Creek	C2	Matney Creek @ NE 68th St.	T2N R3E S09	same as above	83-91	same as above	same as above	same as above	
Clark Co. [6]	28	Lacamas Creek	C3	Fifth Plain Creek @ Fourth Plain Rd	T2N R3E S07	same as above	83-84	same as above	same as above	same as above	
Clark Co. [6]	28	Lacamas Creek	C4	Lacamas Creek @ Fourth Plain Rd	T2N R3E S07	same as above	83-85	same as above	same as above	same as above	
Clark Co. [6]	28	Lacamas Creek	C5	Lacamas Creek @ Goodwin Rd	T2N R3E S20	same as above	83-86	same as above	same as above	same as above	
Clark Co. [6]	28	Lacamas Creek	C6	Lacamas Creek @ Zellerbach	T2N R3E S02	same as above	83-90	same as above	same as above	same as above	
Clark Co. [6]	28	Lacamas Creek	LL1	Lacamas Lake @ NE shore	T2N R3E S27	same as above	83-87	same as above	same as above	same as above	
Clark Co. [6]	28	Lacamas Creek	LL2	Lacamas Lake @ Boat launch	T2N R3E S34	same as above	83-88	same as above	same as above	same as above	
Clark Co. [6]	28	Lacamas Creek	RL1	Round Lake @ North shore	T1N R3E S02	same as above	83-89	same as above	same as above	same as above	
Clark Co. [6]	28	Lacamas Creek	A1 (current name LAC050)	Lacamas Cr at Goodwin Road	T2N R3E S20	TSS, TP	99-	Monthly (some seasonal)	Long-term WQ status, effects of pollution loading (Ecology grant for Phase 1) [2]	same as above	same as above
Clark Co. [6]	28	Lacamas Creek	L1 (current name LACL11)	Lacamas Lk at center near deepest area	T2N R3E S27	Cond, Temp, pH, DO, TP, OP, TSS, NH3-N, NO2-NO3, TKN	99-	Monthly (some seasonal)	same as above	same as above	same as above
Clark Co. [6]	28	Lacamas Creek	L0 (current name LACL00)	Lacamas Lk outlet at SR 503	T1N R3E S02	TSS, TP	99-	Weekly (some seasonal)	same as above	same as above	same as above
Clark Co. [6]	28	Washougal River	JNS060	Jones Cr upstream of Camas water intake	T2N R4E S03	Cond, FC, DO, pH, Temp, Turb, E.coli, TP, NH3-N, NO2-NO3, TSS	01-	Monthly (Started October 2001)	Long term index, Trend	Clark County stormwater fees	Level 4 - per Ecology standards
Clark Public Utilities [3, 7, 8]	28	Salmon Creek	-	Salmon Creek at NW 36th St.	T3N R1E S20	DO, pH, temp, cond, FC, turb, TSS, TKN, Cl-, S03, NO2-NO3, OPDIS, TPP	95-01	Monthly and Quarterly (Long-term)	TMDL Study - Salmon Creek Monitoring	same as above	same as above
Clark Public Utilities [3, 7, 8]	28	Salmon Creek	-	Cougar Creek at NE 119th St.	T3N R1E S33	same as above	95-01	Monthly (Long-term)	same as above	same as above	same as above

Appendix K (cont.)
Water Quality Monitoring Activities in WRIAs 27 and 28

Agency	WRIA	Watershed	Site No.	Monitoring Location	Lat/Long-TRS	Parameters	Yrs. Monitored	Test Frequency	Monitoring Objectives	Funding Sources	Data Mngt/ QA/QC
Clark Public Utilities [3, 7, 8]	28	Salmon Creek	-	Salmon Creek @ Salmon Rd	T3N R1E S24	same as above	95-01	same as above	TMDL Study - Salmon Creek Monitoring	same as above	same as above
Clark Public Utilities [3, 7, 8]	28	Salmon Creek	-	Mill Creek @ Salmon Rd	T3N R1E S24	same as above	95-01	same as above	same as above	same as above	same as above
Clark Public Utilities [3, 7, 8]	28	Salmon Creek	-	Curtin Creek @ NE 139th St.	T3N R2E S20	same as above	95-01	same as above	same as above	same as above	same as above
Clark Public Utilities [3, 7, 8]	28	Salmon Creek	-	Salmon Creek at NE 122nd St.	T3N R2E S15	same as above	95-01	same as above	same as above	same as above	same as above
Clark Public Utilities [3, 7, 8]	28	Salmon Creek	-	Woodin Creek @ NE 122nd Av	T3N R2E S15	same as above	95-01	same as above	same as above	same as above	same as above
Clark Public Utilities [3, 7, 8]	28	Salmon Creek	-	Salmon Creek @ 199th St.	T3N R3E S03	same as above	95-01	same as above	same as above	same as above	same as above

Long-term - data collected every year. Basin - data collected for one year and may be revisited every five years.

Abbreviations: Cond (Conductivity), DO (Dissolved Oxygen), FC (Fecal Coliform), NH3-N (Ammonia Nitrogen), NO2-NO3(Nitrite-Nitrate), OPDIS (Phosphorous Soil Reaction), Press (Barometric Pressure), TSS (Total Suspended Solids), Temp (Temperature), TPP (Totabr

Notes:

1 Ecology monitoring protocols can be found in Ecology's publication "Stream Sampling Protocols for the Environmental Monitoring Trends Section"

2 Lacamas Lake Restoration Program: WY 2000 and WY 2001 Water Quality Monitoring, Clark Co. Public Works, Water Resources Section.

3 Monitoring of these sites is now the responsibility of the Clark County

4 Data from the Washington State Department of Ecology's websitewww.ecy.wa.gov/apps/watersheds/riv/stationlistbywria.asp?wria=28

5 Data from the Eleventh Annual Monitoring and Evaluation Report for the Gifford Pinchot National Forest for the fiscal year 2001.

6 Data from a Clark County Spreadsheet titled Water Resources Site Inventory and from a document titled Long-Term Index Site Monitoring Project: 2001 Data Summary by Clark County Public Works Water Resources Section

7 Data from the Salmon Creek Basin Monitoring and Management Implementation Plan Technical Memorandum Report, 2000, dated May 2001 prepared by Pacific Groundwater Group

8 Monitoring was changed during 2002, but is still ongoing. Monitoring at this site is being performed by Clark County rather than Clark County Public Utilities; the parameter list has changed slightly, and the sites have new station names to match the Couwas changed d