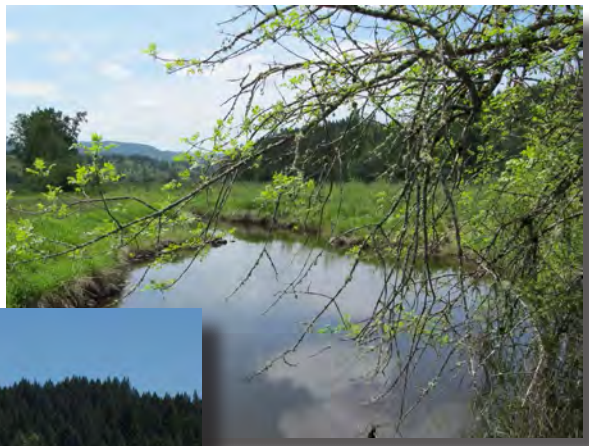
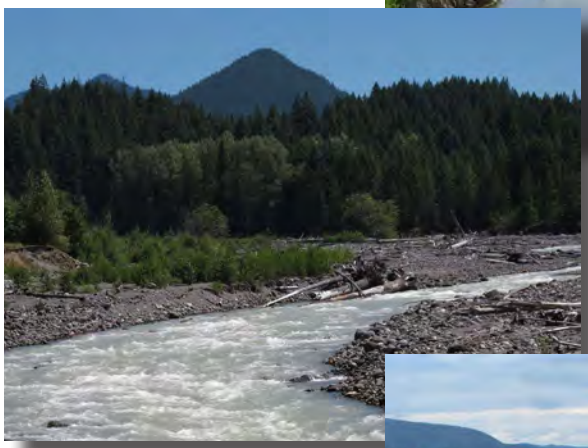
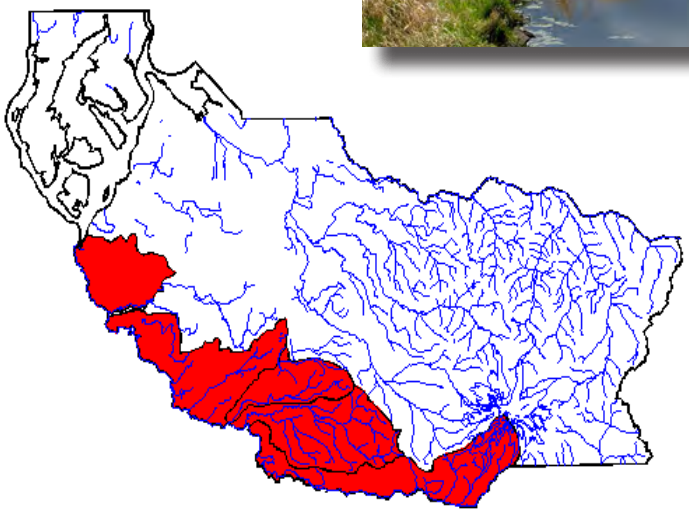
Nisqually River Basin Plan

VOLUME I - BASIN PLAN







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Pierce County

Public Works and Utilities

Surface Water Management

NISQUALLY RIVER BASIN PLAN

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NISQUALLY RIVER BASIN PLAN

EXECUTIVE SUMMARY

ES.1 INTRODUCTION

This Nisqually River Basin Plan (Basin Plan) is intended to serve as a comprehensive guide to storm drainage and surface water management activities in the portions of the Nisqually River Basin in unincorporated Pierce County. The Basin Plan was prepared by and for Pierce County Public Works and Utilities, Surface Water Management Division (Surface Water Management), the storm drainage and surface water management utility for unincorporated Pierce County. Figure ES-1 shows the Nisqually River Basin planning area.

Surface Water Management prepares basin plans to identify and prioritize capital improvement projects and other surface water management activities in individual drainage basins in the Surface Water Management service area. Basin plans address the flooding, water quality, and aquatic habitat problems in the stream drainages of non-federal lands in unincorporated Pierce County. Surface Water Management uses the basin plans to develop its capital improvement, maintenance and repair, property acquisition, and program budgets and schedules.

ES.2 GOALS AND OBJECTIVES

Before embarking on the basin planning process, Surface Water Management prepared a basin planning guidance document to promote consistency among the basin plans. The goals and objectives for the Nisqually River basin plan, listed in Table ES-1 below, are derived from the Surface Water Management guidance document. The goals and objectives listed in Table ES-1 will form the basic criteria for selection and prioritization of the actions recommended in the basin plan. This will help ensure consistency and comparability with Surface Water Management's other basin plans.

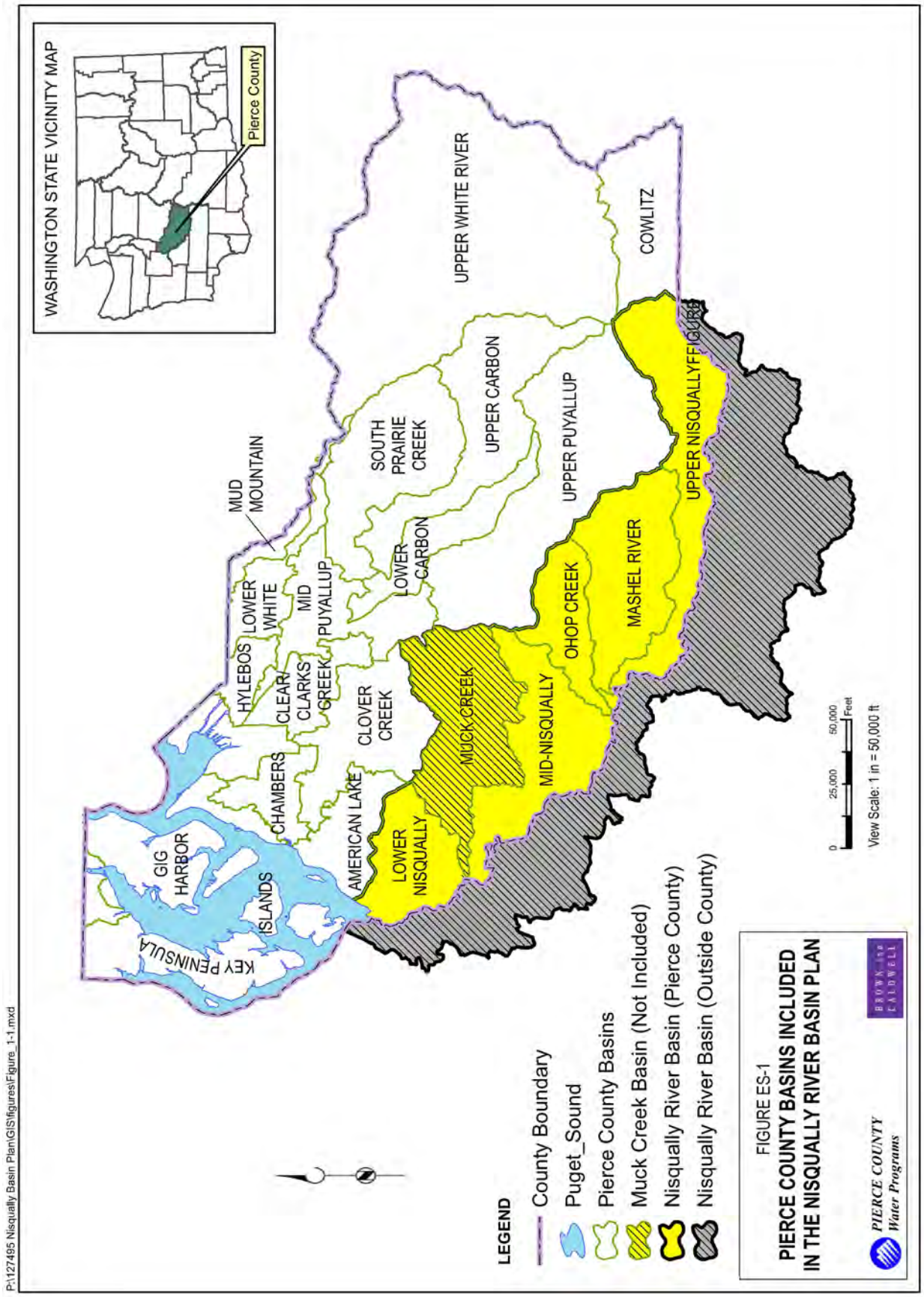

WASHINGTON STATE VICINITY MAP
Pierce County
UPPER WHITE RIVER
COWLITZ
UPPER NISQUALLY
UPPER CARBON
UPPER PUYALLUP
SOUTH PRAIRIE CREEK
MUD MOUNTAIN
LOWER CARBON
MASHEL RIVER
OHOP CREEK
LOWER WHITE
MID PUYALLUP
HYLEBOS
CLEAR CREEK
CLARKS
MUCK CREEK
MID-NISQUALLY
CLOVER CREEK
CHAMBERS
AMERICAN LAKE
LOWER NISQUALLY
GIG HARBOR
ISLANDS
KEY PENINSULA
0
25,000
50,000
Feet
View Scale: 1 in = 50,000 ft
LEGEND
County Boundary
Puget_Sound
Pierce County Basins
Muck Creek Basin (Not Included)
Nisqually River Basin (Pierce County)
Nisqually River Basin (Outside County)
FIGURE ES-1
PIERCE COUNTY BASINS INCLUDED IN THE NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
P:\127495 Nisqually Basin Plan\GIS\figures\Figure_1-1.mxd

TABLE ES-1
Goals and Objectives of the Nisqually River Basin Plan

Goal	Objectives
Reduce flood hazards	Property loss and repetitive damage are reduced. Streams will not be adversely impacted by flood events. Pierce County standing under the Federal Emergency Management Agency's Community Rating System is improved. New development is located outside of flood-prone areas.
Improve fish habitat	Number of stream miles available for wild, native fish populations is increased. Population numbers of species listed as endangered or threatened under the ESA are maintained or increased. Quality and quantity of available wetlands and riparian habitat is improved.
Improve water quality	State Surface Water Quality Standards (WAC 173-201a) are met. Number of impaired (303d listed) water bodes is reduced. Pierce County complies with its NPDES permit for stormwater by meeting permit terms and condition to the maximum extent practicable. Risk of groundwater contamination is reduced. Rates of erosion are reduced.
Demonstrate coordinated and responsible use of public resources	Cost of maintaining stormwater facilities are reduced. Project value is favorable when measured in terms of costs and benefits. Polls demonstrate that public awareness of flooding, fish habitat, and water quality issues has increased. Monitoring and enforcement programs demonstrate an increase in services per dollar spent. Basin plan implementation addresses elements of other Pierce County plans. Other agencies and jurisdictions use basin plan to support their surface water management activities.
Influence location and methods for new development	Low Impact Development techniques are widely used. Effective BMPs are identified and widely used.

Source: Guidance for Basin Planning, Pierce County Surface Water Management,, Pierce County Public Works & Utilities, Surface Water Management; Pierce County Storm Drainage and Surface Water Management Advisory Board, June 2005.

ES.3 NISQUALLY RIVER BASIN

The Nisqually River basin planning area encompasses approximately 240 square miles within the 760-square mile Nisqually River Watershed. The Nisqually River Basin Plan differs from other Surface Water Management basin plans in a few respects:

- The Nisqually River Basin Plan (NRBP) addresses certain Nisqually River mainstem issues as they pertain to water quality and habitat. The plan recognizes the mainstem Nisqually River conditions and problems but does not address solutions to flooding problems. The Pierce County Rivers Comprehensive Flood Hazard Management Plan (Rivers Plan) addresses mainstem flooding. Although the NRBP suggests studies and programmatic actions related to certain mainstem issues not covered in the Rivers Plan, the emphasis of this plan is on the conditions, problems, and solutions of tributaries to the Nisqually River.
- Pierce County is updating the 1991 Puyallup River Comprehensive Flood Control Management Plan and including the Nisqually River and the portion of the Mashel River with peak flows exceeding 5,000 cubic feet per second. This update is known as the Pierce County Rivers Flood Hazard Management Plan (Rivers Plan). The Rivers Plan will address Nisqually River and Mashel River mainstem flooding problems and issues.
- **The planning area is large.** The Nisqually planning area is more than five times larger than the next largest planning area and includes more than 500 miles of streams. Therefore, the basin characterization approach was adjusted to efficiently cover such a large area.
- **The planning area is mostly rural and new development is expected to be limited.** Existing flooding problems outside of the mainstem tend to be localized and isolated. For example, 60 out of the 89 flooding problems identified are related to roadway flooding. Beaver activity and debris accumulations cause a number of the problems. The Basin Plan recommends capital improvement projects for some of these problems, and programmatic measures for others.
  Based on the current zoning and community plans, future development in the planning area is expected to be relatively low density. Effective impervious areas are not expected to increase much; only five of the 23 subbasins are projected to experience EIA increases of more than 1%. More intense development may occur in several small areas near Roy, Eatonville, and the Mount Rainier National Park boundary.
  To reduce the potential for flooding and streambank erosion problems due to new impervious surfaces, the Basin Plan recommends several programmatic measures, such as low impact development and updating the *Pierce County Stormwater Manual*.
- **The planning area contains some of the best salmon habitat in the Puget Sound lowlands.** The Nisqually mainstem and its major tributaries provide high-quality habitat for a number of salmon species. The Nisqually Tribe and other agencies have been collecting field data and analyzing fish habitat conditions throughout the basin for nearly 30 years, creating a substantial body of information on river and stream conditions, problems, and restoration/preservation needs. The Nisqually River basin planning

approach has been tailored to take full advantage of the river and stream data collected by the Tribe. The Basin Plan recommends an array of capital improvement projects, programmatic measures, and studies to restore and protect key aquatic habitat.

- **The Nisqually Basin planning area contains a large number of lakes.** The basin planning area encompasses more than 16 lakes, which present unique water quality issues. The Basin Plan addresses these issues through a recommendation for a lakes water quality management plan.

ES.4 PROBLEMS, ANALYSIS, AND RECOMMENDATIONS

The problems identified through investigation were grouped into three general categories for analysis and development of recommendations: flooding and drainage, water quality, and aquatic habitat. A brief summary of the problems and recommended solutions for each of these categories is provided below.

ES.4.1 Flooding and Drainage Problems, Analysis and Recommendations

Flooding and drainage problems fell into three general types of flooding: mainstem flooding, local flooding (along tributaries and roadways), and Lake flooding.

Mainstem Flooding

As discussed in Chapter 6, the existing hydrology data, hydraulic modeling, and floodplain mapping for the Nisqually River are outdated and insufficient for accurate evaluation, design, and implementation of sound flood hazard reduction measures. Mainstem flood control measures can be quite costly, and implementing ineffective measures could have serious consequences.

Mainstem flooding will be addressed in the Pierce County Rivers Flood Hazard Plan rather than this plan.

The Lower Nisqually River Flood Mitigation Program (PRG11-01) originally recommended a series of actions including:

- Updating Emergency Response Plan
- Revision of the Flood Hazard Mapping – Wilcox Flats Reach of the Nisqually River

The former will be addressed in the Pierce County Hazard Mitigation Plan. The latter will be addressed in the Pierce County Rivers Flood Hazard Management Plan.

Local Flooding

Most of the local flooding problems identified were related to roadway flooding. An initial screening process was used to separate problems for analyses. Many problems were eliminated from further analysis because they were considered maintenance issues, located on

private roads, or attributed to beaver activity. Of the remaining problems, hydrologic and hydraulic analyses found 11 under-sized culverts and recommended culvert replacements.

- Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit
- Evaluate Beaver Management Policy

Lake Flooding

No new hydrologic studies were performed for the lakes where flooding was reported. Alternatively, available information was collected and outlet conditions were investigated in the field for several of the lakes. In general, lake flooding tended to be the result of blockages at the outlet caused by debris build-up, beavers, or invasive weeds. Programmatic recommendations contained in the basin plan that will address these issues include:

- Develop and Implement Nisqually Riparian Vegetation Management Plan
- Evaluate Beaver Management Policy

ES.4.2 Water Quality Problems, Analysis and Recommendations

Several water bodies within the Nisqually planning area have been identified as "polluted" by the Washington State Department of Ecology (DOE). Non-point sources, such as livestock pollution and septic systems, are the primary cause of the water quality problems. To address these problems, the Basin Plan prescribes a number of programmatic measures including public education, riparian area management, small farm planning, surface water monitoring, septic system inspection coordination, and support for the Nisqually River Council's non-point source control program. Recommended programmatic measures include:

- Develop and Implement an Education, Outreach, and Technical Assistance Program
- Implement Elements of Shellfish Protection Program
- Develop and Implement a "Lake Water Quality Management Program"
- Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems
- Implement Elements of Nisqually Bacteria "Total Maximum Daily Load" (TMDL) *Water Quality Implementation Plan*

ES.4.3 Aquatic Habitat Problems, Analysis and Recommendations

Much of the Nisqually mainstem is still in very good condition, especially compared to most other lowland Puget Sound rivers in urbanizing areas. The mainstem of the river is still a very productive habitat for all species of salmon that are currently found in the Nisqually. However, there have been some losses of habitat due to declines in channel stability, habitat diversity, food availability, and key habitat features.

The aquatic habitat problems have multiple causes that will require a range of solutions; from non-structural programmatic actions to structural measures. The solutions were tailored to address the main causes of habitat degradation as determined by field observations and analysis.

The capital improvement program projects developed to address habitat problems include:

- Wetland, channel migration zone, and floodplain preservation through property acquisition
- Removing fish passage barriers
- Wetland, instream, and riparian habitat restoration
- Revegetation projects

Programmatic measures are recommended to improve aquatic habitat and address problems:

- Develop and Implement a Lake Water Quality Management Program
- Develop and Implement Countywide Vegetation Management
- Nutrient Enhancement using Salmon Carcasses
- Enhance Nisqually River Council Capacity

ES.5 BASIN PLAN SUMMARY

The Nisqually River Basin Plan contains 36 capital improvement projects, 21 programmatic measures, and 18 studies. Capital improvement projects and programmatic measures have been divided into "High-Priority," "Medium-Priority," and "Low-Priority"[1] groups. Studies were not prioritized with the capital improvement projects and the programmatic measures. Estimated costs of recommendations by priority group are as follows:

"High-Priority" Recommendations: $6,491,170

"Medium-Priority" Recommendations: $11,657,010

"Low-Priority" Recommendations: $4,715,600

In addition, this Basin Plan recommends further studies to fill information gaps. The total estimated cost for these studies is **$1,363,500**.

Table ES-2 presents the estimated cost of the Nisqually River Basin Plan recommendations by project type and priority group. Tables ES-3, ES-4, and ES-5 list the capital projects and programmatic measures in each priority group. Table ES-6 lists the recommended studies.

[1] "Low-Priority" does not mean "not a priority." "No Priority" actions have already been excluded from this Basin Plan. Rather, "Low-Priority" means the project rated lower than other needs in the Basin.

Problems identified in the Basin Plan are tabulated at the ends of Chapters 6, 7 and 8. These tables provide a cross reference between problems and recommendations.

TABLE ES-2
Estimated Costs of Plan Recommendations

Project Type	High-Priority	Medium-Priority	Low-Priority
Capital Improvement Projects	$1,682,670	$11,340,010	$4,388,600
Programmatic Measures	$4,808,500	$317,000	$327,000
Studies	$1,363,500		
Total Estimated Cost:	**$24,227,280**		

TABLE ES-3
High-Priority Recommended Projects

ID Code	Project Title	Rating Score	Estimated Cost
PRG00-02	Update Stormwater Management Manual	385	$1,000
PRG00-08	Develop and Implement a BMP Manual for Pierce County Surface Water Management Maintenance Activities	385	$6,000
PRG00-04	Develop and Implement a Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation	385	$7,000
PRG00-06	Develop and Implement an Education, Outreach, and Technical Assistance Program	396	$28,000
CIP08-RED-RST01	Red Salmon Slough Estuary Restoration Phase III	297	$60,270
PRG00-05	Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality	291	$92,000
PRG00-01	Implement a Low Impact Development Program	348	$116,000
PRG00-13	Implement Elements of Shellfish Protection Program	310	$116,000
PRG00-16	Develop and Implement Countywide Vegetation Management Program	325	$136,500
PRG00-03	Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit	398	$170,000
PRG00-09	Develop and Implement an Invasive Species Management Program	361	$806,000
CIP11-TWU-AC01	Tanwax Creek Wetland Protection Phase 1	251	$811,200
CIP11-TWU-AC02	Tanwax Creek Wetland Protection Phase 2	251	$811,200
PRG00-15	Develop and Implement a Lake Water Quality Management Program	362	$2,765,000

PRG00-15	Develop and Implement a Lake Water Quality Management Program	362	$2,765,000
PRG11-03	Enhance Nisqually River Council Capacity	332	$375 ,000
PRG11-01(b)	Revise Flood hazard Maps Nisqually River Wilcox Flat Reach	264	$80,000
		Total Estimated Cost:	**$6,006,170**

TABLE ES-4
Medium-Priority Recommended Projects

ID Code	Project Title	Rating Score	Estimated Cost
PRG00-11	Beaver Management Policy	217	NA
PRG00-12	Encourage Installation of Permanent Buffer Markings and/or Signage	243	$6,000
PRG00-14	Develop and Implement a Habitat Monitoring Program	196	$6,000
PRG11-05	Implement Elements of Nisqually Bacteria TMDL Water Quality Implementation Plan	240	$58,000
PRG11-04	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems	183	$116,000
PRG00-07	Develop and Implement a Surface Water Monitoring Program	239	$131,000
CIP20-MAL-RST01	Mashel Eatonville reach in Stream Restoration Phase II	242	$149,215
CIP20-MAL-VC01	Mashel Eatonville Reach Raparian ReVegetation	221	$226,800
CIP11-NIS-AC02 (renumbered to CIP11-NIS-AC01)	Nisqually River Mainstem Acquisition Phase II	195	$1,060,800
CIP11-NIS-AC03 (renumbered to CIP11-NIS-AC02)	Nisqually River Mainstem Acquisition Phase III	195	$1,060,800
CIP20-MAL-AC03	Mashel Small Properties Acquisitions	174	$617,800
CIP11-NIS-RST01	Nisqually River Wilcox Side Channel	148	$302,300
CIP20-MAL-AC02	Mashel Shoreline Buffer Acquisition	171	$848,700
CIP20-MAL-AC01	Mashel Property Acquisition	161	$663,000
CIP11-NIS-RST03	Mainstem off Channel Restoration	148	$747,200
CIP11-KRG-C01	Silver Lake Culvert Replacement	151	$217,600
CIP11-NIS-AC04	Wilcox Flats Repetitive Loss Acquisition	198	$222,300
CIP19-ASH-C01	Culvert Replacement at 278th Avenue East	147	$288,100
CIP14-OHL-RST01	Lower Ohop Valley Restoration Phase 1 (Segments D, E, and F)	242	$404,595

TABLE ES-4
Medium-Priority Recommended Projects

ID Code	Project Title	Rating Score	Estimated Cost
CIP11-BRI-C01	Upper Brighton Creek Culvert Replacements	180	$448,300
CIP14-OHU-AC01	Upper Ohop Shoreline Protection (Hancock-Ohop) Phase 1	177	$572,100
CIP14-OHU-AC02	Upper Ohop Shoreline Protection (Hancock-Ohop) Phase 2	177	$572,100
CIP14-OHL-RST02	Lower Ohop Valley Restoration Phase 2 (Segments A, B, and C)	242	$606,600
CIP14-OHL-AC04	Ohop Creek Repetitive Loss Property Acquisition	195	$606,800
CIP14-OHL-AC01	Ohop Creek Property Acquisition Phase 1	241	$617,800
CIP14-OHL-AC02	Ohop Creek Property Acquisition Phase 2	174	$618,900
CIP14-OHL-AC03	Ohop Creek Property Acquisition Phase 3	174	$618,900
CIP19-COP-AC01	Upper Nisqually Property Acquisition	213	$748,300
CIP14-OHL-RST03	Lower Ohop Valley Restoration Phase 3 (Segments G, H, I, J, K, and L)	242	$799,600
		Total Estimated Cost:	**$13,335,610**

TABLE ES-5
Low-Priority Recommended Projects

ID Code	Project Title	Rating Score	Estimated Cost
PRG00-10	Require Flood Disclosure Statements on Property Titles	123	$7,000
CIP11-CLR-C01	West Clear Lake Road Culvert	69	$108,100
CIP11-HRN-FP01	Horn Creek Barrier Removal (waterfall at RM1.0)	114	$126,100
CIP11-TWU-C02	Webster Road Culvert Replacement	102	$136,600
CIP11-TWL-C01	Culvert Replacement at 365th Street East	76	$180,100
CIP11-TWU-C03	Culvert Replacement at Thomas Road	82	$196,800
CIP11-TWU-C01	Benbow Drive Culvert Replacement	143	$198,600
CIP11-MUR-C01	Tisch Road South Culvert Replacement	60	$230,700
CIP11-HRN-FP02	Horn Creek Barrier Removal (Hart Lake Loop Rd.)	136	$282,500
CIP11-KRG-C02	Dean Kreger Road Culvert Replacement and Slope Stabilization	128	$285,900
CIP11-HRT-C01	Hart's Lake Loop Road Culvert Replacement	139	$288,300
PRG11-02	Nutrient Enhancement using Salmon Carcasses	81	$320,000
CIP11-HRN-C01	364th Street East Culvert Replacement	76	$443,100
CIP11-TWL-RST01	Lower Tanwax Riparian Enhancement	145	$738,600
CIP11-BRI-FP01	Brighton Creek Culvert Replacement (Harts Lake Loop Rd.)	121	$788,700
CIP11-NIS-RST02	Wilcox Flats Off Channel Rest	142	$384,500
		Total Estimated Cost:	**$4,715,600**

Table ES-6
Studies and Costs

Study Number	Name	Estimated Cost
ST11-BRI-ST01	Brighton Creek Barrier Removal Assessment (62nd Ave. S.)	$5,500
ST11-HRN-ST01	Horn Creek Barrier Removal Assessment (368th St. S.)	$5,500
ST11-HRT-ST01	Harts Creek / Harts Lake Habitat Assessment	$75,000
ST11-MUR-ST01	Lower Murray Restoration Assessment	$85,000
ST11-MUR-ST02	Murray, Brighton and Horn Creek Wetlands Restoration Assessment	$275,000
ST11-MUR-ST03	Murray Creek Barrier Removal Assessment (48th Ave. S., RM 6.2)	$5,500
ST11-MUR-ST04	Murray Creek Barrier Removal Assessment (pipeline crossing, RM 7.2)	$5,500

Table ES-6
Studies and Costs

Study Number	Name	Estimated Cost
ST11-MUR-ST05	Murray Creek Hydrologic Study and Flood Hazard Mapping	$95,000
ST11-NIS-ST01	Mainstem Nisqually LWD Assessment and Restoration Plan	$125,000
ST11-TWL-ST01	Cranberry and Rapjohn Lakes Assessment	$75,000
ST11-TWL-ST02	Lower Tanwax Sediment Reduction Assessment	$50,000
ST11-TWU-ST01	Tanwax Valley Restoration Assessment	$275,000
ST11-TWU-ST02	Eatonville Cutoff Road Culvert Replacement Assessment (Mud Creek)	$5,500
ST11-TWU-ST03	Eatonville Cutoff Road Culvert Replacement Assessment (Tanwax Creek)	$5,500
ST11-TWU-ST04	Trout Creek at 352nd Street East Culvert Replacement Assessment	$5,500
ST14-OHU-ST01	Clay City Sediment Reduction Assessment	$70,000
ST19-NIS-ST03	Analysis of Flooding at State Route 7 in Community of Elbe	$150,000
ST20-LMR-ST01	Lower Mashel Restoration Assessment	$50,000
	Total Estimated Cost	**$1,363,500**

CHAPTER ONE
INTRODUCTION

The Pierce County Public Works and Utilities Department, Surface Water Management (Surface Water Management) is responsible for surface water management in unincorporated Pierce County. Surface Water Management plans, designs, secures permits for, builds, and maintains storm drainage and surface water management facilities. Surface Water Management also identifies non-structural solutions to surface water problems, such as monitoring needs, enforcement, or services.

Surface Water Management advises and works with other entities, local jurisdictions, and with private interests to ensure that storm drainage and surface water issues are dealt with by appropriate parties as close as possible to the source of the problem.

Related responsibilities include compliance with the stormwater quality requirements of the federal *Clean Water Act*, the Pierce County's (County) *Municipal Stormwater National Pollutant Discharge Elimination System* (NPDES) permit, state waste discharge permit, and certain fish habitat protection activities.

Other Surface Water Management responsibilities and activities include river levee maintenance, emergency response during floods; stream gauging, water quality monitoring, rainfall data gathering, water supply planning, and providing public information.

Fees paid by property owners in unincorporated Pierce County and grant funds pay for these facilities and services.

1.1 BASIN PLANNING PROGRAM

Surface Water Management prepares basin plans to identify and prioritize capital improvement projects and other Surface Water Management activities in individual drainage basins. Basin plans comprehensively address the flooding, water quality and fish habitat aspects of surface water management in the major stream systems of the non-federal lands within unincorporated Pierce County.

The basin plans are updates of the county-wide *Pierce County Storm Drainage and Surface Water Management Plan* (Montgomery Engineers Inc., 1991), referred to here simply as the *1991 Plan*, by identifying and addressing the flooding, water quality, and stream habitat problems in more detail than was possible in 1991. In addition, the basin plans address the relevant requirements of major federal, state and Pierce County laws, regulations, and policies enacted since the *1991 Plan*, such as the *State Growth Management Act*, NPDES, Total Maximum Daily Load (TMDL) requirements of the federal *Clean Water Act*, FEMA's *Community Rating System* (CRS), and the fish listings under the federal *Endangered Species Act* (ESA).

The basin plans will be implemented primarily through Surface Water Management activities. However, Surface Water Management will share information from basin plans with other

entities, non-profit organizations, tribes, and jurisdictions to identify needs and resolve issues that might most effectively be dealt with by those agencies.

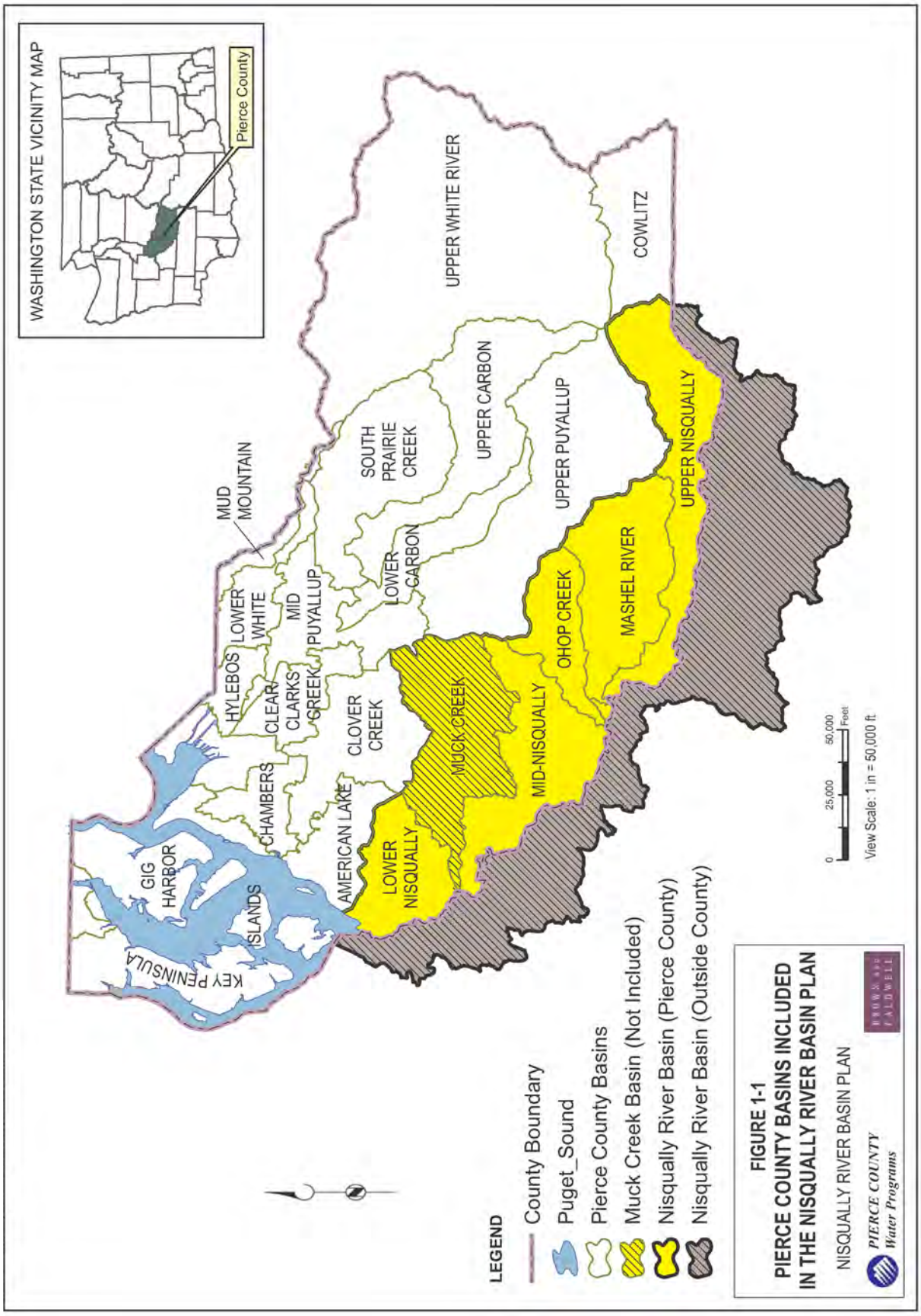
The *Nisqually River Basin Plan* is one of 10 basin plans developed by Surface Water Management. Figure 1-1 shows the location of the Nisqually River basin relative to the other drainage basins in Pierce County. Basin plans have been completed or are underway for other drainage basins in unincorporated Pierce County.

Basin plans identify existing conditions that affect storm drainage and surface water, forecast future hydrological conditions, identify existing and potential problems, and evaluate alternative solutions based on technical, environmental, and cost considerations. The basin plans are used to develop Surface Water Management' capital improvement, maintenance, repair, property acquisition, and program schedules and budgets.

The basin plans concentrate on remedies for frequently flooded areas, water quality problems, fish habitat protection, and other surface water management concerns in the unincorporated parts of Pierce County. Drainage facilities within incorporated cities and towns, national forests, certain timber lands, tribal lands, parks, and military bases are not within the scope of basin plans unless they affect surface water management in unincorporated areas within the basin plan service area.

The basin planning process involves three phases:

- **Phase 1 - *Basin Characterization***. This phase consists of inventorying and documenting existing conditions, such as a history of flooding, water quality and fish habitat problems; existing storm drainage and surface water management facilities; the regulatory environment; existing and future land use; stream flow characteristics; stream reaches and associated wetlands; other critical areas; the creek's ability to support various fish species; and the fish species present. It also identifies key problem areas and data gaps that are addressed in *Phase 2*. A basin characterization report is developed to document the results of *Phase 1* of the Nisqually River basin planning process.
- **Phase 2 - *Plan Development and Adoption***. This phase builds on the findings of *Phase 1* by filling information gaps, correcting information, performing hydrologic analyses based on planned future conditions, investigating problems, identifying solutions, and recommending solutions.
- **Phase 3 – *Implementation and Monitoring***. This phase consists of plan implementation, on-going monitoring, and future plan updates.


WASHINGTON STATE VICINITY MAP
Pierce County
UPPER WHITE RIVER
COWLITZ
UPPER CARBON
UPPER PUYALLUP
UPPER NISQUALLY
SOUTH PRAIRIE CREEK
MUD MOUNTAIN
LOWER CARBON
MASHEL RIVER
OHOP CREEK
LOWER WHITE
MID PUYALLUP
HYLEBOS
CLEAR CREEK
CLARKS CREEK
CLOVER CREEK
MUCK CREEK
MID-NISQUALLY
CHAMBERS
AMERICAN LAKE
LOWER NISQUALLY
GIG HARBOR
ISLANDS
KEY PENINSULA
0 25,000 50,000 Feet
View Scale: 1 in = 50,000 ft
LEGEND
County Boundary
Puget_Sound
Pierce County Basins
Muck Creek Basin (Not Included)
Nisqually River Basin (Pierce County)
Nisqually River Basin (Outside County)
FIGURE 1-1
PIERCE COUNTY BASINS INCLUDED
IN THE NISQUALLY RIVER BASIN PLAN
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL

1.2 PLANNING AREA

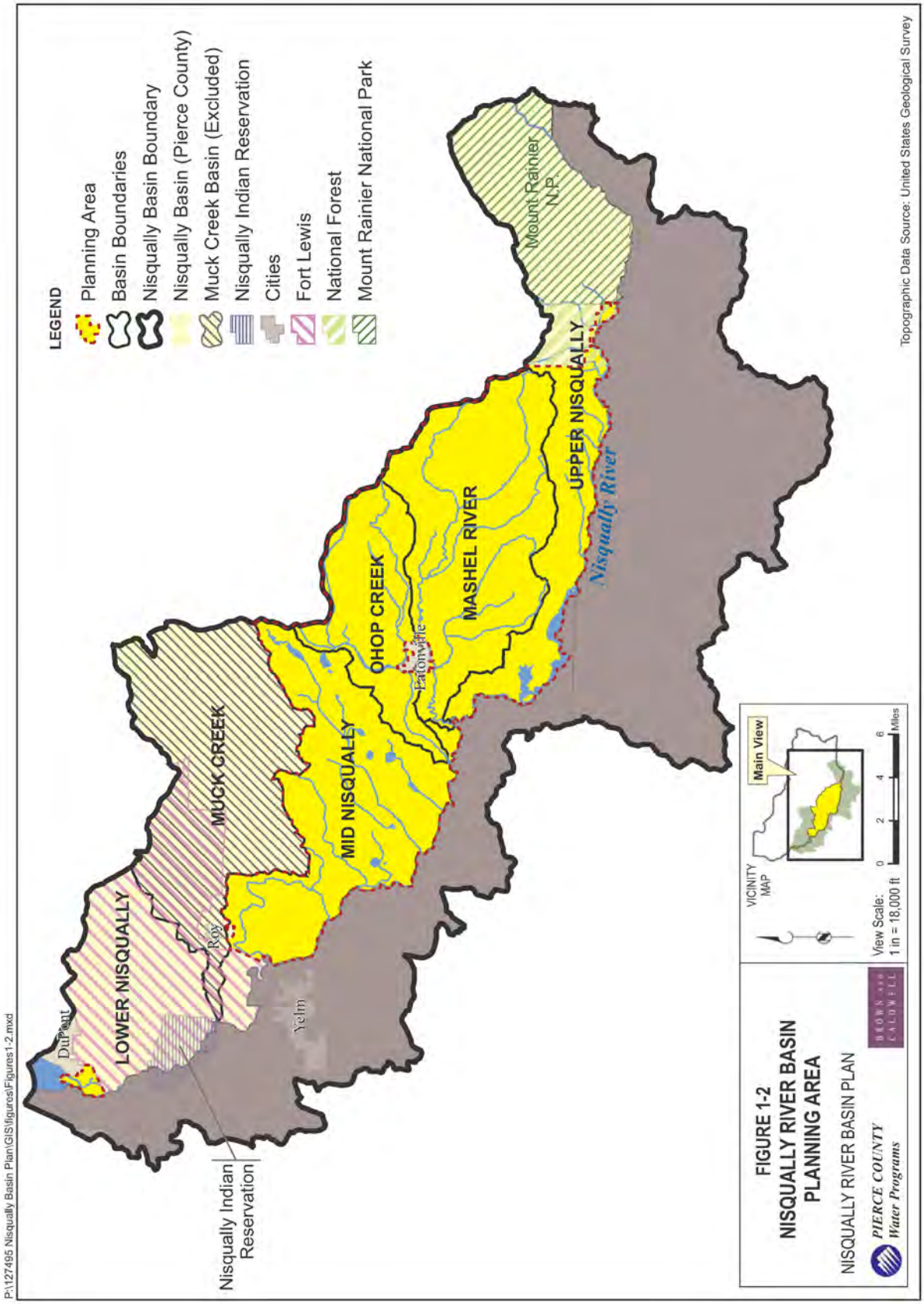
The Nisqually River originates on Mount Rainier and flows approximately 78 miles before discharging into Puget Sound. It is the only river in the nation with its headwaters in a national park and its estuary in a national refuge. The Nisqually River drains an area of approximately 760 square miles.

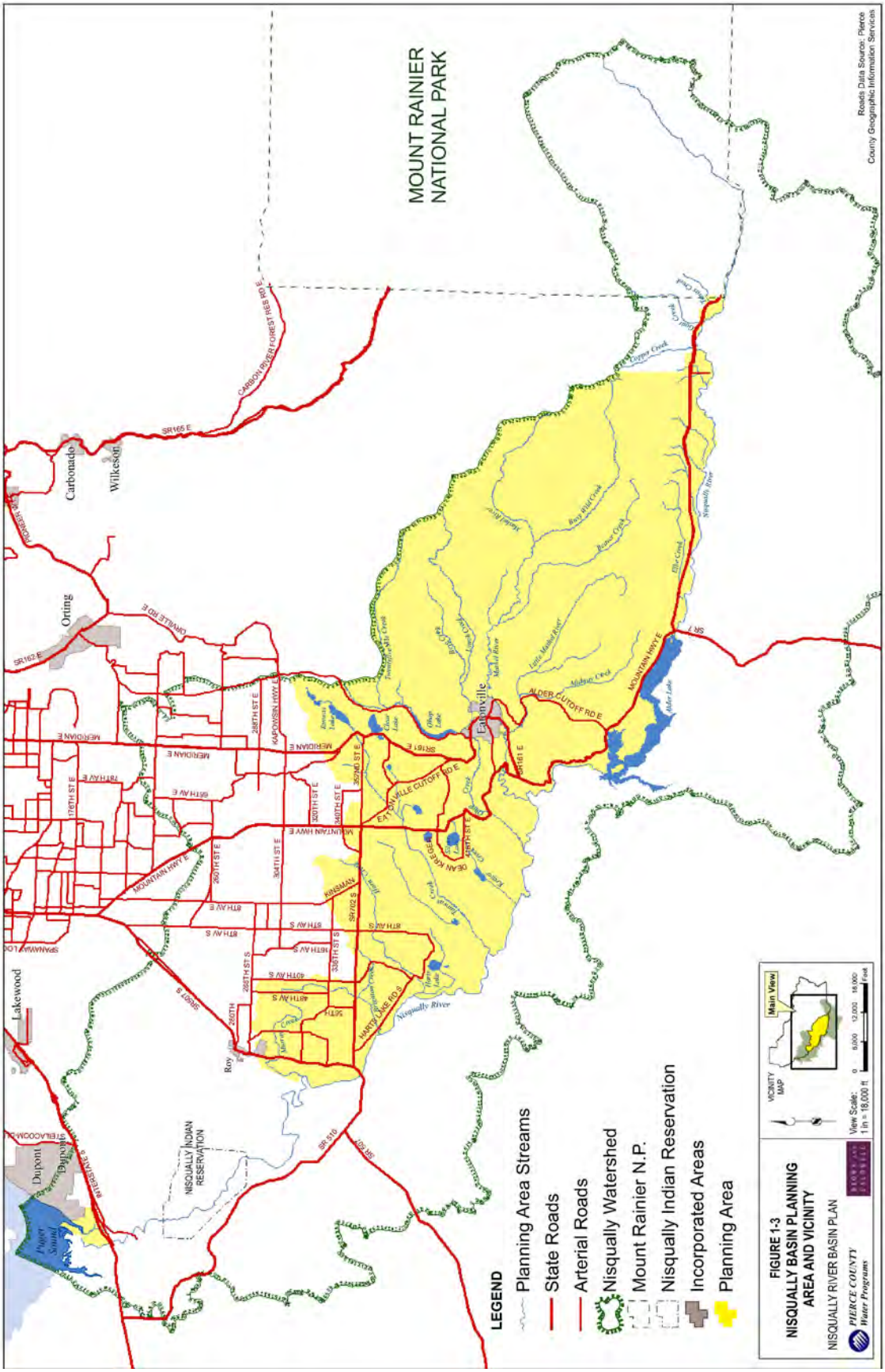
The Washington State Department of Ecology (Ecology) has designated the Nisqually River basin as "Water Resource Inventory Area" (WRIA) 11. The Nisqually River basin planning area includes the unincorporated Pierce County portion of WRIA 11, exclusive of the Muck Creek Basin. The Muck Creek Basin was addressed separately by the Muck Creek Basin Plan (2004). Moreover, the Nisqually Basin Plan does not cover areas of the Basin that lie within other jurisdictions. This includes incorporated towns and cities, commercial timber lands regulated by the Washington State Department of Natural Resources (DNR), Thurston and Lewis counties, and federal lands; except where activities in these areas may contribute to surface water management problems in unincorporated Pierce County. Figure 1-2 shows the 240 square mile planning area. Figure 1-3 shows the planning are and vicinity. Chapter 4 of this report describes the general characteristics of the planning area.

1.2.1 Key Elements of the Basin Plan

Key elements that will be addressed in the Nisqually River Basin Plan are:

- **Existing Conditions**
  - ✓ Characterization of topography, soils, current and future flow volume, water quality, fish habitat, and land cover factors influencing surface water runoff.
- **Problems**
  - ✓ Flooding due to surface water and/or groundwater.
  - ✓ Surface water quality impairment related to stormwater runoff.
  - ✓ Stream and riparian habitat degradation due to stormwater.
- **Impacts**
  - ✓ Negative effects of stormwater runoff affect the ability to meet federal, state, and local regulations.
  - ✓ Property damage from flooding, inadequate drainage or high groundwater.
  - ✓ Threats to public health and safety (road inundation, impaired surface water quality, etc.).
- **Solutions**
  - ✓ Capital projects (e.g., flood control facilities, creek and watershed restoration, etc.).
  - ✓ Direct or indirect control of land uses (e.g., planning, zoning, buffers, stormwater facility design standards, etc.).
  - ✓ Basin-specific development standards (e.g., discharge rates and volume control).
  - ✓ Storm drainage system maintenance activities.
  - ✓ Additional research or on-going monitoring.
  - ✓ Other activities as appropriate.


LEGEND
Planning Area
Basin Boundaries
Nisqually Basin Boundary
Nisqually Basin (Pierce County)
Muck Creek Basin (Excluded)
Nisqually Indian Reservation
Cities
Fort Lewis
National Forest
Mount Rainier National Park
LOWER NISQUALLY
MUCK CREEK
MID NISQUALLY
OHOP CREEK
MASHEL RIVER
UPPER NISQUALLY
Nisqually River
Mount Rainier N.P.
DuPont
Roy
Yelm
Eatonville
Nisqually Indian Reservation
VICINITY MAP
Main View
View Scale: 1 in = 18,000 ft
0 2 4 6 Miles
FIGURE 1-2
NISQUALLY RIVER BASIN PLANNING AREA
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
Topographic Data Source: United States Geological Survey
P:\127495 Nisqually Basin Plan\GIS\figures\Figures1-2.mxd


MOUNT RAINIER NATIONAL PARK
Roads Data Source: Pierce County Geographic Information Services
Carbonado
Wilkeson
Orting
Eatonville
Lakewood
Dupont
Steilacoom
Puget Sound
Roy
NISQUALLY INDIAN RESERVATION
Nisqually River
LEGEND
Planning Area Streams
State Roads
Arterial Roads
Nisqually Watershed
Mount Rainier N.P.
Nisqually Indian Reservation
Incorporated Areas
Planning Area
VICINITY MAP
Main View
View Scale: 1 in = 18,000 ft
0 6,000 12,000 18,000 Feet
FIGURE 1-3
NISQUALLY BASIN PLANNING AREA AND VICINITY
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs

Statement of purpose

The purpose of the *Nisqually Basin Plan* is to establish the actions Pierce County will take and what is needed to reduce flood hazards, protect water quality, and to protect fish and wildlife habitat in the Nisqually River Drainage Basin. To determine basin plan actions and needs, consideration is given to the following: physical characteristics of the basin; laws, policies and regulations that apply to surface water management in Pierce County; the preferences of citizens in the County and in the Nisqually River Basin; and the character of existing land use and planned growth as set out in the *Comprehensive Plan for Pierce County, Washington*.

1.3 PLAN GOALS AND OBJECTIVE

Before embarking on the basin planning process, Surface Water Management prepared a basin planning guidance document to promote consistency among the basin plans. The goals and objectives for the Nisqually River basin plan, listed in Table 1-1 below, are derived from the Surface Water Management' guidance document. These will form the basic criteria for selection and prioritization of the actions recommended in the basin plan. This will help ensure consistency and comparability with Water Program's other basin plans.

The Nisqually River Basin Plan differs from the other Surface Water Management' basin plans in several respects:

- Surface Water Management' other basin plans do not address mainstem flooding, because these issues are being addressed through flood hazard management plans. Flood hazard management plans have been developed for the other large rivers in Pierce County, but not for the Nisqually River.
- The Nisqually Basin Plan is larger and more rural in nature than the other basins.
- Unlike the other basins, extensive fish habitat analysis data is available for the Nisqually River and its tributaries. The Nisqually Tribe has been collecting field data and analyzing fish habitat conditions throughout the basin for more than 20 years, and has amassed a substantial body of information on river and stream conditions, problems, and restoration or protection needs. The Nisqually River Basin planning approach has been tailored to take full advantage of the river and stream data collected by the Nisqually Tribe.

TABLE 1-1
Goals and Objectives of the Nisqually River Basin Plan

Goal	Objectives
Reduce flood hazards	Property loss and repetitive damage are reduced. Streams will not be adversely impacted by flood events. Pierce County standing under the Federal Emergency Management Agency's Community Rating System is improved. New development is located outside of flood-prone areas.
Improve fish habitat	Number of stream miles available for wild, native fish populations is increased. Population numbers of species listed as endangered or threatened under the ESA are maintained or increased. Quality and quantity of available wetlands and riparian habitat is improved.
Improve water quality	State Surface Water Quality Standards (WAC 173-201a) are met. Number of impaired (303d listed) water bodes is reduced. Pierce County complies with its NPDES permit for stormwater by meeting permit terms and condition to the maximum extent practicable. Risk of groundwater contamination is reduced. Rates of erosion are reduced.
Demonstrate coordinated and responsible use of public resources	Cost of maintaining stormwater facilities are reduced. Project value is favorable when measured in terms of costs and benefits. Polls demonstrate that public awareness of flooding, fish habitat, and water quality issues has increased. Monitoring and enforcement programs demonstrate an increase in services per dollar spent. Basin plan implementation addresses elements of other Pierce County plans. Other agencies and jurisdictions use basin plan to support their surface water management activities.
Influence location and methods for new development	Low Impact Development techniques are widely used. Effective BMPs are identified and widely used.

Source: *Guidance for Basin Planning, Pierce County Surface Water Management*,, Pierce County Public Works & Utilities, Surface Water Management; Pierce County Storm Drainage and Surface Water Management Advisory Board, June 2005.

CHAPTER TWO
APPLICABLE PROGRAMS, POLICIES, AND REGULATIONS

Numerous federal, state, and local regulations, laws, policies, and programs may affect stormwater and surface water management in unincorporated Pierce County. This chapter describes the federal, state, and Pierce County programs, policies, and regulations pertinent to the Nisqually River Basin Plan, and how the Plan will coordinate and be consistent with the other programs, policies, and plans.

2.1 FEDERAL REGULATIONS, POLICIES AND PROGRAMS

The *Nisqually River Basin Plan* is intended to ensure that Pierce County stormwater management efforts are consistent with the federal *Clean Water Act* (CWA), *Endangered Species Act* (ESA), and the *National Flood Insurance Program* (NFIP).

2.1.1 Clean Water Act

Several regulations and programs under the CWA impact local stormwater management efforts. These programs and their impact on local stormwater management are summarized below.

National Pollutant Discharge Elimination System (NPDES)

In 1987, amendments to the CWA required the Environmental Protection Agency (EPA) to promulgate regulations for stormwater discharges. EPA defined certain industrial and municipal stormwater discharges as point source discharges subject to federal regulations under the National Pollutant Discharge Elimination System (NPDES) permit program. Based on the criteria specified in the federal regulations, Pierce County was required to obtain coverage for its municipal stormwater discharges.

EPA delegated responsibility for implementation of the NPDES permit program to the Washington State Department of Ecology (Ecology). Ecology issued the *Phase I Municipal Stormwater NPDES* and State *Waste Discharge General Permit* for the South Puget Sound *Water Quality Management Area* (which includes Pierce County) July 1995. On January 17, 2007 Ecology re-issued the Phase I municipal stormwater permit, which became effective on February 16, 2007. The permit covers stormwater discharges from the County-owned drainage systems throughout unincorporated Pierce County.

The municipal stormwater NPDES permit requires that permit holders control pollutants in stormwater to the maximum extent practicable, primarily by implementing a stormwater management program and to protect water quality.

Pierce County's basin plans are part of the County's Stormwater Management Program. Ecology approved updates to Pierce County's *Stormwater Management Program* (SWMP) in 2008. Required elements include:

- A program to control runoff from new development, redevelopment, and construction sites.
- Treatment and source control measures for existing commercial and residential areas.
- An operation and maintenance program for new and existing stormwater facilities.
- Practices for maintaining public streets and highways to reduce stormwater runoff impacts.
- A program to include water quality considerations in existing and proposed flood management projects.
- A program to reduce pollutants from pesticide and fertilizer use.
- A program to detect, remove, and prevent illicit discharges to the municipal separate storm sewer system.
- A program to reduce stormwater pollution from industrial facilities that discharge into the separate storm sewer system. An educational program for residents, businesses, industries, construction contractors, government employees, and others.
- A monitoring plan to determine the effectiveness of program activities.
- Reporting requirements.
- Coordination among jurisdictions sharing water bodies.

The permit requires adoption of a stormwater technical manual equivalent to the latest version of Ecology's *Stormwater Management Manual for Western Washington*, more extensive monitoring, more comprehensive inspections, and more detailed tracking and reporting of Stormwater Management Program (SWMP) implementation.

Recommendations in the basin plan must be consistent with the County's NPDES stormwater permit requirements and provisions of the Pierce County SWMP. The County's NPDES stormwater permit requires that the County address water quality when developing capital improvement projects for flood control. The NPDES permit also requires retrofitting to address stormwater quality in areas that developed without water quality controls. For example, existing basin flood control facilities and proposed flood control projects should be evaluated to consider whether water quality features should be incorporated. In addition, the basin plan should consider treatment and sources controls for residential and commercial drainage areas.

Section 303(d) List and Total Maximum Daily Loads (TMDL)

Section 303(a, b, and c) of the CWA requires that states establish standards to protect the quality of the waters of the United States. Ecology classified all major bodies of water in Washington based on their current or potential beneficial uses and established a set of water quality standards for each class. Section 303(d) of the CWA requires Ecology to prepare a list of water bodies that are not meeting, or will not meet, water quality standards after application of the required technology-based effluent limits.

If a water body is not in compliance with standards for a particular pollutant, and implementation of technology-based approaches are insufficient, the CWA requires that a "Total Maximum Daily Load" (TMDL) of the pollutant be calculated. The TMDL is the amount of the pollutant that a water body can assimilate without violating water quality standard for the pollutant. TMDLs are implemented through NPDES permits and "Best Management Practices." After a TMDL has been established by Ecology and approved by EPA, Ecology must include the applicable TMDL requirements in the NPDES permits for discharges to that water body. Ecology has individual TMDLs in the current (2007) permit to Pierce County.

Ecology submitted its candidate Section 303(d) list for 2002/2004 to EPA in June 2005. In November 2005, EPA approved the list. Segments of the Mashel River and Ohop Creek, as well as Ohop Lake and Harts Lake, were listed as "polluted" water bodies that do not meet the standards and will require TMDLs (for additional information, see Chapter 4).

Ecology's 303(d) list and TMDLs have implications for basin planning. TMDLs could require reduction of stormwater pollutant loads into water bodies that do not meet water quality standards. In the proposed NPDES permit, TMDLs with a completed *Detailed Implementation Plan* (DIP) will have DIP requirements built directly into permit requirements. Pierce County is performing supplemental monitoring in the Nisqually Basin and is participating in development of the DIP. Also, Pierce County is taking a leadership role in pet and domestic livestock waste management with the community of Eatonville. The basin plan should include recommendations that would improve discharges into water bodies with established or pending TMDLs.

Section 404 Discharge of Fill Materials (Wetland Permits)

Section 404 of the CWA regulates discharge of dredge or fill material in waters of the United States. For the purposes of Section 404, waters of the United States include wetlands adjacent to streams with flow greater than five (5) cubic feet per second and isolated wetlands greater than one acre that are hydraulically connected to regulated streams. Section 404 is administered by the U.S. Army Corps of Engineers (Corps). The Corps' Seattle District is responsible for issuing Section 404 permits in Pierce County.

Projects potentially affecting regulated wetlands could require one of several types of Corps wetland permits. An individual permit is subject to a broader level of public and environmental review. Other activities can be authorized by letters-of-permission, nationwide permits, or regional permits. Stormwater capital improvement projects that involve filling or work in small areas of wetlands may be permitted under one of a number of nationwide general permits.

The goal of wetlands protection is to avoid net loss of wetlands, and therefore enhancement of existing wetlands or creation of new wetlands generally is required to mitigate for projects that involve wetland fill. Some of the projects identified in Pierce County's *1991 Drainage Plan* have proven more costly to build than originally estimated because of mitigation requirements. In general, capital projects that adversely affect wetlands should be avoided.

The Section 404 regulations have a number of potential implications for basin planning. First, acquisition of wetlands can preserve their natural stormwater runoff and flood storage

functions. Second, recommendations for storm drainage facilities should avoid wetlands if possible, and include the costs of compensatory mitigation for projects where wetland impacts are unavoidable. Third, basin plans can identify new programs or program revisions designed to protect existing wetlands or create wetlands. Fourth, basin plan recommendations can be prioritized, in part, upon the extent to which aquatic resource protection and enhancement can be achieved. Therefore, the actions recommended in the basin plan should avoid or minimize potential adverse impacts on wetlands.

2.1.2 National Flood Insurance Program (NFIP)

In 1968, the U.S. Congress initiated the *National Flood Insurance Program* (NFIP) (Chapter 44 in the Code of Federal Regulations) under the *National Flood Insurance Act* to relieve the burden of disaster relief on the national treasury and state and local tax bases). The NFIP is administered by the Federal Insurance Administration, which is part of the Federal Emergency Management Agency (FEMA).

The NFIP makes available affordable flood insurance to communities that adopt approved floodplain management regulations that meet or exceed FEMA standards. Communities that do not participate in the NFIP have limited eligibility for federal flood disaster relief and are not eligible for flood insurance. FEMA's Flood Insurance Rate Maps (FIRMs) form the basis for critical area zoning for flood hazards.

Pierce County participates in the NFIP. Flood hazard management regulations are codified in Title 18E.70 of the Pierce County Code and criteria, and procedures are laid out in Chapter 9 of the *Pierce County Stormwater Management and Site Development Manual.* Federally subsidized flood insurance is available to local residents.

To continue coverage, the County must remain in the NFIP and maintain minimum floodplain management regulations. FEMA requires a certification letter (typically in the form of Letter of Map Amendment or Letter of Map Revision) for any revisions to a FIRM. Certification activities include stream channel modifications, installation of culverts, and bridge construction.

As a reward for communities that do more than meet minimum NFIP requirements by taking actions to minimize flood losses and promote public awareness of flood hazards, FEMA created the Community Rating System (CRS). Community participation in the CRS is voluntary. The CRS offers reduced insurance rates based upon the class rating of a community. The CRS contains ten classes. "Class 1" gives the greatest insurance premium reduction. A "Class 10" community receives no premium reduction. Pierce County was the first county in the nation to earn a "Class 5" rating and has continued to strive for even better ratings. Pierce County currently holds a "Class 3" rating.

Basin plans serve as part of the flood hazard mitigation plan for Pierce County. Improvement projects associated with the basin plan should, if possible, reduce flood hazards and improve the County's rating. Future flood hazard reductions could help to raise the County's rating from "Class 3" to a better class.

To help meet the prerequisites for a better rating, the *Nisqually River Basin Plan* will be developed according to the CRS planning steps listed below:

- Organize – Use a steering committee of department staff.
- Involve the public – Engage people living and working in floodplains to identify problems, community goals, and alternatives that will solve problems.
- Coordinate with other local governments in the planning area, state and federal agencies, Indian tribes, and other Pierce County departments and programs.
- Assess the hazard(s).
- Assess the problem(s).
- Set goals.
- Review possible activities.
- Draft an action plan.
- Adopt the plan.
- Implement the plan, evaluate it periodically, and revise it as needed to keep it current and effective.

Future projects should meet Pierce County floodplain regulations and applicable provisions of the County's Critical Areas Ordinance regarding flood hazards.

2.1.3 Endangered Species Act

The federal *Endangered Species Act* (ESA) directs the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) Fisheries[2] to promulgate a list of endangered and threatened species and designate critical habitat for the listed species and makes it unlawful for any person to conduct activities which result in an unauthorized "take" of listed species. Listed species with the greatest potential to affect surface water management in Pierce County are the Chinook salmon (listed as threatened in March 1999) and the bull trout (listed as threatened in October 1999). Chinook salmon are an important species in the Nisqually basin. Bull trout are believed to have historically been present in the Nisqually watershed; however, no recent evidence has been found that they are still present in freshwater, despite extensive surveys. The Nisqually Estuary is listed as a forage area for the Puyallup watershed bull trout population, and one potential bull trout sighting in the Nisqually Estuary has been reported to the Nisqually Tribe. At the time of this writing, Steelhead have also been proposed for listing. Chapter 4 describes the fish populations in the study area.

Section 9 of the ESA prohibits "taking" of endangered species. To "take" means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct". The regulation explains that "harm" may include "significant habitat

[2] NOAA Fisheries was previously called the National Marine Fisheries Service.

modification where it actually kills or injures listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering."

If a proposed action is federally funded, or if it requires a permit from a federal agency, and if it could have an effect on a listed species, then Section 7 of the ESA requires the involved federal agency to consult with USFWS or NOAA Fisheries. After consultation, USFWS or NOAA Fisheries issues a biological opinion regarding the effects of the action. If USFWS or NOAA Fisheries finds that the action could jeopardize the continued existence of the species, the action cannot be permitted. If USFWS or NOAA Fisheries finds that the continued existence of the species is not jeopardized, then one of the agencies will issue an "Incidental Take Statement" and allow the action to proceed.

Section 4(d) of the ESA requires USFWS and NOAA Fisheries to adopt regulations as necessary to conserve the species listed as threatened. USFWS typically applies the Section 9 "take" prohibitions directly to threatened species. NOAA Fisheries typically promulgates so-called "4(d) rules" that identify specific activities that can be conducted without constituting an unlawful take of the threatened species.

Pierce County is committed to helping to preserve and restore fish habitat. The County has been implementing actions to preserve and restore fish habitat in coordination with King and Snohomish counties and on the Puyallup Tribe of Indians and other stakeholders. For example, the County has revised its road maintenance procedures to be consistent with NOAA Fisheries' approved set of transportation maintenance procedures. Other early actions include culvert replacements to improve fish passage, and restoration and acquisition of key habitat.

The salmonid listings have a broad effect on storm drainage and surface water management plans. The basin plan may identify capital projects or programmatic measures that are designed to protect or restore habitat and improve water quality for listed species. Conversely, some potential stormwater management measures (e.g., bank stabilization, on-line detention) have the potential to adversely affect habitat. Potential habitat impacts need to given full consideration during the evaluation of alternatives and development of recommended projects. In developing solutions, coordination with the various agencies working on fish habitat initiatives is needed to prevent overlap or duplication of effort.

Pierce County also serves as the "salmon lead entity coordinator" for WRIAs 10/12 and participates with the Nisqually Lead Entity on regional salmon recovery.

2.2 STATE REGULATIONS, PLANS, AND PERMITS

Several state statutes and regulations impact Pierce County's basin planning effort, as summarized below.

2.2.1 State Water Quality Standards

Washington Administrative Code (WAC), Chapters 173-201A and 173-200, affect the discharge of stormwater to surface water and groundwater, respectively, by establishing water quality standards for each of the different classes of water and articulating the federal anti-

degradation policy. WAC 173-200 also calls for designation of special groundwater protection areas based on unique characteristics (e.g., aquifer recharge areas, wellhead protection areas, or sole source aquifers). Chapter 4 describes the water quality standards and how well the Nisqually Basin streams achieve the standards.

In July 2003, Washington adopted a new set of water quality standards to protect all life stages of temperature-sensitive fish, such as bull trout and Dolly Varden. A new indicator (enterococci) will be used to measure the amount of bacteria in marine waters that are not used for shellfish harvesting. New values for ammonia in waters without salmon species have been added.

Ecology has also classified fresh waters by actual use (such as fish habitat, swimming and water supply), rather than by class (AA, A, B, C and Lake classes), to make the standards less complicated to interpret and provide future flexibility as the uses of a waterbody evolve.

Storm drainage and surface water management planning considers ground and surface water quality standards, along with other factors, when developing specific capital improvement alternatives, such as a large regional infiltration basin. This is largely because the standards are the foundation for other water quality programs such as NPDES permits, water clean-up plans (also known as TMDLs), and 401 Water Quality Certifications. Water quality standards also are used as benchmarks for developing recommendations for non-structural solutions. The basin plan also need to identify existing and potential water quality problems and recommend measures to address these problems and meet water quality standards.

2.2.2 Section 401 Water Quality Certification

Applicants for a federal permit or license, such as a Section 404 permit, could require a Section 401 Water Quality Certification (401 Certification) from Ecology; if in an area governed by a delegated tribe, it would come from EPA or the tribe. A 401 Certification must be obtained for any activity that would require a federal (Section 404 or Section 10) permit or approval and that might result in a discharge of dredge or fill material into water or non-isolated wetlands, or in excavation in water or non-isolated wetlands. The application for a 401 Certification would be part of the Joint Aquatic Resources Permit Application (JARPA) for a project.

A 401 Certification means that Ecology has determined that the proposed project would comply with state water quality standards and other aquatic resource protection requirements. The 401 Certification could cover both the construction and operation of a project.

The basin plan could result in recommended projects which require 401 Certification from Ecology. The 401 Certification process could include site-specific conditions covering the design, construction, or operation of a proposed project. Conceptual designs and cost estimates for basin plan projects will need to consider the 401 Certification process and any conditions that may be imposed.

2.2.3 Puget Sound Partnership

The Puget Sound Water Quality Management Plan, developed in 1991 and amended in 2000, requires all cities and counties in the Puget Sound basin to adopt stormwater programs that

include minimum requirements for new development and redevelopment. These minimum requirements are stipulated in the Puget Sound Water Quality Management Plan and listed in Ecology's Stormwater Management Manual for Western Washington (Ecology, 2005).

The stormwater management program is to include an ordinance that addresses:

> *"... at a minimum: (1) the control of off-site water quality and quantity effects; (2) the use of best management practices for source control and treatment; (3) the effective treatment, using best management practices, of the storm size and frequency (design storm) as specified in the manual for proposed development; (4) the use of infiltration, with appropriate precautions, as the first consideration in stormwater management; (5) the protection of stream channels, fish, shellfish habitat, other aquatic habitat, and wetlands; (6) erosion and sedimentation control for new construction and redevelopment projects; and (7) local enforcement of these stormwater controls."*

Pierce County's current stormwater management program is designed to address the *Puget Sound Water Quality Management Plan* requirements as well as the NPDES permit requirements described above. The NPDES permit also requires the adoption of Ecology's *Stormwater Management Manual for Western Washington*, or an equivalent. See Section 2.1.1 for more information on the NPDES permit. The basin plan should be consistent with the *Puget Sound Water Quality Management Plan*.

In 2007, the Washington Legislature created a new state agency for the purpose of developing and overseeing the implementation of an "Action Agenda" to restore Puget Sound by 2020. The basin plans will be incorporated into the "Action Agenda" and the Nisqually River Basin Plan will be incorporated into the "Action Agenda" for the South Puget Sound Action Area.

2.2.4 The Growth Management Act and the Comprehensive Plan for Pierce County, Washington

Washington's *Growth Management Act* (GMA) directs local governments of fast-growing counties, cities, and towns to prepare and adopt comprehensive plans and implement regulations for managing their growth. Pierce County was required to prepare a comprehensive plan that meets the GMA precepts. The *Comprehensive Plan for Pierce County, Washington* (*County Comprehensive Plan*) became effective in December 1994. Development regulations to implement the *County Comprehensive Plan* were adopted in 1995. Pierce County reviews and updates the *Comprehensive Plan* on a regular basis.

Three GMA planning goals directly apply to storm drainage planning. They are as follows:

> *"Urban growth. Encourage development in urban areas where adequate public facilities and services exist or can be provided in an efficient manner."*
>
> *"Environment. Protect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water."*
>
> *"Public facilities and services. Ensure that those public facilities and services necessary to support development shall be adequate to serve the development at*

the time it is available for occupancy and use without decreasing service levels below locally established minimum standards."

The GMA compels storm drainage and surface water management services and facilities by requiring that: 1) frequently flooded areas (flood hazard areas) be identified and protected; 2) urban facilities be constructed in urban areas only; 3) a level of service standard be established for storm drainage facilities; and 4) capital improvements be identified to meet the adopted level of service given planned land use.

The basin plan should meet the overall GMA planning goals that apply to storm drainage planning. The GMA mandates that comprehensive plans be internally consistent (Revised Code of Washington (RCW) 36.70A.070) and that counties perform their activities and make capital budget decisions in conformity with their comprehensive plans (RCW 36.70A.120). Because basin plans recommend capital improvement projects and form the basis of the annual capital budget for the County Storm Drainage and Surface Water Management Utility, basin plan recommendations must be consistent with the *County Comprehensive Plan*. Basin plans also are used to formulate the longer-term (six-year) capital improvement plan, also known as the "Capital Facilities Element" of the *County Comprehensive Plan*. (The basin plan will include a supplemental environmental impact statement that evaluates the consistency of the plan's recommendations with the *County Comprehensive Plan*). The basin plan will be coordinated with the County's ongoing land use and GMA planning efforts.

Land use decisions can drive stormwater management infrastructure needs. Adopted land use/zoning and current development regulations will be used in the basin plan to model future hydrologic conditions and help determine the type, size, and location of facilities that will be needed to support planned growth. Critical area designations will be used to indicate potential sites for stormwater facilities, such as infiltration ponds (aquifer recharge areas) or natural stormwater detention sites (wetlands and riparian corridors). Conversely, surface water management recommendations can influence land use density and intensity choices, for instance by identifying stream reaches that must be protected from the adverse hydrologic effects of new development.

2.2.5 State Hydraulic Code

The Washington State Hydraulic Code (RCW 77.55) regulates any activity affecting the state's fresh waters and salt waters in order to preserve fish and wildlife habitats. The Hydraulic Code is administered by the Washington State Department of Fish and Wildlife (WDFW).

The WDFW requires any person, organization, or government agency whose hydraulic project, which affects the bed or flow of a water of the state, to obtain a Hydraulic Project Approval (HPA) permit. An HPA permit is required for any form of work that would use, divert, obstruct, or change the natural flow or bed of state waters. The HPA permit typically specifies how construction projects are designed, managed, sequenced, and conducted to minimize adverse effects on fish and shellfish.

The basin plan may include projects that lie in or near state waters and therefore require an HPA. Conceptual design and cost estimates for these facilities should consider the permitting process and mitigating conditions likely to be imposed on the project via the HPA permit.

2.2.6 1998 Watershed Management Act

In 1998, the Legislature passed the *Watershed Management Act* (HB 2514). Also known as 2514 Watershed Planning and codified in RCW Chapter 90.82, the act provides the framework for locally-based watershed planning with the goal of giving local interests a voice and a forum for collaboration regarding water resource issues. The four planning focuses under the act are water quantity, water quality, habitat, and instream flows.

For watershed planning under the act, the Nisqually Watershed has been designated as *Watershed Resource Inventory Area* (WRIA) 11. WRIA 11 includes the entire Nisqually Watershed within Pierce, Thurston, and Lewis Counties.

The Act creates a planning process that brings together citizens, local governments, tribes, and state and federal agencies to form planning units. Local planning units then develop plans for allocating water, protecting water quality, restoring fish habitat, and developing water resources policies and management for the watershed. The Nisqually watershed planning unit includes representatives of Pierce, Thurston, and Lewis Counties; the Cities of Olympia, Lacey, Yelm, Roy, and Eatonville; several water districts and commercial interests; and Ecology. The Nisqually Tribe has coordinated the planning effort.

In response to the Watershed Management Act, the Nisqually watershed planning unit has prepared a *Nisqually Watershed Management Plan* (Nisqually Tribe, 2003). The five central issues in this plan are growth and land use, groundwater resources and supply, water rights, instream flows, and water quality.

The Nisqually Watershed Management Plan under the Watershed Management Act has a broader focus than this Pierce County basin plan. The Nisqually Watershed Management Plan addresses water supply and encompasses the entire Nisqually Watershed in WRIA 11, while this Pierce County basin plan does not address water supply and applies to the unincorporated areas of Pierce County. The Nisqually Watershed Management Plan covers a broader range of water resources and land use and habitat issues, while this Pierce County basin plan is being developed to address stormwater, water quality problems, and fish and wildlife habitat issues.

The Nisqually Watershed Management Plan collected a great deal of hydrologic, land use, water quality, and habitat information that facilitated preparation of the Basin Characterization Report. The recommendations contained in the *Nisqually Watershed Management Plan* will be considered during development of the Nisqually River Basin Plan. The Basin Plan does not address water rights issues.

2.2.7 Substitute House Bill 323

In Substitute House Bill (SHB) 323, the Legislature directed Ecology in 1985 to create a comprehensive management plan for the Nisqually River. The plan was prepared by the

Nisqually River Task Force, which consisted of federal, state, and local governments, business representatives, the Nisqually Indian Tribe, and interested citizens. This Task Force created the *1987 Nisqually River Management Plan* (*1987 NRMP*), which is available at http://www.nisquallyriver.org/plan.html. The *1987 NRMP* was approved by the Legislature in June 1987.

The *1987 NRMP* provides recommended policies and implementation guidelines. The key issues in the *1987 NRMP* are public access, flood control, fish and wildlife protection and enhancement, maintenance of rural landscapes and economics, and balancing the rights of private landowners with statewide public interests. The plan's management areas consist of the core management zone, which is essentially the shoreline management zones, and the stewardship management zone, which is the viewshed corridor approximately ¼ to ¾ mile on each side of the river.

The *1987 NRMP* is coordinated by the Nisqually River Council. The Nisqually River Council is a coordination, advocacy, and educational organization with no independent authority of its own. The Nisqually River Council consists of 19 active members, including citizens and federal, state, and local governments. The *1987 NRMP* recommends policies and guidelines but does not identify specific projects or methods for their implementation. Pierce County has adopted or endorsed the *1987 NRMP* for those policies that affect County planning (PCC, Section 19A.20.030). Pierce County Resolution No. R92-104 directs "that relevant management policies (of the Nisqually River Management Plan) be integrated into the update of the comprehensive land use plan pursuant to the Growth Management Act and when preparing changes to land use and environmental regulations and other related public programs."

The *1987 NRMP* must be considered during the Pierce County basin planning process. The capital improvement projects and other recommendations from the basin plan need to be consistent with the policies in the *1987 NRMP*. This basin plan could lead to future funding and implementation of several of the policies and goals relating to stormwater and water quality in the *1987 NRMP*.

2.2.8 Archaeological and Cultural Coordination

Environmental laws and review processes at the federal, state, and local levels require that consideration be given to protecting significant historic, archaeological, and traditional cultural sites from damage or loss during development. Environmental laws such as the National Historic Preservation Act and the State Environmental Policy Act (SEPA) require that impacts on cultural resources be considered during the public environmental review process. The Department of Archaeology and Historic Preservation (DAHP) works with agencies, tribes, private citizens, and developers to identify and develop protection strategies to assure that Washington's cultural heritage is not lost.

Section 106 of the National Historic Preservation Act requires that all federal agencies consider cultural resources as part of all licensing, permitting, and funding decisions. For state and local projects under SEPA, DAHP is the sole agency with technical expertise in regard to cultural resources and provides formal opinions to local governments and other state agencies on a

site's significance and the impact of proposed projects upon such sites. The Shoreline Management Act requires that development permits issued by local governments in areas with archaeological sites require a site inspection or evaluation by a professional archaeologist in coordination with affected Indian tribes.

Recommendations in the basin plan should avoid adverse impacts on archaeological, cultural, and historic sites. Development of capital improvement projects should be coordinated with DAHP and the Nisqually Tribe.

2.2.9 Forest Practices Act

Under the *Forest Practices Act* (FPA), the Washington State Department of Natural Resources (DNR) regulates most commercial forest practices on private and state forest land. Forest practices that may require a FPA permit from the DNR include harvesting timber, salvaging standing and down wood, constructing forest roads, installing and replacing culverts or bridges on forest roads and applying forest chemicals with aircraft. A FPA permit can include stream and wetland buffer requirements. These buffers are smaller than what the Pierce County regulations would require. Since 2000, the FPA permits require compliance with the Timber, Fish and Wildlife Agreement, which is intended to prevent logging impacts on ESA-listed species.

DNR regulations (WAC 222-16-050) have established four classes of forest practices. Class I forest practices are small-scale activities (e.g., cutting less than 5,000 board feet within a 12 month period, Christmas tree harvesting) that DNR has determined to have no direct potential for damaging a public resource. Class II practices are those that DNR has determined to have a "less than ordinary" potential to damage a public resource. Examples include harvest smaller than 40 acres, partial cutting of less than 40% of the live timber volume, and logging road construction outside of riparian or wetland areas. Class III practices include operations that are larger in scale and/or occur within riparian or wetland areas, and do not fall under the Classes I, II, or IV. "Class IV – Special" operations are those that DNR has determine to have potential for substantial impact on the environment. Examples include aerial application of pesticides; certain forest practices activities in critical habitat areas; and timber harvest, road building, and gravel mining on potentially unstable slopes. "Class IV-General" includes certain forest practices on lands that area being converted to urban or other non-timber uses.

A "conversion" forest practice converts timber land to a non-forestry use, such as residential, commercial, industrial, or agriculture. Land being converted to a use other than commercial timber production is considered a general forest practice, which requires a FPA permit and is subject to Pierce County's SEPA review and development regulations. Pierce County Code Title 18H regulates forest practices under local government review. Title 18H provides procedures and review criteria for County approval of special conversion forest practices, general forest practices, and conversion option harvest plans.

The *Nisqually River Basin Plan* should identify and evaluate any foreseeable conversions of timber land to residential development within unincorporated areas of the Nisqually watershed. The basin plan also should analyze any potential stormwater and water quality

problems within the County's jurisdiction caused by logging within or outside of the timber lands.

2.3 PIERCE COUNTY REGULATIONS

Pierce County has adopted ordinances and regulations that should be considered in the basin planning process. The key County ordinances and programs are summarized below.

2.3.1 Critical Areas Ordinance

Pierce County's *Critical Areas Ordinance* (Pierce County Code Title 18E) is intended to "protect critical areas of Pierce County from the impacts of development and protect development from the impacts of hazard areas" by establishing development standards for sites that contain or are adjacent to critical areas, such as wetlands, fish and wildlife habitat, and flood hazard areas. The ordinance includes standards for determining critical areas and identifies them on the County's *Critical Areas Atlas* maps.

The basin plan could recommend projects that affect critical areas. Such project may require special permits or approvals, and may need to incorporate design features and construction practices that would mitigate impacts. Stormwater projects sited in critical areas or their buffers likely would have increased costs for permitting and mitigation. Therefore, critical areas should be considered when evaluating potential solutions to drainage, water quality, or fish habitat problems in the basin. Where possible, the basin plan should avoid recommendations that would adversely affect critical areas.

2.3.2 Land Use and Zoning Designations and Development Regulations

Land use activities in Pierce County are guided by the *County Comprehensive Plan*, community plans, zoning designations, and development regulations. Various Titles of the Pierce County Code establish development regulations for future projects. Development of individual stormwater facilities must be consistent with adopted County policies, zoning designations, and regulations.

Land use approvals generally include a zoning consistency review. Where applicable, Pierce County would conduct a review of potential projects relative to the site-specific zoning and the County development regulations.

Land use and zoning designations could affect the siting and design of future projects. The Pierce County Code lists specific uses allowed in each zone. Depending of the site's underlying zoning, a project may be permitted outright or could require a conditional use or variance. The basin plan should ensure that future projects would be located and designed to be consistent with the site-specific land use and zoning designations.

2.3.3 Pierce County Shoreline Master Program

The Washington *Shoreline Management Act* (SMA) establishes a broad policy for how shorelines of the state can be used, giving preference to uses that:

- Protect the quality of water and the natural environment.
- Depend on proximity to the shoreline (water-dependent uses).
- Preserve and enhance public access or increase recreational opportunities for the public along shorelines.

Shorelines of the state include all marine waters; streams with a mean annual flow greater than 20 cubic feet per second; lakes 20 acres or larger; upland areas 200 feet landward from mean high water; associated wetlands and river deltas; and some or all of the 100-year floodplain, including all wetlands within the entire floodplain.

The SMA divides authority for compliance between local and state governments. Cities and counties are the primary regulators. Each city and county adopts a shoreline master program (SMP) and use regulations that are based on Ecology guidelines but are tailored to the needs of the community. Pierce County adopted its SMP in 1974 and the use regulations in 1975 (amended in 1992). The SMP provides policies and regulations addressing shoreline use and protection, and it establishes a permit system for administrating the program.

Some of the proposed projects contained in the Basin Plan may be located within a regulated shoreline area and therefore subject to the County shoreline policies and regulations. The basin plan should ensure that future projects would be located and designed to be consistent with the County SMP. Such projects may be subject to special requirements (e.g., setbacks or buffers), and site-specific mitigation measures could be imposed. If a proposed project is inconsistent with the shoreline designation, a variance or conditional use permit may be required. Future projects within regulated shorelines would undergo permitting review at time of implementation. Stormwater capital projects sited in designated shorelines could have increased costs for permitting and mitigation.

2.3.4 Pierce County SEPA Regulations

SEPA provides a way to identify possible environmental impacts that may result from governmental actions. These decisions may be related to issuing permits for private projects, constructing public facilities, or adopting regulations, policies, or plans. SEPA review is not a permit, but is a process that helps agency decision-makers, applicants, and the public understand how a proposal would affect the environment. This information can be used to change a proposal to reduce potential impacts or to condition or deny a proposal when adverse environmental impacts are identified.

SEPA applies to all levels of state and local government. Pierce County has adopted its own SEPA regulations in Title 18D of the Pierce County Code, which adopts most of the Ecology SEPA regulations. For most projects and programs proposed by the County under the basin plan,

Pierce County would be the lead agency under SEPA and would be responsible for completing SEPA review under County SEPA policies and regulations.

Any proposal that requires a local agency to license, fund, or undertake a project, or the proposed adoption of a policy, plan, or program, could trigger environmental review under SEPA. A proposal with potential significant adverse environmental impacts could require an environmental impacts statement. Proposals without significant impacts likely would require a determination of non-significance and accompanying environmental checklist. SEPA review includes both preparing environmental documents and public review, the extent of which depends on the location, magnitude, and potential impacts of the proposal.

The basin plan itself will undergo SEPA review before its adoption, and a non-project or programmatic SEPA document will be prepared concurrently with the basin plan. Individual capital improvement projects prescribed in the basin plan would undergo SEPA review at the time they are designed and permitted. SEPA review could identify site-specific mitigation measures which could increase the costs of basin plan projects.

2.4 SUMMARY OF KEY REGULATIONS AND PROGRAMS

Table 2-1 lists the federal, state, and county regulations, programs, and policies that may affect the *Nisqually River Basin Plan*. The table summarizes how each regulation may affect the basin plan.

TABLE 2-1
Federal, State and County Regulations and Programs Relevant to the Nisqually Basin Plan

Law or Regulation	Application to the Nisqually River Basin
Federal Laws	
Clean Water Act: Section 402 National Pollutant Discharge Elimination System (NPDES) Permit	Stormwater NPDES permit requires that the County address water quality when developing CIP for flood control. Permit also requires retrofitting to address stormwater quality in areas that developed without water quality controls. Basin plan recommendations must adhere with the County's NPDES Permit and Stormwater Management Program (SWMP).
Clean Water Act: Section 303(d) Total Maximum Daily Load (TMDL) Listing	The basin plan should include recommendations to improve discharges into water bodies that do not meet water quality standards and that require TMDLs. TMDLs could require reduction of stormwater pollutant loads.
Clean Water Act: Section 404 Permit Requirements for Wetlands	The basin plan should avoid CIP or other actions that could adversely affect wetlands. If wetland impacts cannot be avoided, the project cost estimates should include wetland mitigation. The basin plan could identify projects that would acquire, protect, create, or enhance wetlands.
Endangered Species Act (ESA)	Basin plan recommendations should include projects and programs that would improve water quality and restore fish habitat, which would benefit endangered fish. Future projects should be located and designed to avoid impacts on ESA-listed species. Potential site-specific impacts on ESA-listed species should be coordinated with resource agencies.
National Flood Insurance Program	Basin plan recommendations should reduce flood hazards and maintain or improve the County's rating under the Community Rating System. Future projects must meet County floodplain regulations and the provisions of the County Critical Areas Ordinance regarding flood hazards.

TABLE 2-1
Federal, State and County Regulations and Programs Relevant to the Nisqually Basin Plan

Law or Regulation	Application to the Nisqually River Basin
State Laws, Plans and Regulations	
Water Quality Standards	The basin plan should consider ground and surface water quality standards when developing CIP alternatives. The basin plan also should identify current and potential water quality problems, and then recommend measures to address problems and meet water quality standards.
401 Water Quality Certification	Individual projects could require a 401 certification from Ecology. A 401 certification could include site-specific mitigation measures, which should be included in project design and cost estimates.
Puget Sound Water Quality Management Plan	The basin plan recommendations should be consistent with the *Puget Sound Water Quality Management Plan*.
Growth Management Act (GMA) and *County Comprehensive Plan*	The basin plan recommendations must be consistent with the overall GMA planning goals and *County Comprehensive Plan*. To support planned growth and enhance critical areas, the basin plan was developed based on land use policies and designations in the *County Comprehensive Plan*.
State Hydraulic Code	Many individual projects would require a HPA permit. The HPA could include mitigation measures, which should be included in cost estimates.
Watershed Management Act	The basin plan should evaluate the data collected and consider the recommendations for water quality and fish habitat protection that are contained in the *Nisqually Watershed Management Plan*
Substitute House Bill 323	The CIP and other recommendations under the County's basin plan should be consistent with the stormwater and water quality policies in the *1987 Nisqually River Management Plan*.
Archaeological and Cultural Coordination	Recommendations in the basin plan should avoid adverse impacts on archaeological, cultural, and historic sites. Development of CIP projects should be coordinated with the Department of Archaeology and Historic Preservation (DAHP) and the Nisqually Tribe.
Forest Practices Act	The *Nisqually River Basin Plan* should identify and evaluate any foreseeable conversions of timber land to residential development within unincorporated areas of the Nisqually watershed. The basin plan also should analyze any potential stormwater and water quality problems related to logging under County jurisdiction in the Nisqually watershed.
Pierce County Regulations, Policies & Programs	
Critical Areas Ordinance	The basin plan should avoid recommendations that would adversely affect critical areas (e.g. wetlands, fish and wildlife habitat). If a project must be sited in a critical area, the cost estimate should include costs for mitigation and permitting.
Land Use and Zoning Designations and Development Regulations	Land use and zoning designations could affect the siting and design of future projects. The basin plan should ensure that future projects would be consistent with the underlying land use and zoning designations.
Pierce County Shoreline Master Program (SMP) and Washington Shoreline Management Act (SMA)	Future projects should be located and designed to be consistent with the County shoreline policies and regulations. Projects within designated shorelines could require permits and mitigation, which should be incorporated into the costs of individual projects.
Pierce County and Ecology SEPA Regulations	The basin plan itself would undergo SEPA review before its adoption, and a non-project or programmatic SEPA document would be prepared concurrently with the basin plan. Future projects would undergo SEPA review.

2.5 COUNTY LAND USE POLICIES

The GMA and 1991 GMA amendments require counties to prepare comprehensive plans that direct growth to occur in places of least impact to the environment. The *Pierce County Comprehensive Pl*an, completed in 1994 and updated biannually, outlines growth and management policies and provides a framework for more focused planning. The overall goals of the plan include:

- Promoting economic development and allowing for housing choices and opportunities.
- Containing urban sprawl and preserving resources and rural lands as well as ecologically fragile areas by careful site and general planning.
- Allowing citizen and local input into the planning process.
- Coordinating regional and local planning efforts.

The comprehensive plan also includes policies related to natural resources, open space, environmentally sensitive areas and, to an extent, agriculture (as open space).

County policies are implemented in several ways. Some are implemented through regulations, including zoning and other codes. Others are implemented through services provided by the County, such as permitting, or through guidance from the SEPA process or actions in conjunction with SEPA. In addition, policies may guide public hearings, variance or rezone requests, and community planning efforts.

The critical areas element of the *County Comprehensive Plan* (PCC 19A.60) contains a number of policies relevant to fish habitat mitigation or protection. These policies provide direction for the County critical areas regulations, SEPA regulations, and other codes regulating land development. In addition, they guide County staff in the preparation of community and basin plans. Other policies in the *County Comprehensive Plan* may also have implications relevant to fish habitat. The key policies are summarized below.

- **19A.30.70**: Classify lands that have been designated as having long-term commercial agricultural significance.
- **19A.30.080**: Conserve and protect forest resource lands while allowing conversion and limited development under urban conditions.
- **19A.30.170**: Designate and identify open space areas.
- **19A.40.030**: Conserve rural resources.
- **19A.50.040**: Encourage growth of readily-accessible, large planned employment center sites.
- **19A.60.010**: Create and support an environmental quality commission to evaluate, review, and recommend programs for environmental enhancement affecting the County.
- **19A.60.020**: Comply with air and water quality standards by the year 2000. Achieve no net loss of wetlands, and improve conditions so that wild fish runs can be restored to healthy, viable populations.

- **19A.60.030**: Coordinate with other agencies and tribes to protect critical areas and address environmental issues.
- **19A.60.050**: Identify, map, and manage water resources on a watershed basis through watershed action plans, groundwater resource inventories and protection programs. Identify actions that maintain surface water base flows, control flooding, and protect water quality. Develop performance standards and regulate land uses, which include constructing employment and community facilities outside of shorelines. Protect commercial and recreational shellfish areas. Maintain aquifer recharge quantity and quality. Establish performance standards for stormwater runoff and nonpoint source pollution that include water conservation measures, enhancing stormwater and erosion control standards, and minimizing areas of impervious surface cover. Continue and strengthen water quality education programs.
- **19A.60.060**: Maintain and improve terrestrial and aquatic ecosystems to maintain viable populations of plants and animals. Conduct watershed analyses to identify watershed processes and ecosystem concerns that need to be addressed; and establish a County ecosystem restoration strategy with other agencies. Establish comprehensive ecosystem management programs to protect fish and wildlife resources within certain geographic areas of the County.
- **19A.60.070**: Maintain and protect habitat areas for fish and wildlife. Identify, map, and place regulatory emphasis on critical fish and wildlife habitat areas. Maintain movement corridors by establishing buffers on aquatic resources. Assess the effectiveness of existing policies and regulations including shoreline regulations, clearing and erosion control requirements, stormwater drainage requirements, and critical habitat protection regulations. Pursue acquisition of critical areas and establish educational programs.
- **19A.60.080**: Avoid endangerment of lives, property, and resources in geologic and flood hazard areas. Protect flood hazard areas as open space or with low-density development
- **19A.60.090**: Provide for no net loss of wetlands. Identify, map, and protect wetland function. Mitigate for wetland losses. Educate the public and pursue acquisition of important wetland areas.
- **19A.60.130**: Recognize that some critical areas have been legally altered and continue to be used for agriculture. Responsible use and maintenance of these areas may continue.
- **19A.80.30**: Provide an efficient road network in order to provide mobility for people, goods, and services.

2.6 PIERCE COUNTY BASIN PLANNING PROGRAM

The *Pierce County Storm Drainage and Surface Water Master Plan* (James M. Montgomery 1991) served as the first capital improvement program (CIP) and program plan for the Pierce County Storm Drainage and Surface Water Management Utility. The Nisqually River basin was

included as part of the rural study areas element of the 1991 plan. Hydrologic modeling was performed for Ohop Creek, Mashel River, Murray Creek, Tanwax Creek and Horn Creek as part of that planning effort; however, the 1991 plan did not include much detail regarding the physical attributes of the Nisqually basin or the drainage systems within it. The 1991 plan identified only one CIP project in the Nisqually Basin–vegetation removal from the inlet and outlet of Whitman Lake in the upper Tanwax subbasin. No other projects have been identified or completed.

In the late 1990s, the County evaluated its progress toward implementation of the 1991 plan. Based on that evaluation, the County decided to identify stormwater CIP needs by developing detailed basin plans rather than by revising the Countywide 1991 plan. The County then developed basin planning guidelines to ensure consistency among the basin plans. As discussed in Chapter 1, the *Nisqually River Basin Plan* is being developed in accordance with the County's guidelines.

CHAPTER THREE
STAKEHOLDER INVOLVEMENT

This chapter summarizes the stakeholder involvement activities conducted during development of this Basin Plan. Stakeholders were identified and contacted to inform them of the planning process and to solicit information on basin issues. The project team held three public meetings and conducted two surveys by mail during the basin planning process. Stakeholders were continually involved in plan development, and throughout the development of recommendations.

3.1 IMPORTANCE OF STAKEHOLDER INVOLVEMENT

Stakeholders are people, agencies, or groups of people with an interest in the outcome of the basin plan. Effective stakeholder involvement is an important component of Pierce County's basin planning process. Stakeholder involvement is needed to ensure that stakeholders are aware of the basin plan and that they have the opportunity to participate.

Stakeholder involvement is also important for floodplain management. The Nisqually River Basin planning area encompasses several areas of major tributaries that have been mapped by the Federal Emergency Management Agency (FEMA) as flood hazard zones. Property owners within these designated floodplains may be eligible for coverage under the *National Flood Insurance Program* (NFIP). FEMA developed the *Community Rating System* (CRS) to recognize and encourage community floodplain management that exceeds the minimum NFIP standards. Under the CRS, communities with strong floodplain management programs can qualify for lower flood insurance premiums.

The following bullets list key FEMA CRS criteria for public and agency involvement:

- Public meetings at beginning of planning process
- Public meeting at end of planning process
- Public information activities that encourage input
- Questionnaires asking the public for information
- Solicitation of input from advisory groups
- Contact with other agencies
- Meetings with other agencies and stakeholders
- Public involvement in plan development
- Stakeholder involvement in plan development
- Consider community land use plans
- Review of draft plan by other agencies

3.2 STAKEHOLDER INVOLVEMENT FOR NISQUALLY RIVER BASIN PLAN

The stakeholder involvement strategy for the *Nisqually River Basin Plan* was designed to support the basin planning process by:

- Facilitating basin characterization and problem identification.
- Helping to develop solutions that are realistic and acceptable to the community.
- Fostering support for basin plan implementation.

In addition, the stakeholder involvement strategy was designed to help Pierce County maintain a favorable CRS ranking by including the CRS public and agency involvement elements listed in Section 3.1 above.

The first step in the planning process was to identify potential stakeholders and their likely level of involvement in the basin planning process. The planning team identified a broad range of stakeholders, including state and local governments, citizen groups, environmental groups, local businesses, and basin residents.

Residents and landowners in the Nisqually River Basin planning area are the primary stakeholders. Citizen stakeholders include landowners within the floodplain and riparian areas, lakeside homeowners, landowners who reported drainage-related problems, and other basin residents. Larger landowners and businesses are Tacoma Power and Centralia City Light. Until recently Weyerhaeuser was a large land holder; they have divided up and sold their land within the basin.

Federal and state agencies consist of Fort Lewis, Mount Rainier National Park, the Nisqually National Wildlife Refuge, Washington State Department of Ecology (Ecology), Washington State Parks (Nisqually Mashel State Park), Washington Department of Natural Resources (DNR) and Washington State Department of Fish and Wildlife (WDFW). Pierce County departments include Pierce County Surface Water Management, Planning and Land Services (PALS), and Transportation Services. Other local governments are Thurston and Lewis Counties and the Cities of Roy and Eatonville. Other entities include the Nisqually Tribe, Nisqually River Council, Nisqually Land Trust, the Thurston Shellfish Committee, Nisqually Salmon Habitat Workgroup, Pierce County Conservation District, Eatonville Land Use Committee, Upper Nisqually Land Use Advisory Commission, University of Washington Pack Forest, and the WRIA 11 Planning Unit.

The various stakeholders may be involved at different levels during the plan development process. All stakeholders will be informed at key junctures in the process and will be provided opportunities for input at public meetings.

Figure 3-1 shows the Pierce County basin planning area and its relation to other jurisdictions in the Nisqually River watershed. The following sections summarize the stakeholders and their involvement in the development of this Basin Plan.

3.2.1 Pierce County Surface Water Management

The *Nisqually River Basin Plan* will serve as the basis for the Pierce County Surface Water Management' *Capital Improvement Program* (CIP) and future activities in the basin. Surface Water Management's staff developed the scope of work for and managed the project team throughout development of this Basin Plan.

Based on the information contained in this plan, Surface Water Management will select the recommendations (projects, proposed policies, other suggestions in the Draft Basin Plan) that will be presented to the public and to the *Storm Drainage and Surface Water Management Advisory Board* (SWM Advisory Board). The SWM Advisory Board will then provide its recommendations regarding the basin plan to the Pierce County Planning Commission, County Executive, and County Council.

Surface Water Management will transmit a proposed basin plan and *Final Supplemental Environmental Impact Statement* to the Pierce County Executive, who will then refer it to the County Council. Basin plans must be approved and adopted by ordinance.

3.2.2 Nisqually Tribe

As the co-manager of Nisqually River fisheries, the Nisqually Tribe (Tribe) has a strong interest in protecting water quality and aquatic habitat throughout the Nisqually River watershed. The Tribe has played a lead role in the development of the *Watershed Management Plan* (HB2514) for WRIA 11, development of the *Nisqually Basin Salmon Recovery Plan*, and the identification and implementation of habitat restoration and preservation projects. The Tribe also plays an active role on the Nisqually River Council. Parts of the Nisqually River Basin are Nisqually Indian Reservation, as depicted in Figure 3-1.

The Tribe was a major contributor to development of this Basin Plan, providing key information concerning a number of areas:

- Existing and potential water quality problems within the basin planning area.
- Current conditions of habitat within the basin planning area, including an extensive evaluation of stream habitat.
- WRIA 11 technical assessment, management plan, and monitoring plan.
- Salmon recovery planning and projects.
- Completed, current, and proposed habitat restoration projects.
- Proposed land acquisitions for conservation and/or restoration opportunities.
- Recommendations for habitat restoration projects and additional studies.

3.2.3 Federal Entities

The basin planning area includes a number of areas administered by the U.S. government. While the Nisqually River Basin Plan does not directly apply to federal lands, it is possible that activities on federal lands could affect surface water management in some portions of unincorporated Pierce County. The federal agencies administering lands within the planning

area boundary were important sources of information to planners and were therefore involved in the planning process. These federal installations are discussed below.

Mount Rainier National Park

The headwaters of the Nisqually River are located in Mount Rainier National Park (Park). The Park covers the uppermost portion of the Nisqually River Basin and forms the eastern boundary of the planning area (see Figure 3-1).

The Park maintains several facilities along the Nisqually River. The two most notable are Sunshine Point Campground and Longmire Wilderness Information Center, as described below.

- Sunshine Point is a campground and picnic area approximately 0.25 miles inside the park boundary. The campground has been affected by flooding along the Nisqually River in the past. Pierce County maintains a levee along the north bank of the Nisqually River near the Sunshine Point Campground. The levee extends approximately 1,800 feet east of the park boundary. The County is currently renegotiating an agreement with the Park for a right-of-way (ROW) permit to maintain these facilities.
- Longmire Wilderness Information Center is approximately 6 miles inside the park boundary and is a relatively large development consisting of several structures. These facilities are also affected by flooding along the Nisqually River. As a result the Park has constructed some revetments at this location for bank protection.
- Other Park facilities within the Nisqually River Basin include the Jackson Visitor Center and the Paradise Visitor Center near the Paradise River, which is a tributary to the Nisqually River. The Park also maintains bridges on Tahoma Creek and Kautz Creek.

The Pierce County project team reviewed the Park's land use plan/EIS and consulted with Park staff to notify them of the basin plan and to obtain information regarding the Park's facilities and future development within the Nisqually River Basin. Pierce County and Park staff discussed basin planning issues on a number of occasions during plan development.

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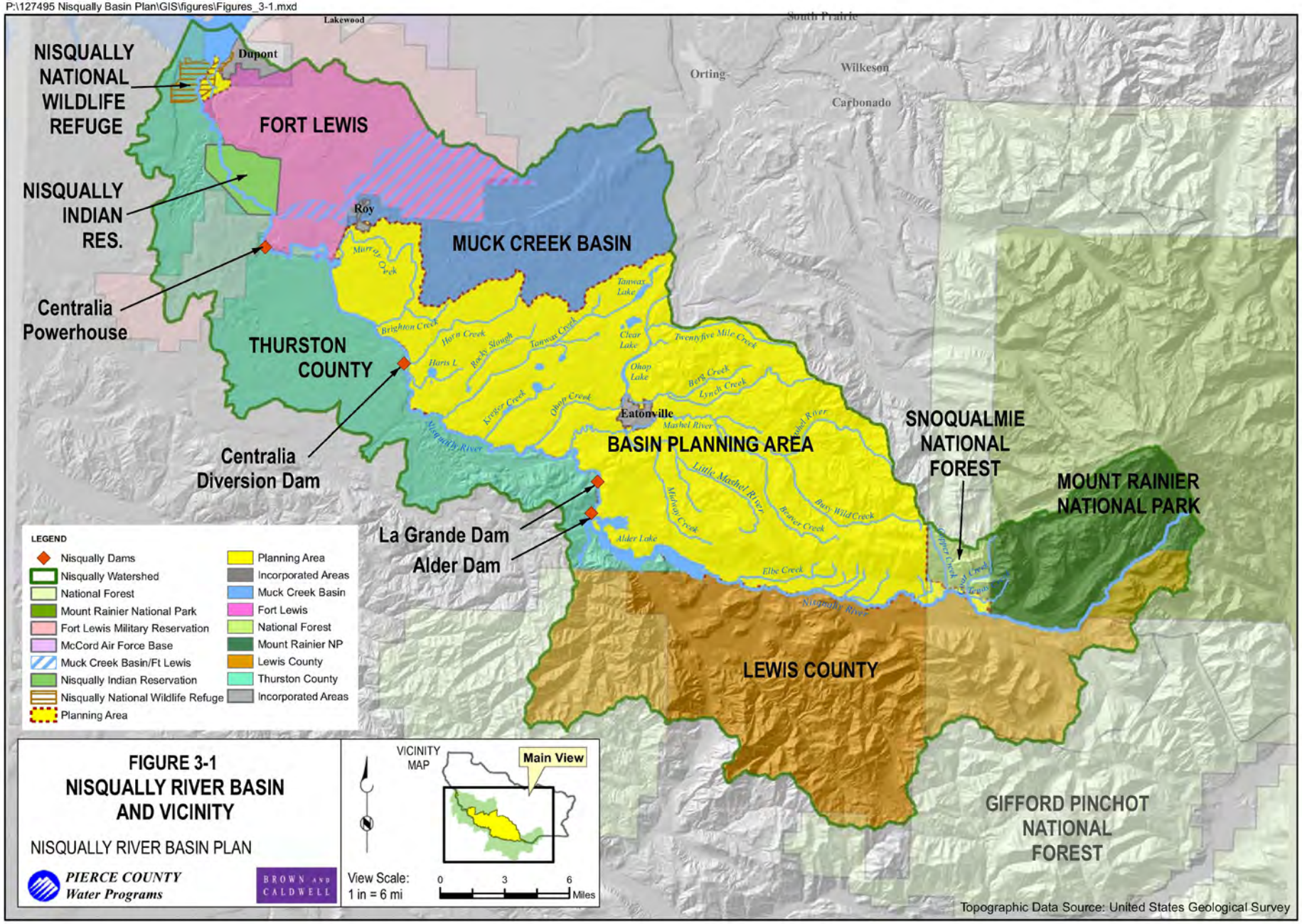


FIGURE 3-1
NISQUALLY RIVER BASIN AND VICINITY

NISQUALLY RIVER BASIN PLAN

Fort Lewis

Fort Lewis (Fort) covers a large portion of the lower drainage area of the Nisqually River Basin. Much of the area covered by the Fort is in the Muck Creek Basin, for which a separate basin plan has been developed. The Fort also covers areas of the Red Salmon Creek drainage and encompasses several miles of the Nisqually mainstem.

Fort Lewis is under federal jurisdiction. However, the project team consulted with Fort Lewis environmental staff to notify them of the basin plan and to obtain information regarding activities along the Nisqually River mainstem. The Fort Lewis staff indicated that most of the Fort's permanent facilities are located outside of the Nisqually River floodplain, and at this time the Fort does not have any projects planned along the mainstem. The Fort does have one crossing on the Nisqually River, which was damaged by flooding in the late 1990's. The Fort described this crossing as not a typical bridge or "hard" structure. The crossing has not been used or maintained since the flood damage occurred and would require improvements before it could be used in the future. Currently, there are no plans to make those improvements.

Nisqually National Wildlife Refuge

The Nisqually National Wildlife Refuge (Refuge), also under federal jurisdiction, located in the Nisqually River Delta. The 2,925-acre refuge is managed by the U.S. Fish and Wildlife Service (USFWS). The refuge protects valuable estuarine habitat for wildlife including migratory birds and salmon. The refuge is divided between Pierce and Thurston Counties.

The project team contacted the Refuge to notify them of the basin plan and obtain relevant information. The team also reviewed the recently completed Comprehensive Conservation Plan for the Refuge (USFWS, 2004). The plan describes several alternatives for future management of the refuge and recommends a preferred alternative, which would involve:

- Expansion of the refuge boundary by adding an additional 3,479 acres, including areas of Pierce County.
- Removal of existing dikes and construction of new dikes to reduce the protected area and restore 699 acres of estuarine habitat.
- Removal of some existing recreational trails and adding new trails, including a loop on the Pierce County side of the river.

3.2.4 State Agencies

The following state agencies administer programs and policies that impact stormwater management within the Nisqually River basin.

Washington State Department of Ecology (Ecology)

The *Washington State Department of Ecology* (Ecology) is the permitting authority in Washington under the federal *National Pollutant Discharge Elimination System* (NPDES). Pierce County Surface Water Management has a "Phase I" *Municipal Stormwater NPDES Permit*. Actions recommended in basin plans must comply with the NPDES permit terms.

Ecology also is responsible for many aspects of watershed protection grants and activities, administration of the *State Environmental Policy Act* (SEPA), and enforcement of sediment, groundwater, and surface water quality standards.

The federal *Clean Water Act,* Section 303(d) requires that every two years, Ecology must identify all water bodies that do not support their designated beneficial uses, as indicated by water quality standards. The resulting list of "impaired" or "polluted" waters is called the "303(d) list." Ecology is responsible for establishing water clean-up plans, or total maximum daily loads (TMDLs), for the impaired or polluted water bodies in order to bring them into compliance with the applicable water quality standards. After a TMDL has been established by Ecology and approved by the US EPA, Ecology must revise the affected NPDES permits to require compliance with the applicable TMDLs.

Surface Water Management staff has had extensive interaction with Ecology regarding current and potential NPDES and TMDL issues. The insights gained through these interactions have been factored into this Basin Plan.

Washington State Department of Fish & Wildlife (WDFW)

The Washington State Department of Fish and Wildlife (WDFW) is the agency responsible for issuing hydraulic project approval (HPA) permits for in-stream work in state waters. Primary WDFW interests in the Nisqually River Basin are:

- Salmon recovery
- Watershed management
- Protection of other fish and wildlife species

The basin planning team met with the regional WDFW biologist to discuss the basin plan and obtain input regarding potential problems, issues, and opportunities related to fish and wildlife habitat in the Nisqually River Basin. The biologist confirmed that WDFW does regular surveys of Nisqually streams, but did not identify any specific problems or opportunities in the basin. He noted that HPA permits will be required for any County projects that include in-stream work. This includes the removal of beaver dams which are a common problem in the Nisqually River Basin. WDFW allows the removal of beaver dams, but does not have a specific policy for beaver dam removal. Each case is reviewed individually.

Washington State Parks and Recreation Commission

Washington State Parks has begun a project to establish a new state park at in Pierce County, near Eatonville. This destination park is adjacent to the Nisqually River, and it is bordered by the Mashel River on the East and the Ohop Creek on the West, and Highway 7 to the North.

Washington State Department of Natural Resources

Washington State Department of Natural Resources (DNR) manages the Elbe Hills State Forest which is located southeast of Eatonville. The DNR is charged with protecting and managing lands and natural resources for long-term productivity; habitat; and other conservation, education, and recreation benefits. As discussed in Section 2.2.9, the DNR administers the state *Forest Practices Act*, which regulates forest practices on private and state land.

3.2.5 Pierce County Agencies

The basin planning team also exchanged information with and sought input from the following Pierce County agencies.

Pierce County Planning and Land Services (PALS)

Within unincorporated areas of Pierce County, the County's Department of Planning and Land Services (PALS) provides the following public services:

- Administers the County's environmental review regulations.
- Enforces compliance with the County's land use zoning and development codes.
- Issues development permits and authorizations.
- Conducts long-range land use planning for unincorporated county areas.

As discussed in section 2.2.9, PALS has a role in the regulation of timber lands that are converted to non-forestry land uses. Such conversions require a *Forest Practice Application* (FPA) from the state DNR, and are subject to Pierce County SEPA review and development regulations. PALS is responsible for administering Title 18H of the Pierce County Code, which provides procedures and review criteria for County approval of special conversion forest practices, general forest practices, and conversion option harvest plans.

The project team consulted with PALS regarding project areas and permit review areas that extend into the Nisqually River Basin planning area. PALS staff provided information concerning the following:

- Effects of storm drainage and surface water management activities on existing and planned land uses.
- Effects of planned land uses, density, and current development regulations on surface water management objectives.
- Growth management policies regarding land use and public facilities.
- Future land use in the Eatonville and Upper Nisqually areas, as described in the *Comprehensive Plan for the Town of Eatonville* and the *Upper Nisqually River Community Plan*. Chapter 4, Current Conditions, summarizes these community plans and their potential implications for the Nisqually River Basin Plan.
- Conversion of commercial forest land to rural residential land uses.

The PALS staff noted that large areas of forest lands are being converted to low-density rural residential land uses (one home per 10 or 20 acres). This trend will likely lead to reduced tree cover, slightly increased impervious surface area, and increased domestic animal population in the basin. In addition, some lakes in the basin are experiencing increased residential development.

Pierce County Transportation Services

Pierce County Transportation Services provides road maintenance on all county roads, including all associated bridges, culverts, and storm drains. The project team consulted with

Transportation Services staff regarding roads in the basin planning area and obtained information as follows:

- Road maintenance problems related to storm drainage and surface water management activities.
- Other observed problems within the study area related to flooding and storm drainage, water quality, and/or riparian habitat.
- Current or future transportation projects within the planning area that could affect storm drainage and surface water management activities.

Tacoma-Pierce County Health Department (TPCHD)

The *Tacoma-Pierce County Health Department* (TPCHD) provides many programs for health care and disease prevention. Programs relevant to the Nisqually River Basin Plan include:

- *Source Protection Program* – TPCHD promotes environmental protection and distributes public information on well water, household hazardous waste, and boating and recreation.
- *Septic System Program* – TPCHD works to ensure that septic systems are located and installed correctly and kept in good working condition in an effort to reduce the risk of contaminating groundwater and surface water and to reduce the risk to public health.
- *Safe Shellfish Program* – TPCHD promotes safe harvesting and consumption of shellfish on local beaches and waterways in Pierce County. TPCHD receives financial support from the Surface Water Management Division to fund its Shellfish Program.

TPCHD also monitors for toxic blue-green algae blooms in local lakes and streams and cautions citizens when public waters become unsafe.

The project team met with TPCHD staff to discuss potential problems related to septic systems and lake water quality in the basin.

3.2.6 Other Municipalities

Although the Basin Plan focuses on unincorporated Pierce County, surface water follows topography without regard for political boundaries. For example, stormwater runoff within cities may flow into unincorporated areas and vice versa. Drainage conditions and decisions in cities have the potential to improve or worsen flooding, water quality, and fish habitat conditions in unincorporated areas. Conversely, stormwater management decisions for County-governed areas could affect the surface water volume and quality in other jurisdictions. With these relationships in mind, other municipalities were included as stakeholders. The Nisqually River Basin contains a number of local jurisdictions as listed below:

- Town of Eatonville (1.7 square miles of basin)
- City of Roy (0.5 square miles)
- City of DuPont (2.4 square miles)
- Thurston County (129 square miles)

- Lewis County (193 square miles).

Town of Eatonville

The Town of Eatonville is centrally located in the basin planning area (see Figure 3-1). The Eatonville Comprehensive Plan was developed in response to the *Growth Management Act* of 1990, and was completed in 2005. The urban growth area specified in the Plan lies in both the Lynch Creek and Mashel River drainage areas. Future decisions by the town with regard to land use and stormwater management is of interest to the basin planning effort because of the town's stormwater discharge to Lynch Creek. As noted above, the project team met with PALS staff to obtain information about the Comprehensive Plan for the Town of Eatonville (Eatonville, 2005). The project team also met with the Town Administrator to discuss the Town's future projects and future development areas. The Town Administrator noted that water quality in Lynch Creek is a key concern. Runoff from the town and from unincorporated lands discharges into the Creek via a large ditch. Several residential subdivisions have been built recently or are underway. Subdivisions are required to follow the Pierce County stormwater management manual requirements. He also noted that the town owns land on the lower portion of the ditch, which might be available for a stormwater treatment facility.

City of Roy

The City of Roy is located on the west side of the basin planning area. Most of Roy is located within the Muck Creek drainage area (not included in this basin plan). However, parts of Roy extend into the Murray Creek drainage area. The project team spoke with the City of Roy's planning consultant by phone to discuss surface water management problems and the future projects. According to the City of Roy's planning consultant, Roy does not anticipate substantial growth in the near future. No major projects related to surface water management are planned for the future.

City of DuPont

The City of DuPont is located at the north end of the Nisqually River Basin near Puget Sound. Only a portion of the city boundary extends into the Nisqually River Basin; most of the city lies within the Sequalitchew basin. The project team consulted with staff at the City of DuPont to notify them of the basin plan and to obtain relevant information. The City of DuPont did not identify any issues related to the Nisqually River Basin. Surface water management in the city is primarily concerned with Sequalitchew Creek.

Thurston County

Thurston County forms the southwestern boundary of the planning area along the Nisqually River mainstem (Figure 3-1). The project team consulted with the Thurston County planning staff regarding problems that may exist along the shared reach of the Nisqually River, and any Thurston County activities or initiatives planned for the basin. Thurston County staff did not identify any problems or planned activities relevant to the basin plan.

Lewis County

Lewis County forms the southern boundary of the planning area along the upper reaches of the Nisqually River mainstem (Figure 3-1). The project team consulted with the Public Works Department of Lewis County regarding current or potential problems along the shared reach of the Nisqually River. The upper Nisqually River is an active braided channel and rapid channel migration has led to flooding problems along the valley floor. One such area was the Hidden Valley subdivision on the Lewis County side of the river. Pierce County and Lewis County are currently working together to map the "Channel Migration Zone" (CMZ) of the upper Nisqually River.

3.2.7 Other Entities

The planning team also contacted several other agencies and companies that serve the planning area as described below.

Nisqually River Council

The Nisqually River Council (NRC) has been actively involved in water resources and land use management activities in the Nisqually River watershed for almost 20 years. The NRC was originally formed to guide the development and implementation of the *Nisqually River Management Plan*, which was adopted in 1987.

The NRC is composed of a broad cross-section of local, state, and federal agencies and organizations, including Pierce, Lewis, and Thurston Counties; the Nisqually Tribe; the WDFW; the Washington Department of Natural Resources; the cities of Eatonville, Yelm and Roy; the Washington Conservation Commission; Fort Lewis; Tacoma Public Utilities; the Nisqually National Wildlife Refuge; the US Forest Service; and the University of Washington Pack Forest. The NRC also includes several members of the Nisqually Citizens Advisory Committee and manages the Nisqually Land Trust. Therefore, the NRC is a key group for stakeholder involvement in the *Nisqually River Basin Plan*.

The NRC recently completed the *Nisqually Land Trust Stewardship Plan* for the watershed. This plan considers the Nisqually Watershed an integrated whole and provides for a balanced stewardship of the basin's economic, cultural and environmental resources. It is a community-based plan that will be voluntarily implemented by landowners and neighbors and communities, cities and counties, state and federal government, and the Nisqually Indian Tribe (Nisqually Land Trust Stewardship Plan, 2005).

Pierce County Surface Water Management staff attended several monthly meetings of the NRC. County staff met with the NRC and its members about the basin plan to provide an overview of the basin plan scope and objectives, ask for information regarding problems and opportunities within the basin, and notify the NRC of public meetings. The project team had numerous discussions with members of the Nisqually Tribe who are involved with the NRC.

Pierce Conservation District

The Pierce Conservation District (Conservation District) is a special-purpose district authorized by Chapter 89.09 of the Revised Code of Washington to help citizens manage natural resources wisely. The chapter authorizes conservation districts to conduct surveys and research, conduct educational and demonstration projects with the consent of landowners, design improvements, and recommend actions by individuals and governments to conserve natural resources. A conservation district cannot regulate or require adherence to its programs or recommendations. The Conservation District administers a dairy waste management program, a farm assistance program, salmon recovery programs, and a stream team program. Water quality, soil conservation, fish habitat protection, and habitat restoration are at the heart of these Conservation District programs.

The Conservation District created a database of culverts throughout the Nisqually River Basin. The database includes evaluations by District staff of each culvert's potential for fish passage. This database was used in this Basin Plan report to help identify fish barriers within the planning area.

Tacoma Power

Tacoma Power owns and operates the Nisqually River Project, which consists of Alder Dam, La Grande Dam, the reservoirs and associated lands. The Nisqually River Project is subject to Federal Energy Regulatory Commission (FERC) licensing requirements and was issued a new FERC license in 1997. The project team consulted with staff at Tacoma Power staff to obtain information regarding current water quality and habitat related activities at the Nisqually River Project. Staff referred us to their operating rules affecting surface water management, which are outlined in Chapter 4 of this Basin Plan.

Centralia City Light

Centralia City Light operates a small diversion and powerhouse on the lower Nisqually River. The diversion canal alignment is on the Thurston County side of the river. The project team consulted with Centralia City Light staff to obtain information regarding existing conditions at the diversion and whether any problems have been observed in the area.

University of Washington Pack Forest

Pack Forest is an approximately 4300-acre research and demonstration forest owned and managed by the University of Washington's College of Forest Resources. Pack Forest staff is responsible for maintaining the setting and forest diversity so that academic and research opportunities may continue and expand.

3.2.8 Citizens within the Nisqually River Basin

Public involvement was an integral part of the basin planning process. The project team held its own public meetings and attended others. Two surveys of the basin residents were also conducted.

Public Meetings

The project team held two public meetings during the basin characterization phase of the basin planning process in an effort to involve and solicit input from basin residents.

The first meeting was held on June 1, 2005, toward the beginning of the characterization phase, at Weyerhaeuser Elementary School near Eatonville. This meeting was intended to inform residents of the planning process and to solicit information regarding drainage/flooding, water quality, and/or fish habitat problems in the basin.

A second meeting was held in September of 2006 to present the draft findings of the basin characterization and obtain citizen input.

As noted above, Surface Water Management staff attends the Nisqually River Council (NRC) meetings, and will continue to attend throughout the basin planning process. The first meeting occurred at the start of the basin planning process. At that initial meeting, Surface Water Management presented an overview of the basin planning process and invited NRC members to participate. Surface Water Management staff provided basin planning status reports at subsequent meetings. The key findings of the basin characterization phase were presented to the NRC on July 21st, 2006. The NRC was asked to provide input on the problem areas identified during basin characterization and on the proposed data gaps to be addressed during basin plan development.

A list of public meetings and presentations conducted by the project team is provided in "Appendix B."

Basin Residents Survey

In March 2005, the County mailed a questionnaire to basin residents, along with a cover letter explaining the basin planning process. The intent of this questionnaire was to collect information on flooding and drainage, water quality and/or fish habitat problems and priorities. "Appendix B" contains a copy of the questionnaire.

In July 2007, the County mailed a second questionnaire to basin residents. This questionnaire was sent to nearly 800 lakeshore property owners on 16 lakes to collect information regarding lake use and problems associated with flooding, water quality, and aquatic habitat. The methodology and results for this survey are summarized in Chapter 7.

Basin residents receiving questionnaires were property owners that met one of the following criteria:

- A portion of their property is in or nearly in the FEMA designated floodplain (Zone A).
- A portion of their property is near a water body
- A drainage, water quality, or fish habitat related problem was reported on or near their property and was entered into the County's Service Response System (SRS) database.

The mailing list was developed based on a series of geographic information system (GIS) database queries. The County's tax parcel database was queried to identify parcels that were at least partially within the FEMA 100-year floodplain, or within 200 feet of a mapped watercourse or water body. The selected parcels were filtered to only include those parcels with an improved value greater than $25,000 to filter out vacant or unimproved parcels. The SRS database was also queried to identify all parcels that contained reported drainage, water quality, or fish habitat problems. The SRS database query encompassed all parcels in the study area (not just parcels in the FEMA floodplain or riparian corridors described above).

The GIS and SRS database queries described above identified approximately 1,700 property owners. The questionnaire was mailed to every property owner identified. Approximately 120 completed questionnaires were returned to Surface Water Management. The questionnaire results are summarized in Chapter 5.

Tanwax Citizens Group

The Tanwax Citizens Group is an organization of citizens living in the subbasin of Tanwax Creek and its tributaries. Pierce County Surface Water Management staff attended a Tanwax Citizens Group meeting in December of 2005. Surface Water Management staff gave a presentation on the Nisqually River Basin Planning process. Citizens were encouraged to identify surface water management-related problems and to provide input for the basin planning process. Several people mentioned problems involving beaver activities and lake level management. The Tanwax group has been instrumental in obtaining grant funding for revegetation projects on Rapjohn Lake and Tanwax Creek (Personal communication with David Hymel, June 2006).

CHAPTER FOUR
CURRENT AND FUTURE CONDITIONS

This chapter summarizes the salient features of the Nisqually River Basin. It is based on existing studies, plans and reports, stakeholder input, and focused field investigations by the project team. The primary focus is on Basin conditions relevant to Surface Water Management, including drainage/flooding, water quality, and fish habitat.

4.1 LAND USE AND POPULATION

Land use and population density can affect surface water drainage/flooding, water quality, and fish habitat. This section summarizes existing and planned land use and population in the Nisqually River Basin Planning area.

4.1.1 Land Use

Various land uses have different effects on the water quality and the hydrologic components of a watershed. Undeveloped forested land allows for maximum infiltration of rainwater and has the least potential for causing water pollution.

Highly developed areas (characterized by large areas of impervious surfaces), whether residential, commercial, or industrial land uses, increase the surface runoff of stormwater, carrying pollutants picked up from the manmade surfaces into the streams and waterways. Increased stormwater discharges can erode drainage ditches and stream channels, increase turbidity of stream water, deposit sediment in habitats important to fish and aquatic life, and fill downstream flood storage areas.

Poor agricultural practices, such as improperly applied irrigation methods and feeding or watering livestock too close to a stream, can also contribute to water quality problems when the practices increase erosion and disturb soils adjacent to streams. These areas can be significant sources of sediment, fecal coliform bacteria, and nutrients such as nitrate and phosphate. Excess nutrients in water reduce the dissolved oxygen content that fish and other aquatic organisms require.

Existing Land Use

Figure 4-1 shows the existing land use in the planning area as classified by the County's tax parcel database. The western portion of the planning area (west of Eatonville) has experienced increasing development pressure and is a mixture of rural residential, open space, and agricultural land uses. This area includes the Murray Creek, Brighton Creek, Horn Creek, Harts

Lake, Tanwax Creek, Kreger Creek and Lower Ohop Creek subbasins. The relative distribution of land use is approximately 50% rural residential, between 15% and 30% open space, and between 5% and 10% agricultural. The area generally to the east of Eatonville is more

mountainous and less developed. This area is approximately 75% forested and 25% rural residential.

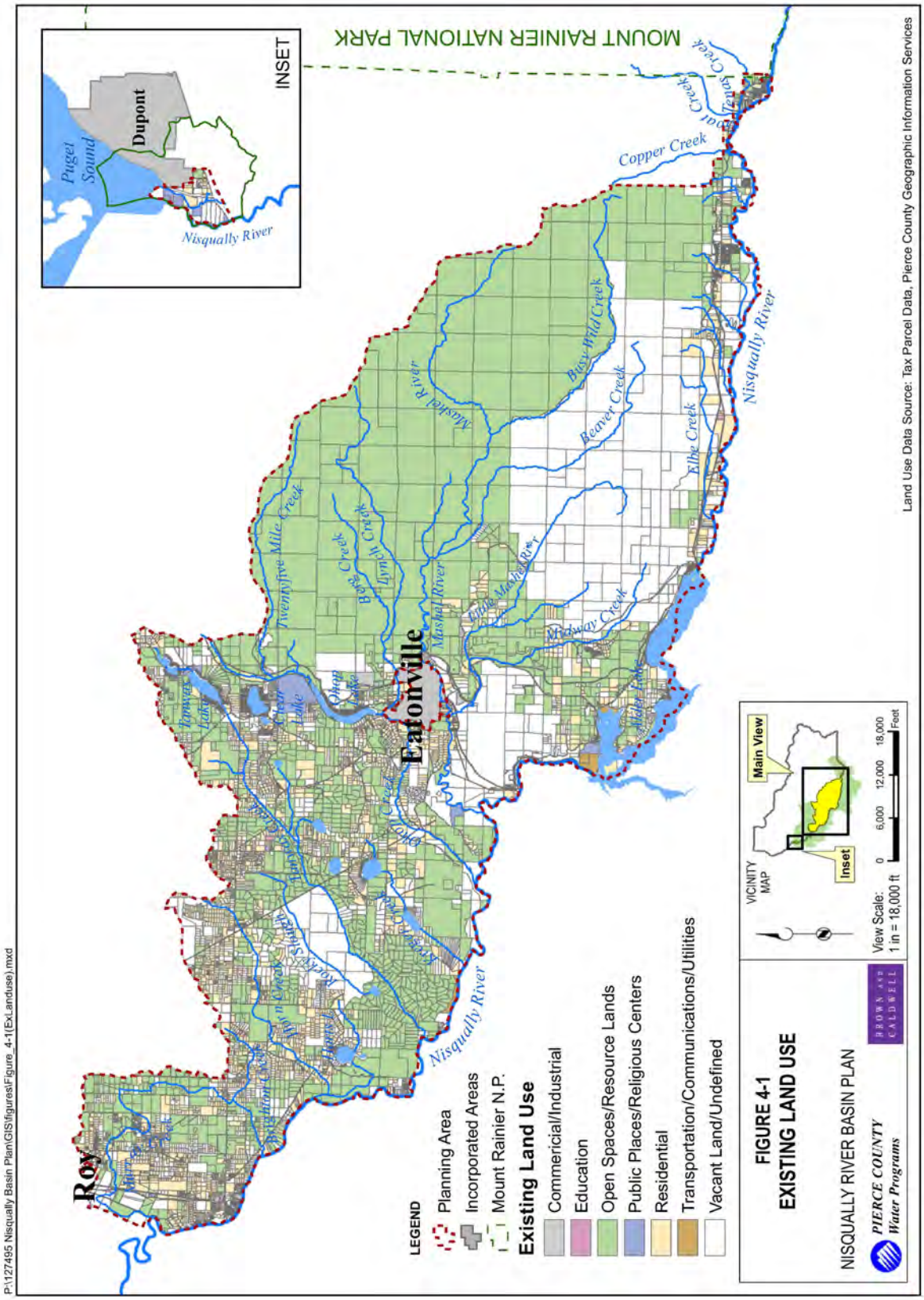
Future Land Use

The *Comprehensive Plan for Pierce County, Washington* (*County Comprehensive Plan*) (Pierce County, March 1999) was developed and adopted in 1994 in response to the requirements of Washington's "Growth Management Act," as described in Section 2.1. The *County Comprehensive Plan* seeks to obtain and balance 13 different planning goals. These goals include reducing sprawl while still encouraging development, providing public facilities and services to support development, protecting the environment while protecting property owners' rights, promoting economic development, preserving archeological and historical sites, artifacts and structures, and processing permits in a timely manner, while at the same time encouraging citizen participation in the planning process (Pierce County, March 1999). The *County Comprehensive Plan*, codified as Title 19A of the Pierce County Code, divides the Nisqually River Basin into rural areas and urban growth areas.

The land use element of the *Pierce County Comprehensive Plan* includes a growth and development strategy on how and where development will occur in the future. It is important to consider the proximity of existing surface water within the Basin to future designated employment centers, commercial centers, mixed-use districts, moderate density and high-density residential districts, and rural activity centers. The future land use designations that lie within the Nisqually River Basin are listed below.

- Agricultural
- Designated Forest Land
- Moderate-Density Single-Family Residential
- Reserve Five
- Rural Five, Ten, Twenty and Forty
- Rural Activity Center
- Rural Neighborhood Center
- Tourist Commercial
- Village Center
- Village Residential

As shown in Figure 4-2, most of the Basin is currently zoned for forest land (eastern portion of the Basin) and rural residential development (western portion of the Basin). Designated forest lands can only have one dwelling unit per 80 acres. Pierce County PALS staff is not aware of any conversions from commercial forest to subdivisions other than the Park Junction resort, between Elbe and Ashford. Outside of Eatonville, there are no subdivisions planned or vested. There may be a few vested short plats in the planning area.


MOUNT RAINIER NATIONAL PARK
INSET
Puget Sound
Dupont
Nisqually River
Roy
Eatonville
Copper Creek
Busy Wild Creek
Beaver Creek
Elbe Creek
Alder Lake
Nisqually River
Mashel River
Little Mashel River
Twenty-five Mile Creek
Lynch Creek
Ohop Lake
Clear Lake
Tanwax Lake
Rocky Shanty Creek
Ashford Creek
LEGEND
Planning Area
Incorporated Areas
Mount Rainier N.P.
Existing Land Use
Commercial/Industrial
Education
Open Spaces/Resource Lands
Public Places/Religious Centers
Residential
Transportation/Communications/Utilities
Vacant Land/Undefined
VICINITY MAP
Main View
Inset
View Scale: 1 in = 18,000 ft
0 6,000 12,000 18,000 Feet
FIGURE 4-1
EXISTING LAND USE
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
Land Use Data Source: Tax Parcel Data, Pierce County Geographic Information Services
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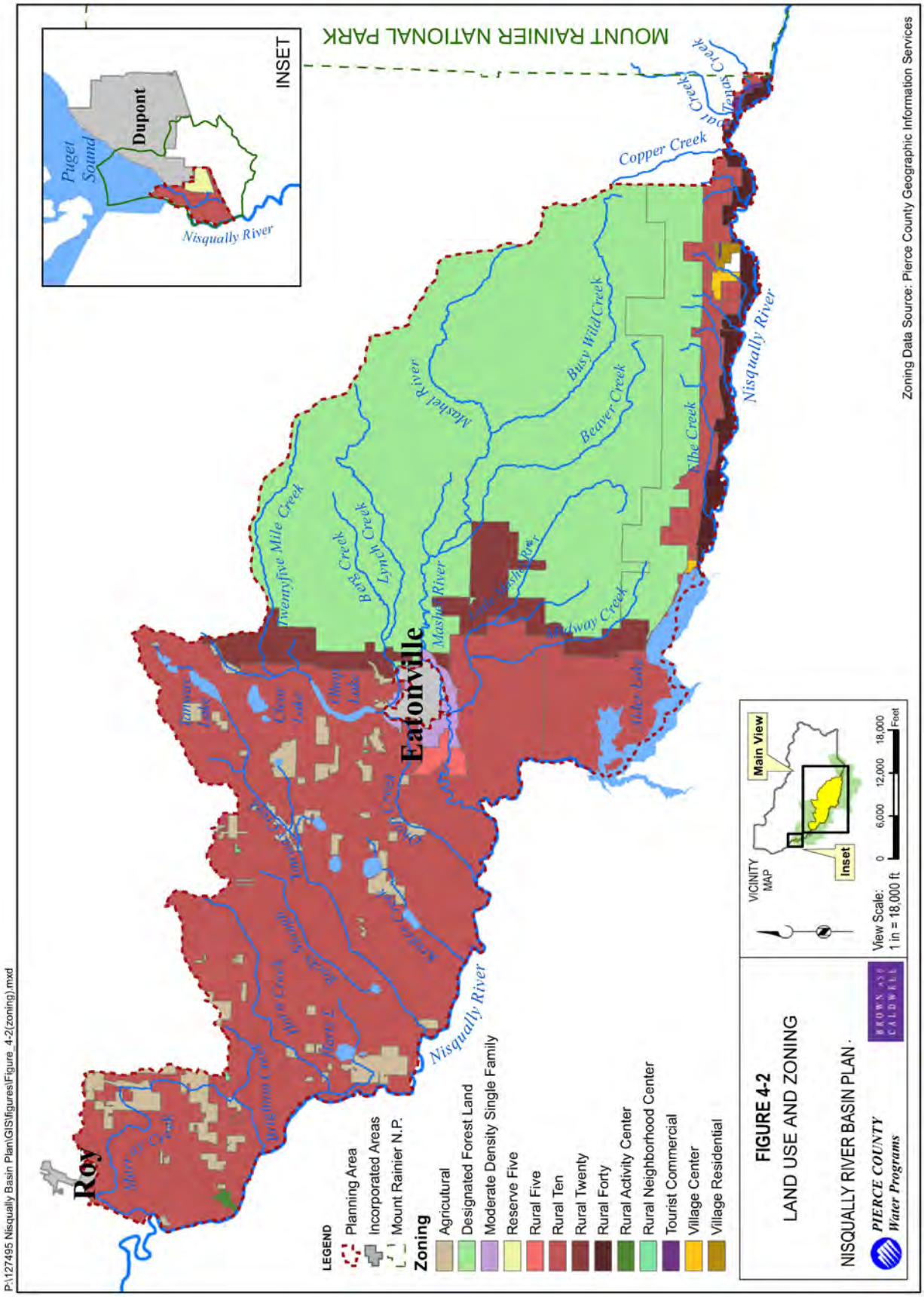
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Roy
Eatonville
MOUNT RAINIER NATIONAL PARK
INSET
Puget Sound
Dupont
Nisqually River
Copper Creek
Busy Wild Creek
Beaver Creek
Elbe Creek
Mashel River
Twenty five Mile Creek
Ohop Lake
Clear Lake
Alder Lake
Nisqually River
LEGEND
Planning Area
Incorporated Areas
Mount Rainier N.P.
Zoning
Agricultural
Designated Forest Land
Moderate Density Single Family
Reserve Five
Rural Five
Rural Ten
Rural Twenty
Rural Forty
Rural Activity Center
Rural Neighborhood Center
Tourist Commercial
Village Center
Village Residential
VICINITY MAP
Main View
Inset
View Scale:
1 in = 18,000 ft
0 6,000 12,000 18,000 Feet
FIGURE 4-2
LAND USE AND ZONING
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL
Zoning Data Source: Pierce County Geographic Information Services

Large tracts in the planning area, such as between Ohop and Harts lake, are being converted from commercial timber to rural residential 20-acre parcels. In one instance (Fairbanks County Estates), property owners with 20-acre parcels would like to further divide the parcels. Many of these tracts will be developed in the future. Rural zoning allows for residences, pastures and hobby farms. The development would increase automobile usage in the Basin. These areas may have logging roads that were not intended for increased traffic and may go through critical areas. In addition, people often clear the land to improve their views.

Therefore, areas that were once forested will have less trees and native vegetation, more impervious areas, and may have pets, livestock, septic systems, and increased traffic–all possible pollutant sources. Some of these properties have direct access to lakes and wetlands. As the land is developed, stormwater drainage systems, built and natural, will be affected by the runoff (due to decreased forest cover increased impervious areas) and potential increased pollutant loading.

In an effort to address the impacts associated increased development, the Basin Plan will include stormwater runoff estimates based on planned land uses. These estimates will be used to determine if the existing drainage system has enough capacity. Recommendations will be made for facilities and projects to manage the stormwater without significant flooding and loss of property. The Basin Plan will also make recommendations related to water quality and fish habitat that may be impacted by increased development

Community Planning Efforts

Two community plan area lies within the boundaries of the Nisqually River planning area: the *Upper Nisqually Valley Community Plan* and the *Graham Community Plan.* The community planning process uses the *County Comprehensive Plan* as a foundation and allows citizens to make specific recommendations regarding such things as special areas to protect, infrastructure, and transportation design features, commercial and large-scale housing design, and certain land use patterns – things that can directly affect surface water and groundwater resources.

Upper Nisqually Valley Community Plan

The Upper Nisqually Valley Community Plan area begins slightly north of Alder Dam, extends eastward through the communities of Alder, Elbe, and Ashford, and terminates at Mount Rainier National Park. The Upper Nisqually Valley Community Plan was adopted by the Pierce County Council on September 28, 1999. The Upper Nisqually Land Use Advisory Commission is a County-appointed board that is responsible for monitoring and implementing the Community Plan.

Under the plan, the communities of Ashford and Elbe are largely zoned Village Center, which allows for a mix of commercial, residential, and civic uses. The area adjacent to Mount Rainier National Park also was rezoned to Tourist Commercial. This zone is restricted to four uses: lodging, restaurants, and sales of general merchandise and rental of recreational equipment.

The Plan attempts to balance environmental and economic factors by recognizing the abundance of local natural resources such as wildlife, water, and forests with the opportunity to allow local citizens to make a sustainable living from the visitors to the area.

Also at the MRNP Entrance, the UNVCP recognized the then 35-year old high-density residential subdivision of Nisqually Park as a legal non-conforming use with the Rural-40 Zone that was expected to grow and develop to its potential of 100+ residences within the constraints of water availability. Downstream, at Kernahan Road, the community of Alpine Village was also designated as a legal nonconforming use within the Rural Zone. The stated purpose of the designation of the Tourist Commercial Zone and the legal nonconforming uses was to recognize and facilitate the gateway and support functions of the Upper Nisqually Valley, particularly SR 706, as the primary year-round gateway to MRNP, a regional, national, and international destination park. Over one-half million visitors to the park enter through the Nisqually entrance each year.

Graham Community Plan

The communities within the greater Graham area of unincorporated Pierce County was authorized to prepared the Graham Community Plan, which was completed in March 2006, and is currently under review by the Pierce County Council.

The Graham Community Plan area is located in south central Pierce County at the fringe of the County's urban growth area limits. The plan area is bounded by the communities of Spanaway, Frederickson and South Hill to the north, with the northern most limits ranging from 208th to 176th Street East. State Route 7 is located along the western boundary of the plan area and 352nd St. East represents the southern boundary. The plan area extends as far east as the Puyallup River Valley. Many small, distinct communities are located within the plan area including Graham, Elk Plain, Kapowsin, Thrift, and Rocky Ridge (Graham Community Plan, 2006).

The Graham Community Plan includes two new land use designations (Rural Sensitive Resource and Rural Farm) and five new zoning classifications (Community Employment, Single Family, Moderate High Density Residential, Rural Sensitive Resource, and Rural Farm) and one zoning overlay (Thun Field Airport Overlay). The Graham Community Plan seeks to designate land uses that reflect a rural character and provide a stepped-down scale from the intensity and density of uses found in the more urban neighboring community plan areas of South Hill, Frederickson, and Parkland-Spanaway-Midland.

As such, the community has chosen to lower the maximum urban residential densities and commercial intensities. In addition, rural residential densities have also been amended to reflect a larger lot pattern or provide increased protections for or from critical areas. Finally, agriculture is very important to citizens within the plan area and the area designated as farm land has been significantly increased to more accurately reflect current farming and agricultural activities (Graham Community Plan, 2006).

4.1.2 Population

Current Population

Population estimates in the study area of this Basin Plan were prepared using 2000 census block group data from the U.S. Census Bureau. Populations of census groups that were partially located within the Basin were estimated using aerial photographs or by multiplying the total block group population by the percentage of the block group located within the Basin. Using the process described above, population within the study area was estimated to be 12,881. Figure 4-3 shows a distribution of the population in the Basin Planning area.

Future Population

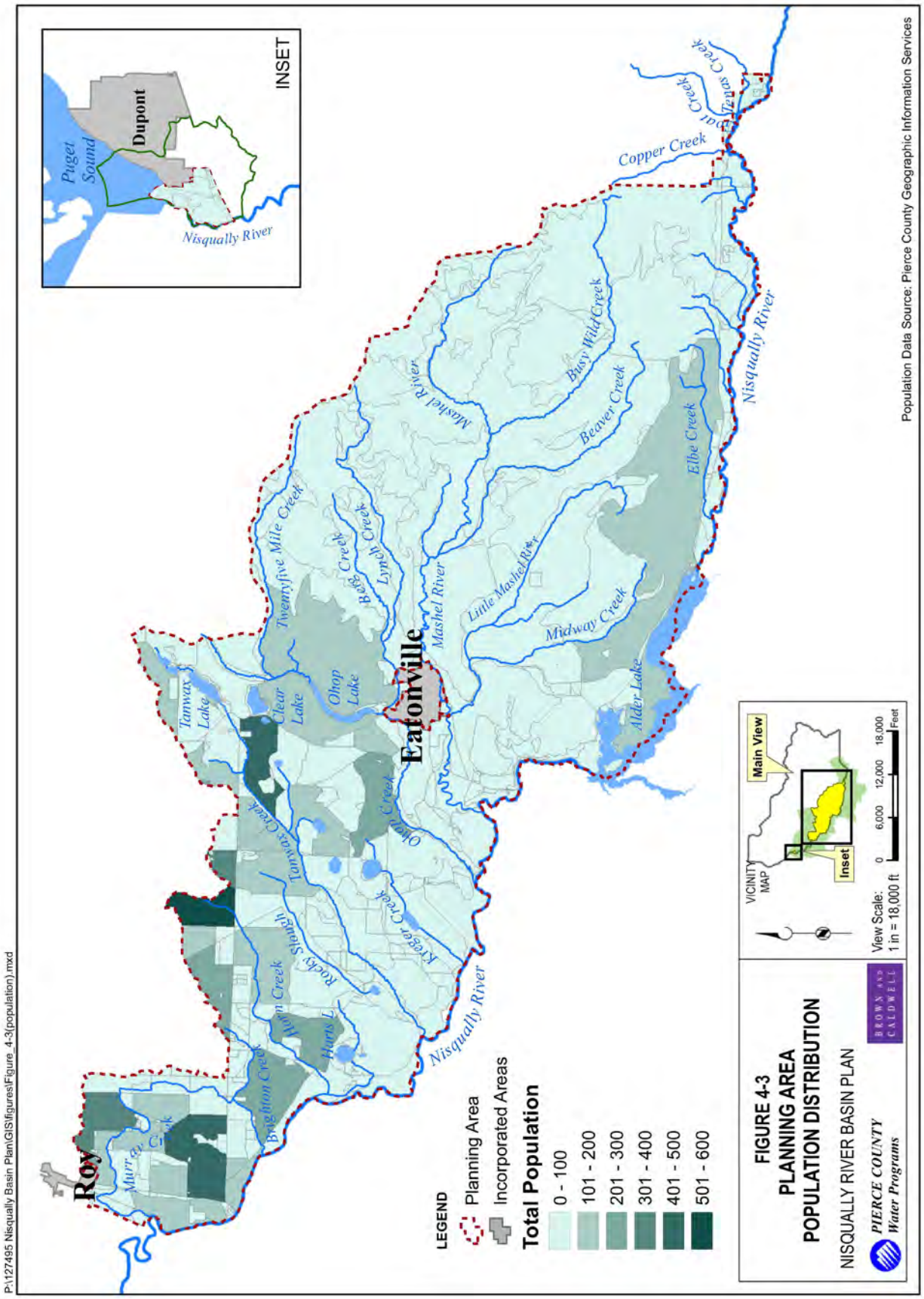
Pierce County has experienced substantial growth in previous years and is expected to support more growth over the next 30 years. According to the U.S. Census, the population of Pierce County in 2000 was 586,203.

According to the Puget Sound Regional Council's (PSRC) long-range population forecasts for the forecast analysis zones within Pierce County, the County is expected increase 16% to 812,859, by the year 2010 (PSRC, 2002). According to the *2001 Population and Employment Forecasts* report for the central Puget Sound region, Pierce County is expected to reach the following populations in the years 2010, 2020, and 2030 (PSRC, October 2001):

2010: 812,859
2020: 892,314
2030: 951,747

Future population projections for Pierce County can help to predict future populations within the Nisqually River Basin. The estimated 2000 population in the Nisqually River Basin Planning area was 12,881, which is 1.8% of the county's total population 700,820 in 2000.

Assuming that the planning area will continue to capture at least 2% of the county's growth, it is predicted that in 2010, the population residing in the Nisqually River Basin Planning area will be approximately 16,300 and 18,000 people will reside within the Basin in 2020.


INSET
Puget Sound
Dupont
Nisqually River
Roy
Eatonville
Copper Creek
Busy Wild Creek
Beaver Creek
Elbe Creek
Nisqually River
Mashel River
Little Mashel River
Midway Creek
Alder Lake
Twentyfive Mile Creek
Bobb Creek
Lynch Creek
Ohop Lake
Clear Lake
Tanwax Lake
Tanwax Creek
Ohop Creek
Kreger Creek
Rocky Slough
Hurn Creek
Hurts L.
Brighton Creek
Murray Creek
Nisqually River
LEGEND
Planning Area
Incorporated Areas
Total Population
0 - 100
101 - 200
201 - 300
301 - 400
401 - 500
501 - 600
FIGURE 4-3
PLANNING AREA
POPULATION DISTRIBUTION
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL
VICINITY MAP
Main View
Inset
View Scale:
1 in = 18,000 ft
0 6,000 12,000 18,000 Feet
Population Data Source: Pierce County Geographic Information Services
P:\127495 Nisqually Basin Plan\GIS\figures\Figure_4-3(population).mxd

4.2 TOPOGRAPHY, SOILS, AND RAINFALL

The Nisqually River Basin Planning area lies within the Nisqually watershed, which has been designated by the state as Water Resource Inventory Area (WRIA) 11. WRIA 11 covers approximately 760 square miles. The general topography, soils, and typical rainfall patterns in WRIA 11 are described below.

4.2.1 Topography and Geology

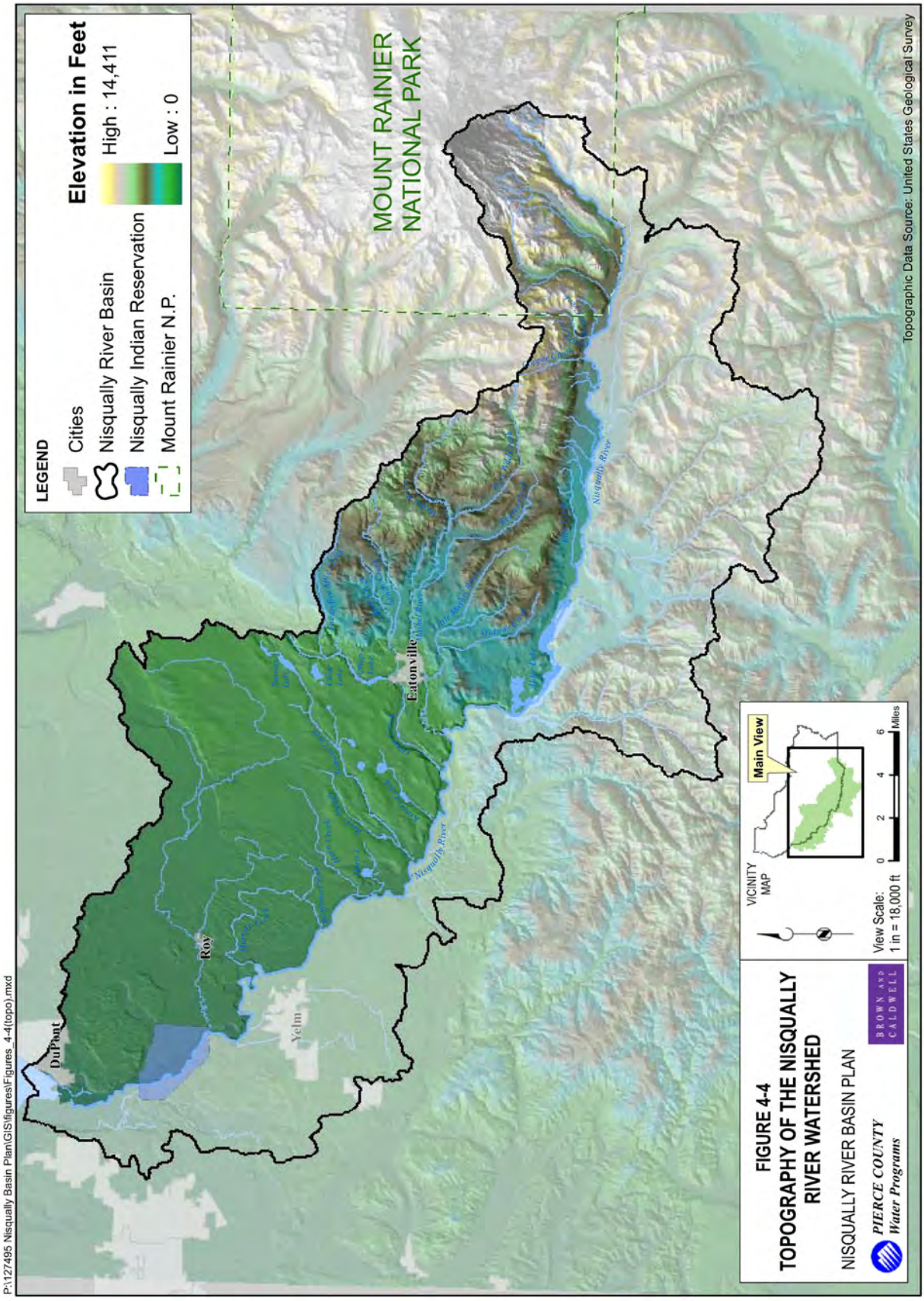
Elevations in WRIA 11 range from sea level to over 14,000 feet, although most of the Basin lies below 1,000 feet (see Figure 4-4). The steepest subbasins within the Pierce County portion of the watershed are the Mashel and the Upper Nisqually subbasins.

The varied topographical landforms in the Nisqually River Basin are the product of volcanic activity, tectonic uplifting, glacial advances and retreats, and erosion by rivers and streams. Intermittent volcanic activity and uplift of the volcanic range eventually resulted in the creation of the Cascade Mountain Range. Deposits of sandstone, shale, and coal were compressed, folded, uplifted, and eroded into the foothills of Mount Rainier and the Cascade Range. Over the past one million years, glaciation modified the landscape of what is now the Puget Sound lowlands, as repeated advances and retreats of the Puget Sound lobe of the Cordilleran ice sheet scoured elongated hills and valleys oriented in a north-south direction (LPWMC, 1992). Ice from the most recent episode of glaciation, known as the Vashon stage, retreated about 12,500 years ago. Figure 4-5 maps the surficial geology of the Nisqually River Basin.

Glacial deposits resulting from the Vashon glaciation include advance outwash, glacial till, and recessional outwash. Advance outwash (rock carried forward as a glacier advances) and glacial till (unsorted, unstratified mixture of fine and coarse rock debris deposited by a glacier) were formed of deposits of silt, sand, clay, gravel, and boulders that were compacted by the weight of overlying ice. Melt water from receding glaciers deposited recessional outwash.

Unlike the western portion, large areas of the eastern portion of WRIA 11, primarily the Upper Nisqually River Basin, Mashel, and Tanwax/Kreger/Ohop subbasins were not covered by continental glacial ice. The surface geology in these areas generally consists of sedimentary and volcanic formations (bedrock).

With the exception of the Mashel subbasin, the subbasins in the western portion of WRIA 11 are low-elevation and of low relief. All subbasins in the lower watershed have a rain-dominated hydrologic regime, except for the Mashel subbasin, which has a rain-on-snow dominated hydrologic regime. The low relief of the subbasins, with the exception of the Mashel, limits the potential energy available to move water through the system, resulting in relatively low stream velocities and erosion potential. The following paragraphs summarize the topography of each subbasin within the Pierce County portion of WRIA 11.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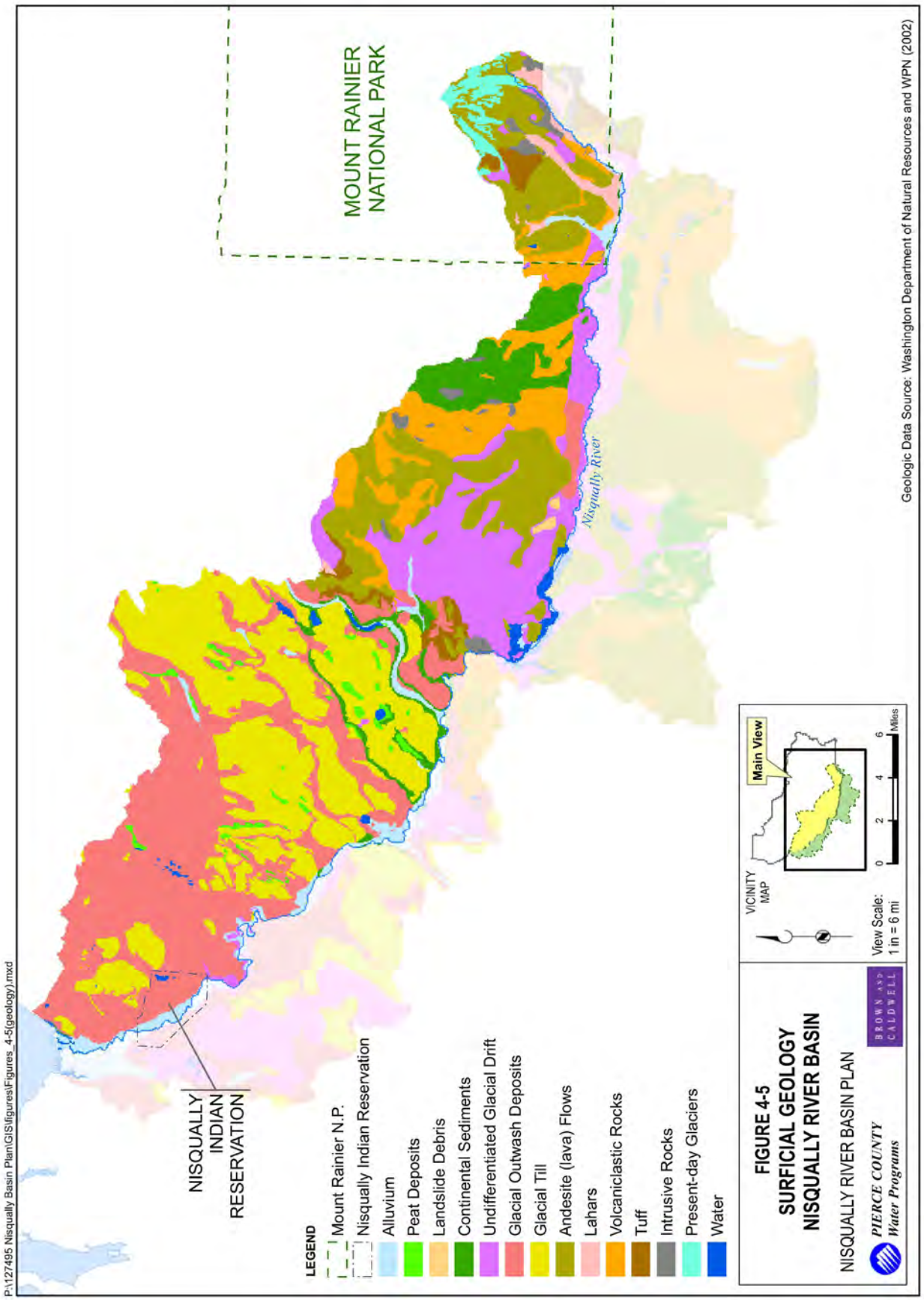
LEGEND
Cities
Nisqually River Basin
Nisqually Indian Reservation
Mount Rainier N.P.
Elevation in Feet
High : 14,411
Low : 0
MOUNT RAINIER NATIONAL PARK
DuPont
Roy
Yelm
Eatonville
Nisqually River
VICINITY MAP
Main View
View Scale:
1 in = 18,000 ft
0 2 4 6 Miles
Topographic Data Source: United States Geological Survey
FIGURE 4-4
TOPOGRAPHY OF THE NISQUALLY RIVER WATERSHED
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL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MOUNT RAINIER NATIONAL PARK
NISQUALLY INDIAN RESERVATION
Nisqually River
LEGEND
Mount Rainier N.P.
Nisqually Indian Reservation
Alluvium
Peat Deposits
Landslide Debris
Continental Sediments
Undifferentiated Glacial Drift
Glacial Outwash Deposits
Glacial Till
Andesite (lava) Flows
Lahars
Volcaniclastic Rocks
Tuff
Intrusive Rocks
Present-day Glaciers
Water
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
FIGURE 4-5
SURFICIAL GEOLOGY
NISQUALLY RIVER BASIN
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
Geologic Data Source: Washington Department of Natural Resources and WPN (2002)

Murray

The Murray subbasin is primarily flat, located below elevation 1,000 feet on a low-lying glacial drift plain. The Murray subbasin is the flattest subbasin in the analysis area. Slightly less than 50% of the area in the subbasin has slopes less than 3%, and approximately 2% of the area has slopes greater than 30%.

Tanwax/Kreger/Ohop

Mean elevation of the Tanwax/Kreger/Ohop subbasin is 1,060 feet above sea level. Average Basin gradient is 16% and elevations range from 360 to 3,720 feet. Precipitation in the subbasin increases with elevation.

Geology underlying the subbasin is diverse. Volcanic and glacial deposits underlie the majority of the Basin. The volcanic material is predominately found on the eastern side of the subbasin.

Mashel River

The Mashel subbasin is higher in elevation and steeper than the Murray and Tanwax/Kreger/Ohop subbasins. Over 40% of the subbasin area has slopes greater than 30%. Mean elevation of the Mashel subbasin is 2,237 feet above sea level. Average Basin gradient is 31% and elevations range from 460 to 4,845 feet.

Geology underlying the subbasin is mostly volcanic deposits and undifferentiated glacial drift.

Upper Nisqually River Basin

The continental glacial ice did not cover the majority of the upper Nisqually River Basin, and as a result the surficial geology in this area consists of Miocene to Eocene sedimentary and volcanic bedrock.

The Upper Nisqually River Basin is the highest portion of the watershed. Elevations range from 600 feet to 14,411 feet. The mean elevation is 2,987 feet and the slope of the Basin is 55%.

4.2.2 Soils

Soil permeability influences the movement of water through and within the soil layers. The majority of the soils in the upper part of the study area are moderately permeable. Soils in the lower Basin range from highly permeable to relatively impermeable. Soils in the western (lower) portion of the watershed are generally more permeable than those in the eastern portion, with the exception of the Mashel subbasin, which generally has more permeable soils than the Tanwax/Kreger/Ohop subbasin.

The NRCS has classified soils into hydrologic soil groups (HSGs) to indicate the rates of infiltration and transmission (NRCS, 1986). Table 4-1 describes the four classes of hydrologic soil groups and Figure 4-6 shows the hydrologic soil groups in the Nisqually River Basin.

TABLE 4-1
Descriptions of Hydrologic Soil Group Properties (NRCS, 1986)

	Group Typical Soil Textures	Hydrologic Properties
A	Deep, well drained to excessively drained gravel, sand, loamy sand, or sandy loam.	High infiltration rates (greater than 0.30 in/hr).
B	Deep to moderately deep, moderately well to well drained soils with moderately fine to moderately coarse textures (silt loam or loam)	Moderate infiltration rates (0.15-0.30 in/hr).
C	Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures (sandy clay loam)	Slow infiltration rates (0.05-0.15 in/hr).
D	Soils are clayey, have a high water table, or are shallow to an impervious layer (clay loam, silty clay loam, sandy clay, silty clay, or clay)	Very slow infiltration rates (0-0.05 in/hr).

The remainder of this section describes subbasin soils in greater detail.

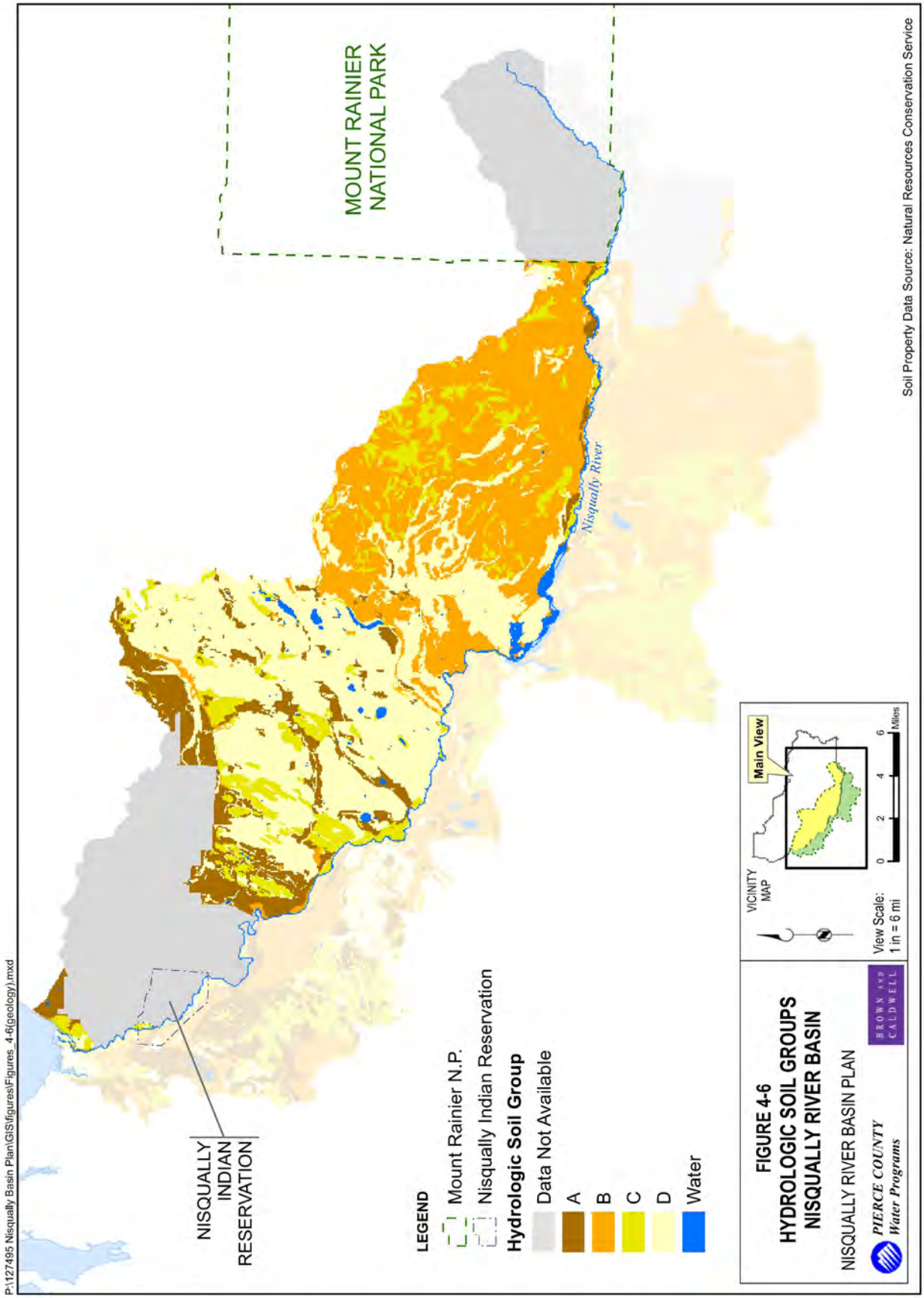
Murray

The Murray subbasin is dominated by soils of the Kapowsin and Spanaway associations. Kapowsin soils formed in glacial till and are underlain by an impermeable till layer at a depth ranging from two to five feet. Perched groundwater and areas of standing water can form during the wetter months. Spanaway soils formed in glacial outwash. These soils drain rapidly, and are underlain by highly permeable gravel deposits. Therefore, these soils have very little surface runoff. Except during periods of high local groundwater levels, surface water in these areas will rapidly infiltrate. These two contrasting conditions have a marked effect upon hydrology in these subbasins.

These subbasins are generally underlain by glacial deposits of substantial thickness. One such hydrogeologic unit, Qc, is used extensively as a source of groundwater that is found primarily under confined conditions. The glacial sediments and associated aquifers in the lower and mid Nisqually systems may extend into adjacent watersheds.

Tanwax/Kreger/Ohop

Little digital soil data is available for the subbasin. Soils over much of the area are expected to be of low to very low permeability. The upland, eastern areas of the subbasin are mainly underlain by bedrock. The aquifers in these areas are limited to small areas near the fractures and joints in bedrock. The western end of the subbasin has areas of coarse-grained deposits, which can support highly productive wells. Groundwater flows toward the mainstem Nisqually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MOUNT RAINIER NATIONAL PARK
NISQUALLY INDIAN RESERVATION
Nisqually River
LEGEND
Mount Rainier N.P.
Nisqually Indian Reservation
Hydrologic Soil Group
Data Not Available
A
B
C
D
Water
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
FIGURE 4-6
HYDROLOGIC SOIL GROUPS
NISQUALLY RIVER BASIN
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
Soil Property Data Source: Natural Resources Conservation Service

River. Detailed regional hydrogeologic studies have not been completed in the subbasin. Estimates of annual groundwater recharge in these subbasins range significantly, between 16.6 and 23.3 inches (WPN, 2002). Soils over much of the area are expected to be of low to very low permeability.

Mashel River and Upper Subbasin

The Mashel subbasin originates on the flanks of Mount Rainier. The underlying geology is mostly volcanic deposits and undifferentiated glacial drift. The soils are primarily of low to moderate permeability.

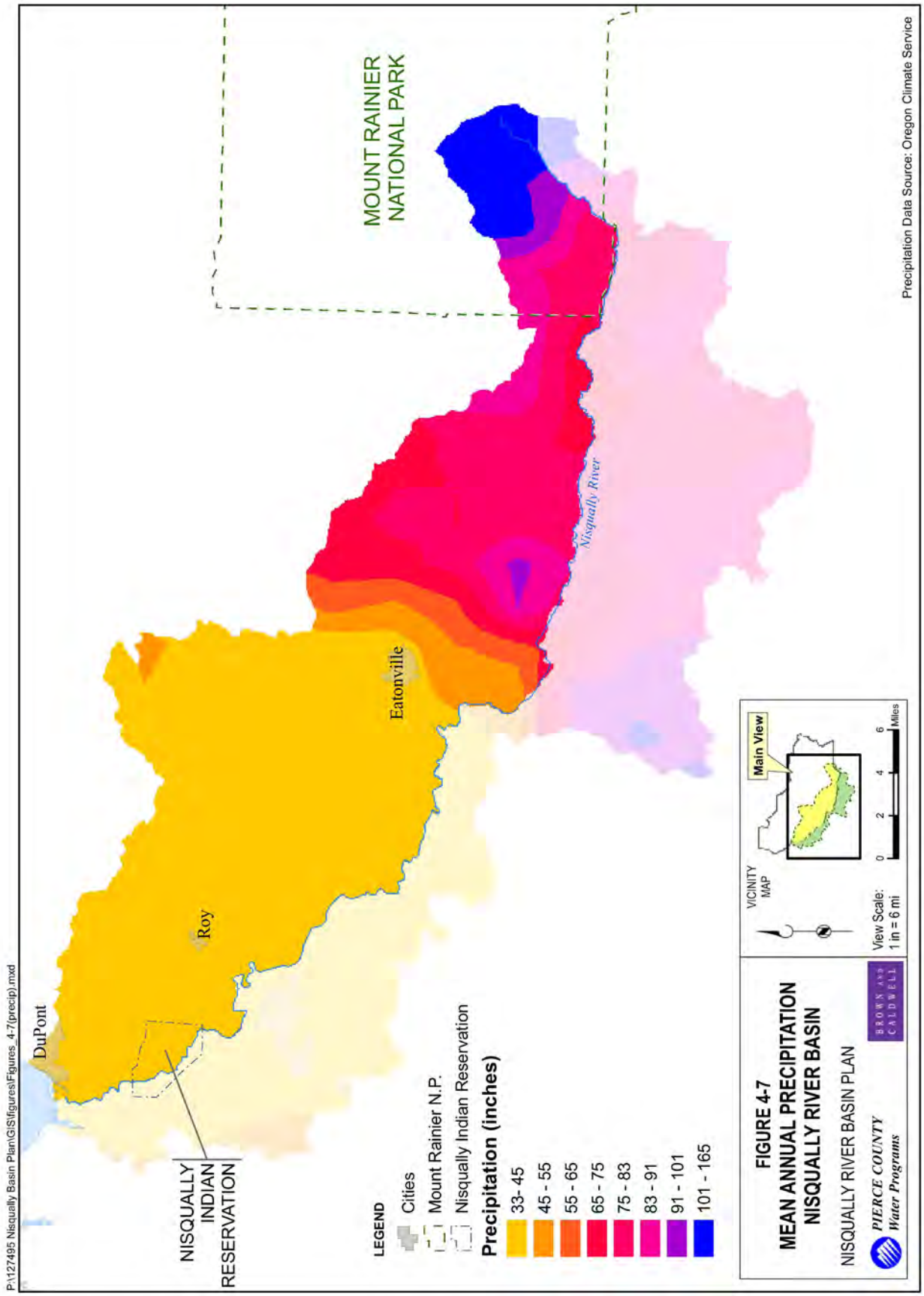
The majority of the Mashel and upper subbasins were not covered by continental glacial ice, resulting in a surficial geology of sedimentary and volcanic bedrock. The aquifers in these areas are limited to small areas near the fractures and joints in bedrock. The western end of the subbasin has areas of coarse-grained deposits which have the ability to contain confined aquifers.

4.2.3 Rainfall

Mean annual precipitation within the Nisqually watershed generally increases as elevation increases, as shown in Figure 4-7. On average, the lower portions of the watershed receive from 33 to 50 inches of precipitation per year. The higher portions of the watershed receive greater than 70 inches of precipitation annually. The wettest months are November through January, and the driest months are June, July, and August.

Precipitation typically cycles over periods of decades from warm/dry periods to wet/cool periods and back again. The climatic cycles are important in interpreting data on water availability. Historically, cool/wet years included the periods from 1890 to 1924 and 1947 to 1976. Warm/dry years occurred from 1925 to 1946 and 1977 to 1995. Although the data is somewhat inconclusive, it appears that we have been moving into another cool/wet period since 1995 (WPN, 2002).

All subbasins in the lower watershed have a rain-dominated hydrologic regime, except for the Mashel subbasin, which has a rain-on-snow dominated hydrologic regime. Similarly, the low relief of all subbasins with the exception of the Mashel limit the potential energy available to move water through the system, resulting in relatively low stream velocities and erosion potential.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MOUNT RAINIER NATIONAL PARK
Nisqually River
Eatonville
Roy
DuPont
NISQUALLY INDIAN RESERVATION
LEGEND
Cities
Mount Rainier N.P.
Nisqually Indian Reservation
Precipitation (inches)
33- 45
45 - 55
55 - 65
65 - 75
75 - 83
83 - 91
91 - 101
101 - 165
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
Precipitation Data Source: Oregon Climate Service
FIGURE 4-7
MEAN ANNUAL PRECIPITATION
NISQUALLY RIVER BASIN
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL

4.3 NATURAL AND CONSTRUCTED DRAINAGE

This section presents an overview of the Nisqually River Basin drainage system and describes the natural and constructed drainage characteristics and features within each subbasin. It also presents brief discussions of historical and current stream flow monitoring and the influences of groundwater on the stream systems.

4.3.1 Drainage Overview

As described in Chapter 1, the Nisqually River Basin Planning area consists of the Nisqually River drainage areas that fall within Pierce County excluding incorporated towns and cities, commercial timber lands regulated by the state Department of Natural Resources, and federal lands. The planning area also excludes the Muck Creek Basin, which has been addressed in a separate Basin Plan. In addition, this Basin Plan covers the entire length of the main Nisqually River.

The Nisqually River Basin Planning area was delineated based on the Basin boundaries and other GIS data provided by Pierce County. To allow for more detailed characterization, the planning area was further subdivided into 23 subbasins based on existing topographic and hydrographic data. Nisqually Tribe staff reviewed the draft subbasin delineations and suggested minor revisions to several. The revised subbasins are shown in Figure 4-8. Table 4-2 lists the salient characteristics of the 23 subbasins.

The three largest tributaries in the planning area are Tanwax Creek, Ohop Creek, and the Mashel River. The drainage areas for each of these tributaries cover 11%, 15% and 32% of the total subbasin drainage area, respectively. Other major streams in the planning area include Red Salmon Creek, Murray Creek, Brighton Creek, Horn Creek, Kreger Creek, Lynch Creek, the Little Mashel River, and Elbe Creek.

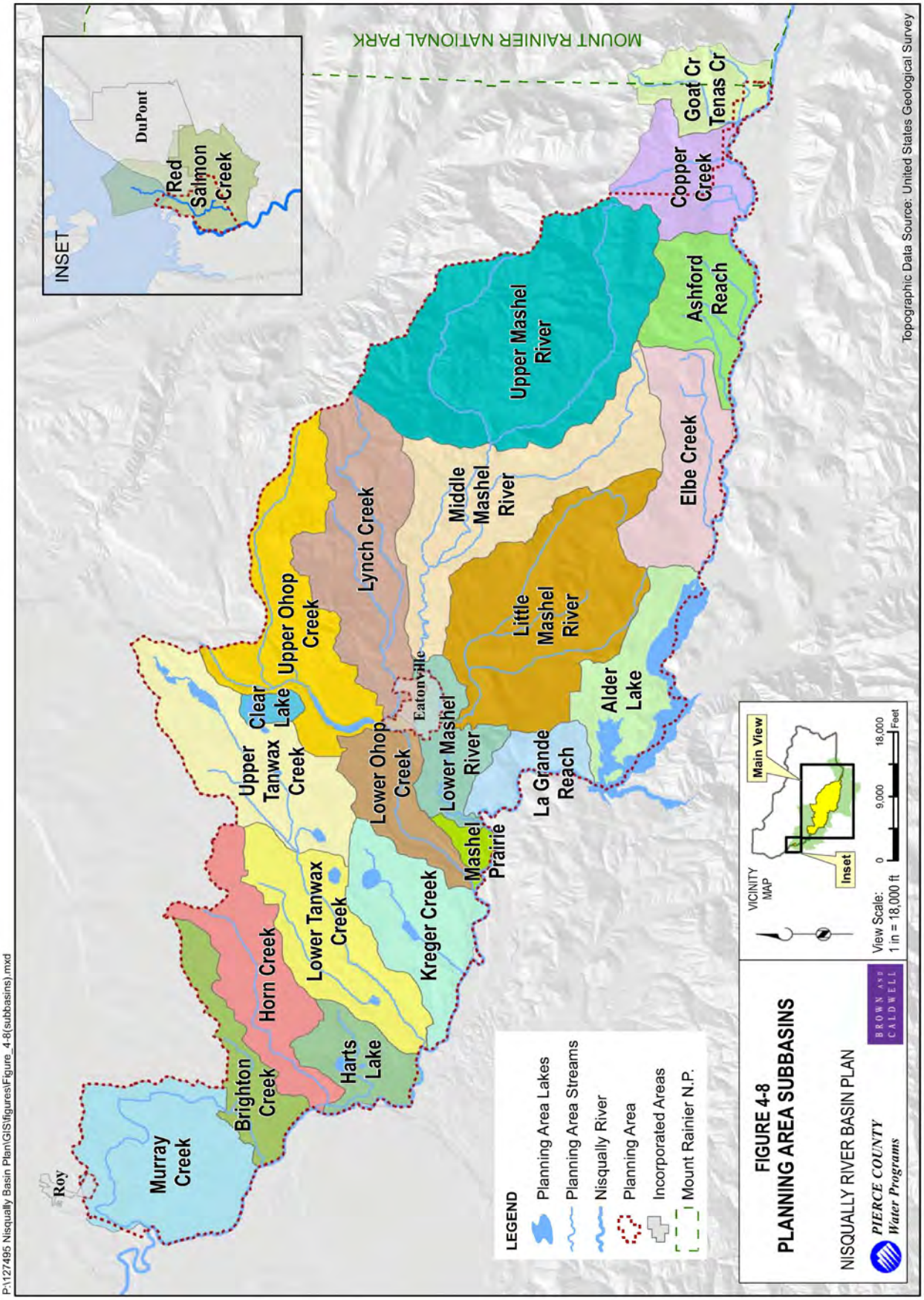

P:\1271495 Nisqually Basin Plan\GIS\figures\Figure_4-8(subbasins).mxd
Roy
Murray Creek
Brighton Creek
Horn Creek
Harts Lake
Lower Tanwax Creek
Kreger Creek
Upper Tanwax Creek
Clear Lake
Upper Ohop Creek
Lower Ohop Creek
Lynch Creek
Eatonville
Mashel Prairie
Lower Mashel River
La Grande Reach
Middle Mashel River
Little Mashel River
Alder Lake
Upper Mashel River
Elbe Creek
Ashford Reach
Copper Creek
Goat Cr
Tenas Cr
MOUNT RAINIER NATIONAL PARK
INSET
DuPont
Red Salmon Creek
LEGEND
Planning Area Lakes
Planning Area Streams
Nisqually River
Planning Area
Incorporated Areas
Mount Rainier N.P.
VICINITY MAP
Main View
Inset
View Scale: 1 in = 18,000 ft
0 9,000 18,000 Feet
FIGURE 4-8
PLANNING AREA SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
Topographic Data Source: United States Geological Survey

TABLE 4-2
Subbasin Areas

Subbasin	Area (sq mi)	Percent of total subbasin drainage area
Alder Lake	9.5	3.6%
Ashford Reach	8.1	3.1%
Brighton Creek	6.5	2.5%
Clear Lake	1.2	0.5%
Copper Creek	8.1	3.1%
Elbe Creek	11.1	4.3%
Goat Cr-Tenas Cr	5.9	2.3%
Harts Lake	5.7	2.2%
Horn Creek	11.5	4.4%
Kreger Creek	10.9	4.2%
La Grande Reach	4.2	1.6%
Little Mashel River	23.7	9.1%
Lower Mashel River	6.2	2.4%
Lower Ohop Creek	7.0	2.7%
Lower Tanwax Creek	12.7	4.9%
Lynch Creek	17.0	6.5%
Mashel Prairie	1.4	0.5%
Middle Mashel River	19.8	7.6%
Murray Creek	16.3	6.3%
Red Salmon Creek	7.3	2.8%
Upper Mashel River	34.1	13.1%
Upper Ohop Creek	16.1	6.2%
Upper Tanwax Creek	15.2	5.9%
TOTAL	259.6	100%

In general, the drainage areas east of Eatonville are characterized by steep slopes and mountainous terrain. Subbasins such as Lynch Creek, Upper Mashel River, and Little Mashel River are primarily covered by designated forest lands. Several subbasins along the upper Nisqually, including the La Grande Reach, Lake Alder, Elbe Creek, Ashford Reach, Copper Creek and Goat Creek-Tenas Creek, are also steep, mountainous and mostly forested.

Although still relatively rural, subbasins west of Eatonville tend to have more development. The drainage areas are characterized by mixed forest, rural residential and agricultural lands. Surface water hydrology is heavily influenced by lakes and wetlands.

4.3.2 Natural Drainage Systems

Red Salmon Creek

Red Salmon Creek is located near the mouth of the Nisqually River and drains directly to Puget Sound through the Nisqually delta. The creek flows from south to north along the east side of the delta, and much of the length of the stream is tidally influenced.

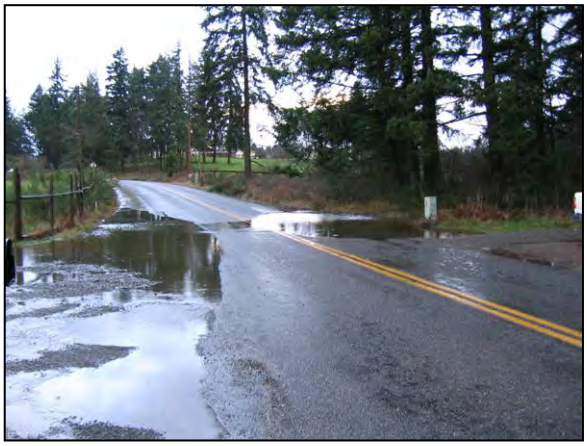
Red Salmon Creek

The Red Salmon Creek subbasin is approximately 7 square miles. Much of that drainage area consists of the low-lying areas along the estuary. Portions of the City of DuPont and adjacent areas to the south drain to Red Salmon Creek through two culverts: one under a railroad track and a second under an adjacent county road. Another area drains to Red Salmon Creek from the south through a culvert under Interstate 5.

Murray Creek

Murray Creek subbasin covers approximately 16 square miles between the towns of Roy and McKenna. The subbasin is a mixture of low-density residential, agricultural and open space land use.

The surficial geology is predominated by glacial deposits, and past glaciation has left the area with a deranged drainage pattern. As a result, there are numerous low-lying areas with poor drainage, and wetlands are scattered throughout the subbasin. Minor flooding and drainage problems are common throughout the Basin.



Roadway flooding over Lyon Drive near 72nd Ave

All four hydrologic soils groups are found in the subbasin. There are large areas of sandy, well-drained Type A soils in the western portion of the subbasin. The eastern portion is mostly Type D soils with poor drainage. The middle of the subbasin is a mixture of Types A, C, and D soils.

Murray Creek begins in the southeastern most extent of the subbasin. Drainages in this area have been altered, and some water from the Brighton Creek subbasin gets diverted into the Murray Creek subbasin. The creek flows for approximately 9 miles before discharging into the Nisqually River on the west side of the subbasin.

Portions of Murray Creek flow intermittently during dry months. Springs provide flow in some reaches on Murray Creek; one major spring is located approximately 2,000 feet upstream from the mouth of the creek.

Lake Serene covers approximately 8 acres and located in the northeast portion of the subbasin.

Brighton Creek

The Brighton Creek subbasin is a 6.5 square mile area southeast of the Murray Creek subbasin. The subbasin is largely rural, but does have some areas of low-density residential development along State Route 702, Kinsman Road, and Allen Road. It is similar to the Murray Creek subbasin in many respects. The upper portion of the subbasin is relatively flat with poorly drained, Type D soils. Minor flooding and drainage problems are common.

Roadway flooding on 50th Ave South

The lower, southern portion of the subbasin has steeper slopes. The Brighton Creek channel becomes deep and somewhat confined as it approaches the Nisqually River near Harts Lake Loop Road.

Horn Creek

Horn Creek drains approximately 11 square miles. The drainage area begins in the relatively flat areas around the intersection of State Route 702 and State Route 7, which has some low-density residential development. As water drains west, the stream becomes more defined at Kinsman Road. From there, the stream flows through a gentle sloping valley with some wide floodplains and wetland areas. This valley has some scattered, low-density residential with a number of small farms with livestock.

As it approaches the Nisqually River, the Horn Creek valley becomes steeper, and the stream is more confined. The mouth of Horn Creek is approximately 2,000 feet downstream from the Centralia Canal diversion.

Harts Lake

Harts Lake is located approximately 5 miles southeast of the community of McKenna along Harts Lake Loop Road. This lake is the dominant hydrologic feature of the Harts Lake subbasin, which covers 5.7 square miles. The lake itself is approximately 110 acres. A few hundred feet south of Harts Lake is Little Lake, which is approximately 10 acres.

North end of Harts Lake

Harts Lake Creek begins approximately 1.5 miles east of the lake, flows west down into the Nisqually River valley and into the southeast side of Harts Lake. The lake outlet is on the southwest side.

The outflow stream flows into the Wilcox Flats area adjacent to the Nisqually River and then follows along the hills on the north side of the valley.

Historically, Harts Lake Creek flowed directly into the Nisqually River at a confluence that would have been located approximately 1,000 feet upstream of the Centralia Canal diversion. However, the creek has now been diverted north along the valley into a wetland area that eventually drains to Horn Creek.

The Wilcox Flats area of the subbasin is used primarily for agriculture. In particular, the Wilcox Dairy is located there. Much of the Wilcox Flats are within the Nisqually River floodplain, and past flooding events have caused damages to structures in this area.

Upper and Lower Tanwax Creek

Tanwax Creek drains approximately 28 square miles. Tanwax Creek is over 13 miles long, beginning approximately 7 miles north of the town of Eatonville and ending at the confluence with the Nisqually River approximately 7 miles southeast of McKenna.

The hydrology of the subbasin is greatly influenced by lakes and wetlands. The largest lake is Tanwax Lake (approximately 174 acres), near the headwaters of the subbasin. Other lakes in the subbasin include:

- North Twin Lake (13 acres)
- South Twin Lake (13 acres)
- Whitman Lake (29 acres)
- Stidham Lake (8 acres)
- Trout Lake (7 acres)
- Twentyseven Lake (21 acres)
- Mud Lake (20 acres)
- Rapjohn Lake (59 acres)
- Cranberry Lake (34 acres)
- Tule Lake (34 acres).

Southwest end of Tanwax Lake

The soils in the Tanwax Creek drainage are mostly poorly drained, “Type D” soils, although there are some areas of highly permeable “Type A” soils.

The Tanwax Basin was divided into upper and lower subbasins to allow for more detailed characterization. The lower Tanwax subbasin is largely undeveloped; however much of this area has been divided into 20-acre lots that are being sold for rural residential development. The upper Tanwax Basin has scattered areas of low-density residential and rural residential development. There are also several small farms and livestock pastures along the upper Tanwax valley.

Kreger Creek

The Kreger Creek subbasin is an 11 square mile drainage area south of the Lower Tanwax subbasin.

Like the Tanwax Creek subbasin, lakes and wetlands are important components of the hydrology of Kreger Creek subbasin. The two major lakes in the subbasin are Silver Lake and Kreger Lake. Silver Lake is near the top of the drainage.

Channel downstream of Silver Lake

Historically, the outlet was on the west side of the lake, and water drained west and then south toward Kreger Lake. However, an outlet drainage ditch was constructed on the south side of the lake. This ditch carries the water south, crosses 416th Street East, and then flows southwest to Kreger Lake.

Kreger Lake is a large wetland area. Downstream from Kreger Lake, the creek flows southwest, down into the Nisqually River valley and discharges into the Nisqually River. Most of the subbasin is covered by poor draining "Type D" soils.

The Kreger Creek subbasin is mostly rural open space. There are some small residential areas along Dean Kreger Road and on the north side of Silver Lake.

Clear Lake

The Clear Lake subbasin is a small, 1 square mile area consisting primarily of Clear Lake in the north portion of the subbasin and the surrounding area that drains to the lake. The lake covers approximately 156 acres.

Development around Clear Lake

The lake discharges via a small ditch on its east side, which flows down a steep slope into the upper Ohop Creek valley.
Nearly all of the Clear Lake shoreline is covered by residences. The residential development occupies a relatively narrow band around the lake.

A second, smaller lake is located in the south portion of the subbasin. Horseshoe Lake covers approximately 12 acres.

Upper Ohop Creek

Ohop Creek is the second largest tributary to the Nisqually River in the Basin Planning area. The total drainage area is over 40 square miles. For purposes of this Basin Planning effort, the drainage has been divided into three subbasins: the upper Ohop, lower Ohop and Lynch Creek. The headwaters are in the steep eastern portion of the Basin and drain into the two main tributaries of the Ohop, Twenty-Five Mile Creek and Lynch Creek.

Wetlands in the Upper Ohop Valley

Historically, the Ohop Creek drainage Basin included an additional area north of the current extent of the Basin. However, in 1889, the upper portion of Ohop Creek was diverted north into the Puyallup Basin, which reportedly reduced the flow in Ohop Creek by about 30% (Watershed Professionals Network, 2002). Consequently, at its confluence with Twenty-Five Mile Creek (approximately 4 miles north of Eatonville), Ohop Creek is the smaller of the two streams.

Approximately 1 mile downstream from the confluence of Ohop Creek and Twenty-Five Mile Creek is Ohop Lake. It is the largest natural lake in the Nisqually River Basin with a surface area of 235 acres. Ohop Lake is long and narrow, approximately 1,000 feet wide and 2 miles long.

Houses on west shore of Ohop Lake

The Ohop Creek confluence with Lynch Creek is approximately 1,000 feet downstream from Ohop Lake. The drainage area upstream of this confluence is approximately 16 square miles.

The upper Ohop valley has a flat floor with steep walls. The valley walls are so steep that slope stability is a problem when the soils become saturated. Numerous springs are located along the valley walls.

The upper Ohop subbasin is rural with minimal residential development. The upper drainage along Twenty-Five Mile Creek is almost all mountainous forest land. The one notable area of residential development is the large number of homes that line the east and west shorelines of Ohop Lake.

Lynch Creek

Lynch Creek drains approximately 17 square miles. The lower reach of Lynch Creek (approximately 1.5 miles) flows along the northern edge of the Town of Eatonville.

Most of the subbasin is located in rugged terrain east of Eatonville and is undeveloped forested land. Lynch Creek has one major tributary: Berg Creek.

There has been some development along this reach. Lower Lynch Creek receives stormwater runoff from a large portion of Eatonville via a large ditch. Ohop Lake acts as a sediment trap. Therefore, Lynch Creek is an important sediment source for the lower Ohop Creek.

Confluence of Lynch Creek and Ohop Creek

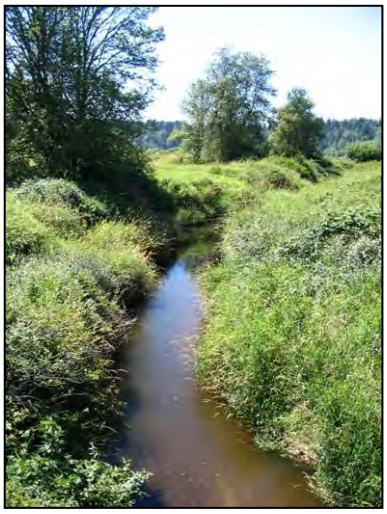
Lower Ohop Creek

The lower Ohop subbasin covers approximately 7 square miles. The subbasin is rural with a few residences in the areas near Eatonville. The lower Ohop valley is wide and flat with steep walls.

This valley was once used for agriculture and dairy farming. Although there are still some small farms in the valley, this usage has diminished in recent years.

Due to the previous agricultural use much of the lower Ohop Creek was channelized, and drainage ditches were built on the valley floor.

The 1 mile reach of Ohop Creek just upstream from the confluence with the Nisqually River is forested and relatively undisturbed.



Lower Ohop Creek

Mashel River

South and east of the Ohop Creek Basin is the Mashel River Basin. The Mashel River is the largest tributary to the Nisqually River; the entire drainage covers over 84 square miles. The headwaters of the Mashel River begin near Mount Rainier and flow west toward the town of Eatonville. The river passes through the southern portion of Eatonville and then flows southwest to the confluence with the Nisqually River.

Major tributaries of the Mashel River are the Little Mashel River, Beaver Creek, and Busy Wild Creek. The drainage Basin was divided into four subbasins: the upper Mashel River, middle Mashel River, lower Mashel River, and the Little Mashel River.

The upper Mashel River subbasin covers approximately 34 square miles and is all mountainous, forested terrain. A majority of this is new growth forest; the area was intensely harvested by commercial timber throughout the 1950s and 1960s. Harvesting disturbances may have contributed to mass wasting that has occurred along the slopes and banks of the river.

Mashel River near Eatonville

The middle Mashel River subbasin is a 20 square mile drainage area beginning at Boxcar Canyon approximately 1 mile east of the town of Eatonville and ending near the confluence with Busy Wild Creek. This area is also rural and mostly forested.

The lower Mashel River subbasin is 6.2 square miles. The northwestern portion of this subbasin has some development in and around the town of Eatonville. Eatonville draws its drinking water from the Mashel River, and secondary-treated waste water is discharged to the river downstream from the town.

As it approaches the Nisqually River, the Mashel River winds through a steep, sinuous canyon. The confluence with the Nisqually River is approximately 1 mile downstream from La Grande Dam.

The Little Mashel River subbasin is also rural, consisting of mostly agricultural and forested lands. The agriculture is almost exclusively livestock and is found mainly in the valleys of the northwestern portion of the subbasin. Midway Creek is a major tributary to the Little Mashel River. The confluence of the Little Mashel River with the Mashel River is located approximately ½-mile south of Eatonville.

La Grande Reach

The La Grande Reach is a small (4.2 square mile) subbasin along the Nisqually River between Alder Dam and the Mashel River confluence. The Nisqually River is confined to a steep narrow canyon in this 4.7 mile long reach. La Grande Dam is located approximately 1.5 miles downstream from Alder Dam.

Both dams are used for hydroelectric power generation. Water is diverted from the Nisqually at La Grande dam and carried through an aqueduct approximately 1.5 miles to the La Grande powerhouse, where is discharged back into the river.

The subbasin area is comprised of several small drainages along the northeast side of the canyon. The only development in the subbasin is the facilities at the La Grande powerhouse and State Route 7.

Alder Lake

Alder Lake is seven miles long, with 28 miles of shoreline and a surface area of 3,065 acres at maximum elevation.

The Alder Lake subbasin encompasses approximately 9 square miles on the north shore of Alder Lake. This area is mostly drained by small intermittent streams.

The subbasin is mostly rural open space, but there is some scattered residential development along the north shore. Also, the small town of Elbe is located at the upstream end of the lake.

Alder Lake

Elbe Creek

The Elbe Creek subbasin covers 11 square miles of drainage area draining to a 4.5 mile reach of the Nisqually River upstream of Alder Lake.

Small streams drain the water from the steep slopes of the north side of the upper Nisqually River valley to the valley floor and into the Nisqually River. The largest of these streams is Elbe Creek, which starts on the west side of the subbasin and flows southeast along the valley.

The steep slopes of the valley are undeveloped forested land. There is rural residential development along the valley floor.

Ashford Reach

The Ashford reach subbasin is similar to the Elbe Creek subbasin. Small streams drain water from the steep slopes in the north across the valley floor to the Nisqually River. The Ashford reach subbasin covers 8.1 square miles and drains to a 5-mile reach of the Nisqually River.

The steep slopes in the north are undeveloped and forested. There are some areas of rural residential development on the valley floor, most notably is the small village area of National and Ashford.

Roadside drainage along State Route 702

Copper Creek

The Copper Creek subbasin is an 8.1 square mile drainage area draining to a 3-mile reach of the Nisqually River. Most of the area is drained by Copper Creek, which starts in the north part of the subbasin and flows down a steep watercourse to the Nisqually River.

The upper portion of the subbasin is forested, although there has been some past timber harvesting. The subbasin is primarily rural open space, but there is some scattered residential development along the valley floor.

Goat Creek and Tenas Creek

Goat Creek drains an area of rugged mountainous terrain on the north side of the valley. Tenas Creek begins in the park on a steep slope, flows to the valley floor and then west along State Route 706 before discharging into the Nisqually River.

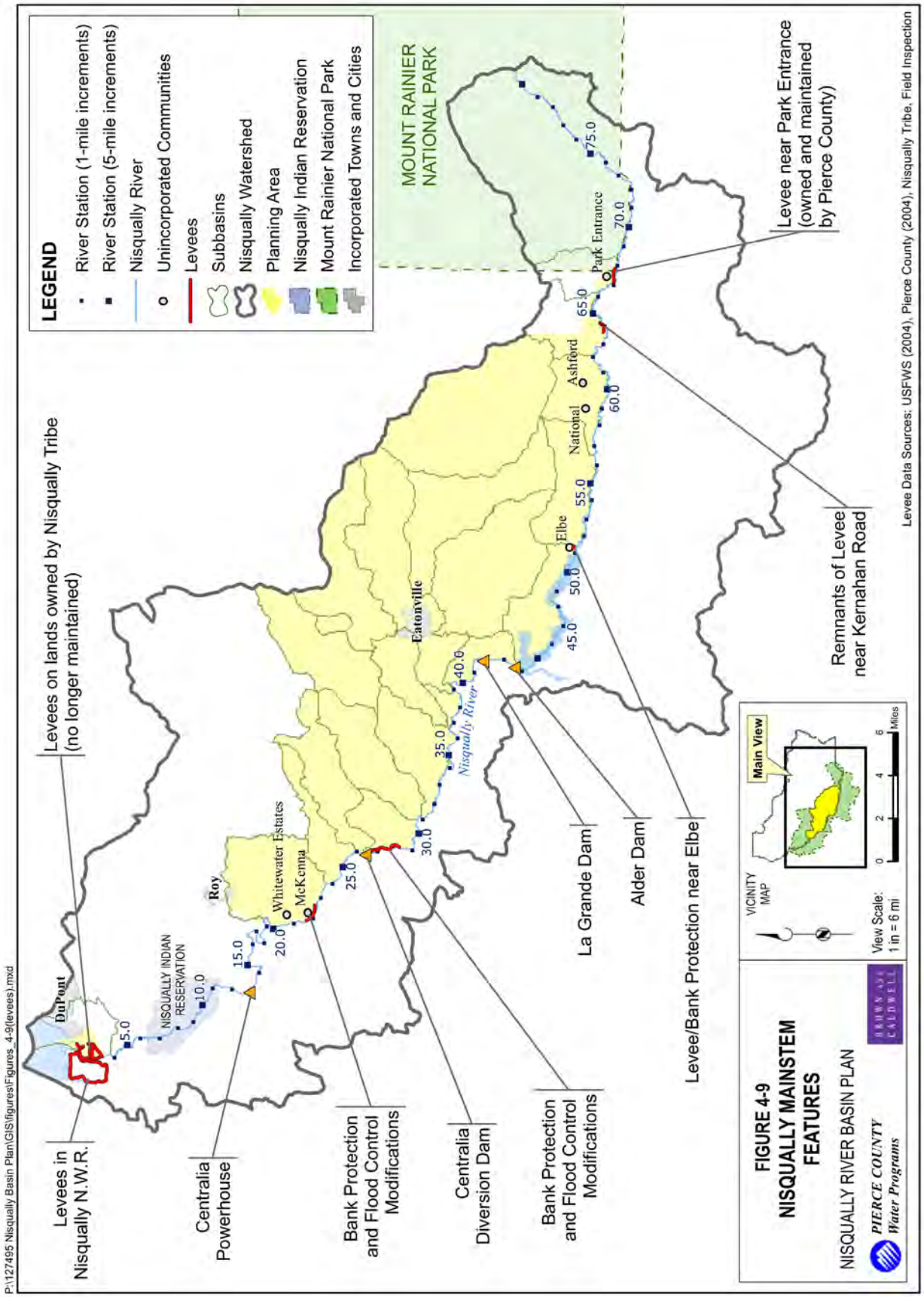
The Nisqually River Basin Planning area extends to the Mount Rainier National Park boundary on the east end of the Nisqually River Basin. It includes a small residential development located near the park entrance. Several of the structures in the residential area are built near the lower section of Tenas Creek.

State Route 702 bridge over Goat Creek

Nisqually River Mainstem

The Nisqually River originates from the Nisqually Glacier on the south slope of Mount Rainier. Water flows approximately 78 miles, west-northwest, to meet salt water at the Nisqually Estuary in South Puget Sound.

The LaGrande Canyon, at river mile 40, divides the watershed into two distinct physiographic areas. Below the canyon, the watershed consists of low hills and prairie plains of glacial outwash. Above the canyon, volcanic rock and steeper mountainous terrain dominate the area. The canyon itself contains sheer cliffs extending upwards of 200 feet. Figure 4-9 shows the


LEGEND
River Station (1-mile increments)
River Station (5-mile increments)
Nisqually River
Unincorporated Communities
Levees
Subbasins
Nisqually Watershed
Planning Area
Nisqually Indian Reservation
Mount Rainier National Park
Incorporated Towns and Cities
MOUNT RAINIER NATIONAL PARK
Levees on lands owned by Nisqually Tribe (no longer maintained)
Levee near Park Entrance (owned and maintained by Pierce County)
Remnants of Levee near Kernahan Road
Levee/Bank Protection near Elbe
Alder Dam
La Grande Dam
Bank Protection and Flood Control Modifications
Centralia Diversion Dam
Bank Protection and Flood Control Modifications
Centralia Powerhouse
Levees in Nisqually N.W.R.
DuPont
NISQUALLY INDIAN RESERVATION
Roy
Whitewater Estates
McKenna
Eatonville
Elbe
National
Ashford
Park Entrance
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Levee Data Sources: USFWS (2004), Pierce County (2004), Nisqually Tribe, Field Inspection
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
FIGURE 4-9
NISQUALLY MAINSTEM FEATURES
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BARNARD CALDWELL
P:\127495 Nisqually Basin Plan\GIS\figures\Figures_4-9(levees).mxd

Nisqually River mainstem with the locations of important features such as residential communities, levees, and dams.

Development along the Nisqually River is relatively limited. Much of the land is either not developable, publicly owned, or under the ownership of the Nisqually Land Trust. There are a few small communities along the river in the upper valley (above Alder Lake) including Elbe, Ashford, National, and an area of development near the Mount Rainier National Park entrance.

Below Lake Alder there is some agricultural and rural residential development in the Wilcox flats area. There is also some residential development around the communities of McKenna and Whitewater Estates.

There are three known levee systems and two hydroelectric dam projects on the Nisqually River mainstem. There is a levee system located on the right bank (looking downstream) of the Nisqually River near the Mount Rainier National Park entrance. The levees were constructed to provide flood protection for residents near the park's entrance and private properties adjoining the parks west boundary along the Nisqually River.

The levee extends approximately 1,800 feet upstream into the park, terminating near the Sunshine Campground. The County maintains the levee (personal communication with Pierce County Engineers Tony Fantello and Randy Brake, 2006). The County is currently renewing an agreement with the park for a maintenance right-of-way into the park. The right-of-way is 1,800 feet long and 100 feet wide (50 feet on either side of the levee centerline).

County maintained levee near park entrance

The last rehabilitation of the levee was co-sponsored by the County and the Army Corps of Engineers through the Corps' Public Law 84-99 Rehabilitation Program.

Field inspections found that there are also levees, or remnants of levees, located along the right bank (looking downstream) of the Nisqually River near Kernahan Road. The levees have not been maintained and no longer appear to be serving as flood control.

Downstream from the park, there are levees on right bank (looking downstream) near Elbe. Tacoma Power (Tacoma Public Utilities) maintains these levees.

The lower reach of the Nisqually River flows through the Nisqually National Wildlife Refuge, prior to discharging to the Sound. A levee known as Browns Farm Dike is located along the west bank of the river through a portion of the refuge. Browns Farm Dike surrounds a 1,000 acre area that is managed as freshwater wetlands and grasslands. A conservation plan and environmental impact statement was prepared for the refuge (U.S. Fish and Wildlife Service, August 2004). This plan included four alternatives for future management of the refuge. The Record of Decision selected management Alternative D, which includes restoring approximately

700 acres of the Nisqually River estuary, by removing sections of a Browns Farm Dike (U.S. Fish and Wildlife Service, December 2004).

Three hydroelectric dams are located on the mainstem of the Nisqually River. Alder Dam and LaGrande Dam comprise the Nisqually River Project. The project is owned and operated by Tacoma Power under a license issued by the Federal Energy Regulatory Commission (FERC). The 40-year FERC license (No. 1862) was issued on March 7, 1997. This license contains articles pertaining to operational requirements including minimum instream flows and reservoir water levels.

Alder Dam

Alder Dam is located on the border of the Alder Lake subbasin and LaGrande reach subbasin. The 285-foot high dam was constructed in 1945.

The dam powerhouse is located at the base of the dam. The dam impoundment, Alder Lake, has a storage capacity of 231,900 acre-feet. Alder Lake and its associated parks are used recreationally for fishing, camping, picnicking, swimming, water skiing and boating. Additional Alder Dam statistics are provided in Table 4-3.

LaGrande Dam

LaGrande Dam is located two miles downstream of the Alder Dam in the LaGrande reach subbasin. The original 1912 dam was replaced in 1945.

The 192-foot high dam has an impoundment with a storage capacity of 2,700 acre-feet. This impoundment is not publicly accessible because of the steep topography. River flow is diverted at the dam to the powerhouse located approximately 1.7 miles downstream. The diverted water re-enters the Nisqually River downstream of the powerhouse. Water is also released from the impoundment to the Nisqually River to maintain a continuous flow. Additional LaGrande Dam statistics are provided in Table 4-3.

TABLE 4-3
Nisqually River Project Dam Characteristics

	Alder Dam	LaGrande Dam
Year completed	1945	Powerhouse 1912 New dam 1945
Type of dam	Concrete arch	Concrete gravity & embankment
Storage Capacity	231,900 acre-feet	2,700 acre-feet
Location	River Mile 44.2	River Mile 42.4
Height above riverbed	285 feet	192 feet
Length	1,600 feet	710 feet
Width at top	15 feet	12 feet
Width at base	120 feet	85 feet
Average flow	1,400 cubic feet/second	1,400 cubic feet/second
Drainage area	286 square miles	292 square miles
Reservoir length	7 miles	1.5 miles
Miles of shoreline	28 miles	3.5 miles
Reservoir area at maximum elevation	3,065 acres	45 acres
Maximum reservoir elevation	1,207 feet	935 feet
Minimum reservoir elevation	1,114 feet	910 feet
Average annual power generation	228 million kilowatt-hours	345 million kilowatt-hours
Number of generators	Two — 25,000 kilowatt	Four — 6,000 kilowatt One — 40,000 kilowatt
Utilization	Municipal electricity for City of Tacoma (Tacoma Power)	

Source: Tacoma Power, 2006

Nisqually River Project Operation

FERC license No. 1862 contains several articles that dictate the operational requirements of Alder and LaGrande Dams. There are no flood control requirements for the project.

Articles related to minimum instream flow requirement and lake levels are discussed below, as well as ramping rate requirements.

Provisions are made for exceptions to the rules, with agreement with the Nisqually River Coordinating Committee (NRCC).

Article 402: Minimum Instream Flow Requirements for the Nisqually River

The project shall be operated such that discharges into the Nisqually River downstream from the LaGrande powerhouse, as calculated at the Centralia Diversion Dam and in the bypassed reach below this dam, meet or exceed the minimum instream flows specified in the 1993 Initial Decision Terminating Docket. The flows in the bypass reach below the LaGrande Dam and mainstem of the Nisqually River shall at all time equal or exceed the flows shown on Table 4-4.

TABLE 4-4
Nisqually River Project Instream Flow Requirements

	Flows to be met or exceeded	
Time of Year	**McKenna Bypass Reach (Nisqually River reach bypassed by Yelm Diversion)**	**Nisqually Mainstem (Below LaGrande Powerhouse)**
October 1 - December 15[(1)]	550 cfs	700 cfs
December 16 – May 31	600 cfs	900 cfs
June 1 – July 31[(2)]	500 cfs	750 cfs
August 1 – September 30	370 cfs	575 cfs

(1) For this period, Tacoma Power agreed "to provide higher flow in the mainstem if water conditions are good and to maintain such higher flow, up to 900 cfs, after it has been established."

(2) This period of flow requirements shall be extended if "in-season steelhead spawning data indicate this is warranted by the Nisqually River Coordinating Committee."

To meet these flows, Tacoma Power's releases from LaGrande dam shall be sufficient so that flow in the mainstem (measured as the flow reaching the Centralia Diversion Dam) shall at all times equal or exceed the greater of:

(1) Flow in the bypass reach specified in Table 4-4 - 120 cfs + the lesser of 720 cfs or the calculated natural inflow at the Centralia Diversion Dam

(2) Nisqually mainstem flows specified in Table 4-4

Tacoma Power's requirements may be reduced, upon agreement with the City of Centralia, in the event that conditions do not permit Centralia to use its full water entitlement. However, the flow in the mainstem shall never be less than that specified in Table 4-4. Under adverse water conditions, Tacoma Power may petition the NRCC for modifications in these minimum flow requirements. The flow schedule may be temporarily modified if required by operating emergencies beyond their control and for short periods upon agreement with the NRCC.

Article 403: Minimum Instream Flows in the LaGrande Canyon

Tacoma Power is to release from the LaGrande Dam into the Nisqually River a minimum flow of 30 cfs, as measured at the spillway plunge pool, or inflow to Alder Lake, which ever is less, for the protection and enhancement of fish and wildlife resources in the LaGrande bypassed reach. This flow may be temporarily modified if requires by operating emergencies beyond the control of the licensee, and for short periods upon agreement between the licensee, the Nisqually Tribe, Washington Department of Fish and Wildlife, National Marine Fisheries Service and FWS.

Article 404: Reservoir Elevations

Should the water level falls below the elevations specified in Table 4-5, the project shall be operated to conserve water such that the combined discharge of LaGrande Dam and the LaGrande powerhouse is no more than 5% greater than the conservation flows shown in Table 4-6, or such temporary flows at the NRCC shall deem appropriate.

TABLE 4-5
Alder Lake Minimum Water Level Elevations

Time of Year	Water Level Elevations that must be exceeded (feet)
Memorial Day to Labor Day	1,197.0
All other times	1,170.0

Except as may be necessary to meet the minimum instream flow requirements

TABLE 4-6
Maximum Conservation Release from LaGrande Dam and Powerhouse

Time of Year	Conservation Flow (cfs)
October 1 - December 15	1,150
December 16 – May 31	1,200
June 1 – July 31	1,100
August 1 – September 30	970

Article 405: Ramping Rates and Critical Flows

The project FERC license also stipulates the allowable down ramping rate, or the rate at which the discharges from dam and powerhouse are reduced. The Nisqually River Project down ramping rate requirements apply to river flows less than 5,000 cfs as described in Table 4-7.

TABLE 4-7
Nisqually River Project Allowable Ramping Rates

Time of Year	Allowable Down Ramping Rates
February 16 - June 15	Daylight: no ramping Night: 2 inches/hour
June 16 – October 31	Daylight: 1 inch/hour Night: 1 inch/hour
November 1 – February 15	Daylight: 2 inches/hour Night: 2 inches/hour

Sediment Transport

There are no known operations at the dam to manage sediment transport through the reservoirs. Most of the sediment load (all except fine suspended sediments) originating from the upper reaches of the Nisqually River is trapped in Alder Lake.

Centralia Diversion Dam

The Centralia Diversion Dam is located 11 miles downstream of the LaGrande Dam in the Harts Lake subbasin. This dam was constructed in 1930, expanded in 1955, and reconstructed in 1985.

The dam is owned and operated by City of Centralia Light Department and is referred to the Yelm Hydroelectric Project. This project is operated under a 40-year FERC license (No. 10703-001) issued on March 7, 1997.

The Yelm Hydroelectric Project is a 12 megawatt run-of-the-river project; there is no water impoundment. The project consists of a low head diversion dam located at river mile (RM) 26.2, a 9.1-mile power canal and a powerhouse (located at RM 12.6) with three generators. The power canal diverts water at the diversion dam (approximately six miles southeast of Yelm), and returns flow to the Nisqually River at the powerhouse (approximately three miles northwest of Yelm).

The dam is a concrete gravity dam with a structural height of 20 feet, but a hydraulic height of only 4 feet at low stages. During high stages the dam is almost completely submerged with a difference between headwater and tailwater of less than one foot. Hydraulic height increases to 200 feet at the powerhouse.

4.3.3 Constructed Drainage Systems

The Nisqually River Basin Planning area is primarily rural and does not have many constructed drainage facilities other than ditches, culverts and pipes associated with roads. Culverts and bridges have been constructed throughout the Basin at driveway, road, and highway crossings. Figure 4-10 shows the constructed drainage facilities throughout the Basin Planning area.

Pierce County recently inventoried all the drainage facilities within the county. Facility locations were determined using a global positioning system (GPS) and entered in the County's geographical information system (GIS). As part of the inventory, the County identified all drainage facilities within the unincorporated portion of the Nisqually River Basin.

According to this inventory, there are no detention ponds, detention pipes, infiltration basins, water quality treatment ponds, sedimentation basins, or bioswales in the planning area. As of September 2004, there were two detention ponds proposed for construction in Harts Lake Estates (Horn Creek and lower Tanwax Creek subbasins). Table 4-8 summarizes the Pierce County inventory of storm pipes and culverts within the subbasins.

In 2002 the Pierce Conservation District (PCD) completed an inventory of culverts and some small dams, fishways and natural fish barriers in the Nisqually River Basin. PCD inventoried 51 structures in the planning area. PCD's focus was on anadromous streams where culverts had

not been previously surveyed. They identified a number of culverts that appeared to block or impede fish passage. These "problem" culverts are included in the problem summary in Chapter 5 of this report.

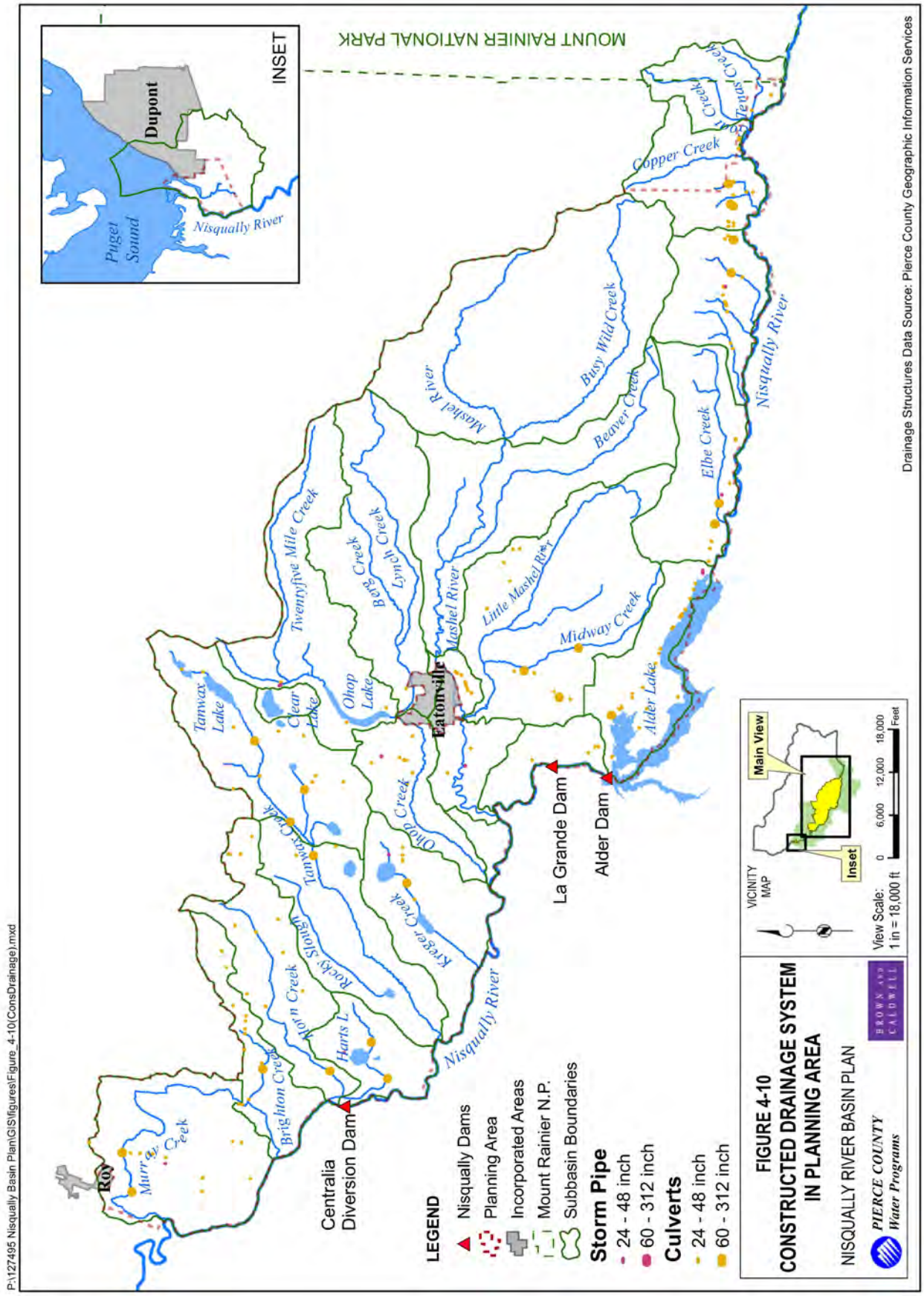

INSET
Dupont
Puget Sound
Nisqually River
MOUNT RAINIER NATIONAL PARK
Copper Creek
Tenalquot Creek
Busy Wild Creek
Beaver Creek
Elbe Creek
Nisqually River
Mashel River
Little Mashel River
Midway Creek
Alder Lake
Eatonville
Twentyfive Mile Creek
Beaver Creek
Lynch Creek
Ohop Lake
Clear Lake
Tanwax Lake
Ohop Creek
Kreger Creek
Tanwax Creek
Rocky Stone Creek
Worn Creek
Harts L
Brighton Creek
Murray Creek
Roy
Centralia Diversion Dam
La Grande Dam
Alder Dam
Nisqually River
LEGEND
Nisqually Dams
Planning Area
Incorporated Areas
Mount Rainier N.P.
Subbasin Boundaries
Storm Pipe
24 - 48 inch
60 - 312 inch
Culverts
24 - 48 inch
60 - 312 inch
FIGURE 4-10
CONSTRUCTED DRAINAGE SYSTEM
IN PLANNING AREA
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL
VICINITY MAP
Main View
Inset
View Scale:
1 in = 18,000 ft
0 6,000 12,000 18,000 Feet
Drainage Structures Data Source: Pierce County Geographic Information Services
P:\127495 Nisqually Basin Plan\GIS\figures\Figure_4-10(ConsDrainage).mxd

TABLE 4-8
Pierce County Drainage Inventory Summary in the Planning Area

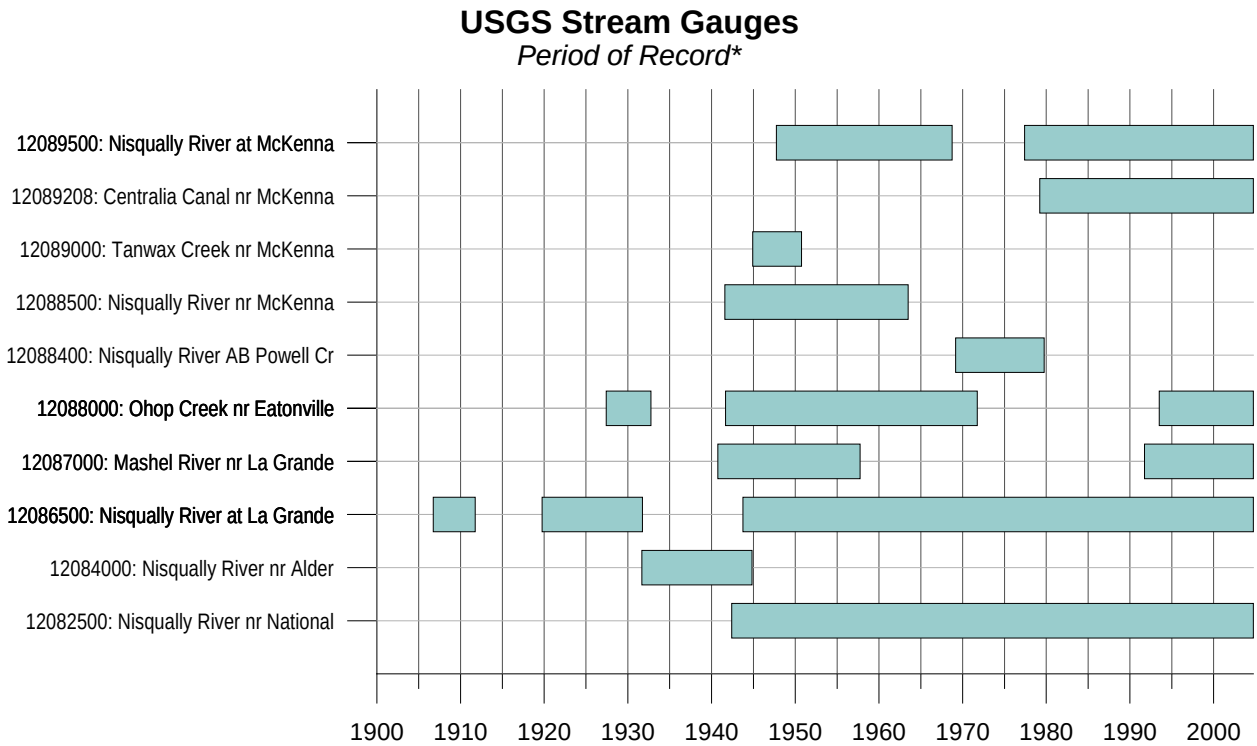
Subbasin	Length of Pipe (feet)			Total Length of Pipe (feet)	Number of Culverts			Total Number of Culverts
	diameter (inches)				*diameter (inches)*			
	< 24	*24 - 42*	*48 - 60*		*< 24*	*24 - 42*	*48 - 312*	
Alder Lake	4,269	424	0	4,693	136	95	3	234
Ashford Reach	1,646	78	0	1,724	167	34	9	210
Brighton Creek	375	0	0	375	139	25	6	170
Clear Lake	314	0	0	314	49	2	0	51
Copper Creek	773	0	0	773	67	33	5	105
Elbe Creek	122	62	0	184	57	13	6	76
Goat Cr-Tenas Cr	302	10	0	312	147	29	0	176
Harts Lake	956	60	0	1,016	51	4	2	57
Horn Creek	98	0	0	98	288	79	5	372
Kreger Creek	887	16	0	902	146	33	4	183
La Grande Reach	869	0	0	869	35	12	0	47
Little Mashel River	859	0	0	859	118	67	6	191
Lower Mashel River	89	119	0	208	92	10	1	103
Lower Ohop Creek	915	213	0	1,128	130	38	0	168
Lower Tanwax Creek	107	0	0	107	69	24	1	94
Lynch Creek	90	0	0	90	36	2	0	38
Mashel Prairie	0	0	0	0	0	0	0	0
Middle Mashel River	34	0	0	34	7	15	0	22
Murray Creek	4,562	34	41	4,637	396	46	5	447
Red Salmon Creek	0	0	0	0	0	0	0	0
Upper Mashel River	0	0	0	0	0	0	0	0
Upper Ohop Creek	1,776	154	0	1,930	131	48	0	179
Upper Tanwax Creek	1,070	36	0	1,106	381	61	10	452
Total	**20,157**	**1,205**	**41**	**21,404**	**2,655**	**674**	**63**	**3,392**

4.3.4 Stream Flow

Stream flow monitoring provides the most accurate means of characterizing hydrologic conditions in the streams. Stream flow measurements can be used to validate hydrologic models, compute long-term streamflow statistics, and analyze trends in water quality. The U.S. Geological Survey (USGS), which has maintained up to 21 stream gauges throughout the Nisqually River Basin. To supplement the USGS data, Pierce County Water Program has recently established six additional stream gauging sites in the Basin Planning area. The following sections describe the current status of stream flow monitoring in the Nisqually River Basin Planning area.

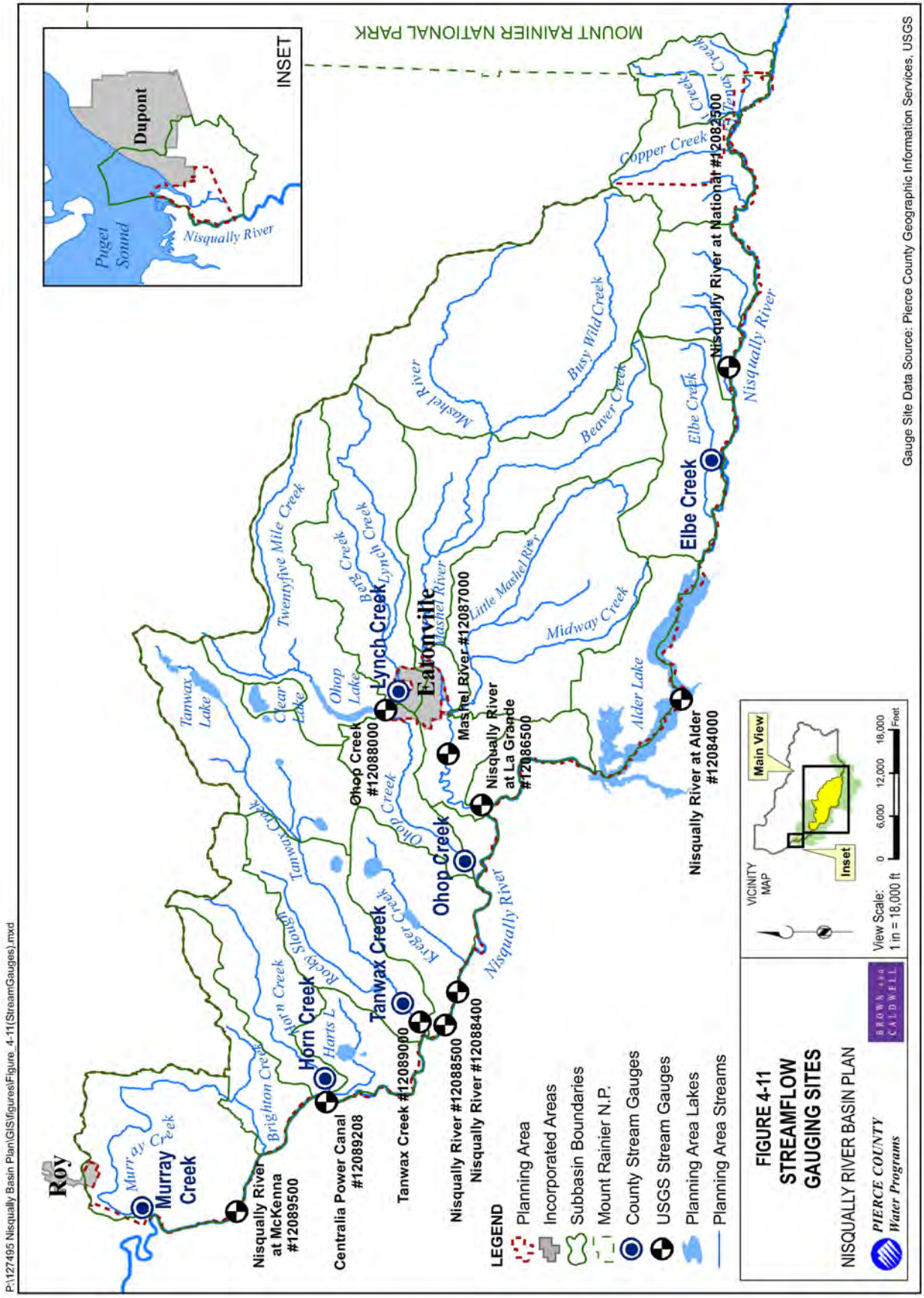
USGS Stream Flow Data

Of the 21 USGS stream gauges in the Nisqually River Basin, 10 are located within the Basin Planning area (Table 4-9, Figure 4-11). Six of the gauges are on the Nisqually River (four active), one is located on the Centralia Power Canal (active), one is located on Ohop Creek (active), one is located on the Mashel River (active), and one was located on Tanwax Creek (inactive). The period of record and the number of records vary for each gauge. Figure 4-12 shows the period of record for each gauge.



*USGS Stream gauges within Nisqually River Basin Planning Area. Records obtained from *http://nwis.waterdata.usgs.gov/*.

Figure 4-12. Period of Record for USGS Stream Gauges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INSET
Puget Sound
Dupont
Nisqually River
MOUNT RAINIER NATIONAL PARK
Roy
Murray Creek
Murray Creek
Nisqually River at McKenna #12089500
Centralia Power Canal #12089208
Horn Creek
Brighton Creek
Horn Creek
Harts L
Rocky Slough
Tanwax Creek
Tanwax Lake
Tanwax Creek
Tanwax Creek #12089000
Nisqually River #12088500
Nisqually River #12088400
Kregger Creek
Ohop Creek
Ohop Creek
Ohop Creek #12088000
Ohop Lake
Clear Lake
Twentyfive Mile Creek
Lynch Creek
Lynch Creek
Eatonville
Mashel River
Mashel River #12087000
Nisqually River at La Grande #12086500
Little Mashel River
Midway Creek
Alder Lake
Nisqually River at Alder #12084000
Elbe Creek
Elbe Creek
Busy Wild Creek
Beaver Creek
Copper Creek
Copper Creek
Tatoosh Creek
Nisqually River at National #12082500
Nisqually River
LEGEND
Planning Area
Incorporated Areas
Subbasin Boundaries
Mount Rainier N.P.
County Stream Gauges
USGS Stream Gauges
Planning Area Lakes
Planning Area Streams
VICINITY MAP
Main View
Inset
View Scale: 1 in = 18,000 ft
0 6,000 12,000 18,000 Feet
FIGURE 4-11
STREAMFLOW GAUGING SITES
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
Gauge Site Data Source: Pierce County Geographic Information Services, USGS

TABLE 4-9
USGS Stream Gauges in the Planning Area

Site Number	Site Name	Records[1]			Latitude (NAD27)	Longitude (NAD27)	Drainage Area (sq.mi.)	Gage datum (feet above sea level NGVD29)
		Beginning Date	Ending Date	Record Count				
12082500	Nisqually River near National, WA	6/1/1942	9/30/2004	22768	46°45'10"	122°04'57"	133.0	1,450
12084000	Nisqually River near Alder, WA	9/1/1931	10/31/1944	4810	46°46'05"	122°16'05"	252.0	1,014
12086500	Nisqually River at La Grande, WA	10/1/1906	9/30/2004	28520	46°50'37"	122°19'46"	292.0	490
12087000	Mashel River near La Grande, WA	10/1/1940	9/30/2004	10958	46°51'25"	122°18'05"	80.7	620
12088000	Ohop Creek near Eatonville, WA	6/1/1927	9/30/2004	17057	46°52'52"	122°16'40"	34.5	518
12088400	Nisqually River at Powell Creek near McKenna, WA	3/1/1969	9/30/1979	3866	46°51'04"	122°26'03"	431.0	389
12088500	Nisqually River near McKenna, WA	8/1/1941	6/30/1963	8004	46°51'20".	122°27'10"	445.0	374
12089000	Tanwax Creek near McKenna, WA	12/1/1944	9/30/1950	2130	46°51'55"	122°27'05"	6.0	390
12089208	Centralia Power Canal near McKenna, WA	3/21/1979	9/30/2004	9326	46°54'01"	122°29'50"	--	330
12089500	Nisqually River at McKenna, WA	10/1/1947	9/30/2004	17663	46°56'01"	122°33'35"	517.0	285

1 – Records may not be continuous from the beginning date to the end date; gaps may exist.

It is important to note that stream flows recorded by stream gauges do not necessarily represent "natural" or pre-settlement conditions. Gauge records are affected by upstream land use, including impoundments, water diversions, and water withdrawals. Some flows are heavily influenced by water regulation. For example, flows in the Nisqually River have been regulated by diversions and dams at La Grande since 1943. Table 4-10 describes the degree of regulation affecting each of the USGS stream gauges as described in the WRIA 11 Level I Assessment (Watershed Professionals Network 2002).

TABLE 4-10
Degree of Regulation Affecting USGS Stream Gauges

Site Number	Site Name	Period of Record[1]	Degree and Type of Regulation
12082500	Nisqually River near National, WA	6/1/1942 - 9/30/2004	*Low:* Flow affected by small diversions for domestic use; seasonally affected by significant snow or glacier melt
12084000	Nisqually River near Alder, WA	9/1/1931 - 10/31/1944	*None:* no upstream diversion or regulation
12086500	Nisqually River at La Grande, WA	10/1/1906 - 9/30/2004	*High:* Flow regulated by City of Tacoma power plant at La Grande since December 1943, by Alder Reservoir since November 1944, and by La Grande Reservoir since February 1945. All diversions returned to river upstream of gauge.
12087000	Mashel River near La Grande, WA	10/1/1940 - 9/30/2004	*Low:* Small diversion for municipal supply for Eatonville. Some regulation at low water by mill pond in Eatonville.
12088000	Ohop Creek near Eatonville, WA	6/1/1927 - 9/30/2004	*Low:* Flow affected by natural storage in Ohop Lake.
12088400	Nisqually River at Powell Creek near McKenna, WA	3/1/1969 - 9/30/1979	*High:* Flow regulated by City of Tacoma power plant at La Grande since December 1943, by Alder Reservoir since November 1944, and by La Grande Reservoir since February 1945.
12088500	Nisqually River near McKenna, WA	8/1/1941 - 6/30/1963	*High:* Flow regulated by City of Tacoma power plant at La Grande since December 1943, by Alder Reservoir since November 1944, and by La Grande Reservoir since February 1945. Yelm irrigation canal diverted up to 70 cfs during the summer, 3.6 miles upstream, for use on downstream lands.
12089000	Tanwax Creek near McKenna, WA	12/1/1944 - 9/30/1950	*None:* no upstream diversion or regulation
12089208	Centralia Power Canal near McKenna, WA	3/21/1979 - 9/30/2004	*High:* Flow Regulated by headworks 500 ft upstream from station.
12089500	Nisqually River at McKenna, WA	10/1/1947 - 9/30/2004	*High:* Flow regulated by City of Tacoma power plant at La Grande since December 1943, by Alder Reservoir since November 1944, and by La Grande Reservoir since February 1945. Centralia Power Canal diverts water 4.4 miles upstream from station, which is returned to the river 9.2 miles downstream from station. Minor irrigation diversion upstream of station.

1 – Records may not be continuous for the entire period of record; gaps may exist.

Pierce County Stream Flow Monitoring

In the spring of 2005 Pierce County Surface Water Management installed six streamflow monitoring gauges within the Nisqually River Basin Planning area (see Figure 4-11).

Stream Gauge on Tanwax Creek

Gauges were installed on the following streams:

- Murray Creek
- Horn Creek
- Tanwax Creek
- Ohop Creek
- Lynch Creek
- Elbe Creek

The locations of the gauges were selected based on accessibility, proximity to the subbasin outlet, and hydraulic conditions.

Each site consists of a staff gauge, a pressure transducer (to measure depth), a data logger, and a battery pack. Flow depths are measured automatically and recorded by the data logger. The data loggers are downloaded monthly.

Several manual estimates of stream discharge will be made at each stream gauging site. These discharges will then be used to develop rating curves that relate stream discharge to flow depth.

The rating curves developed for each site will be used to convert the recorded flow depths into stream discharge estimates. Stream discharge hydrographs will be used calibrate hydrologic models for future analyses.

Mean Monthly Stream Flow

Mean monthly stream flows provide a useful overview of the relative magnitude and seasonal variation of stream flow. Figure 4-13 shows the mean monthly streamflow data for three stream gauges on the Nisqually River. Figure 4-14 shows the mean monthly stream flows for the Mashel River, Ohop Creek, and Tanwax Creek.

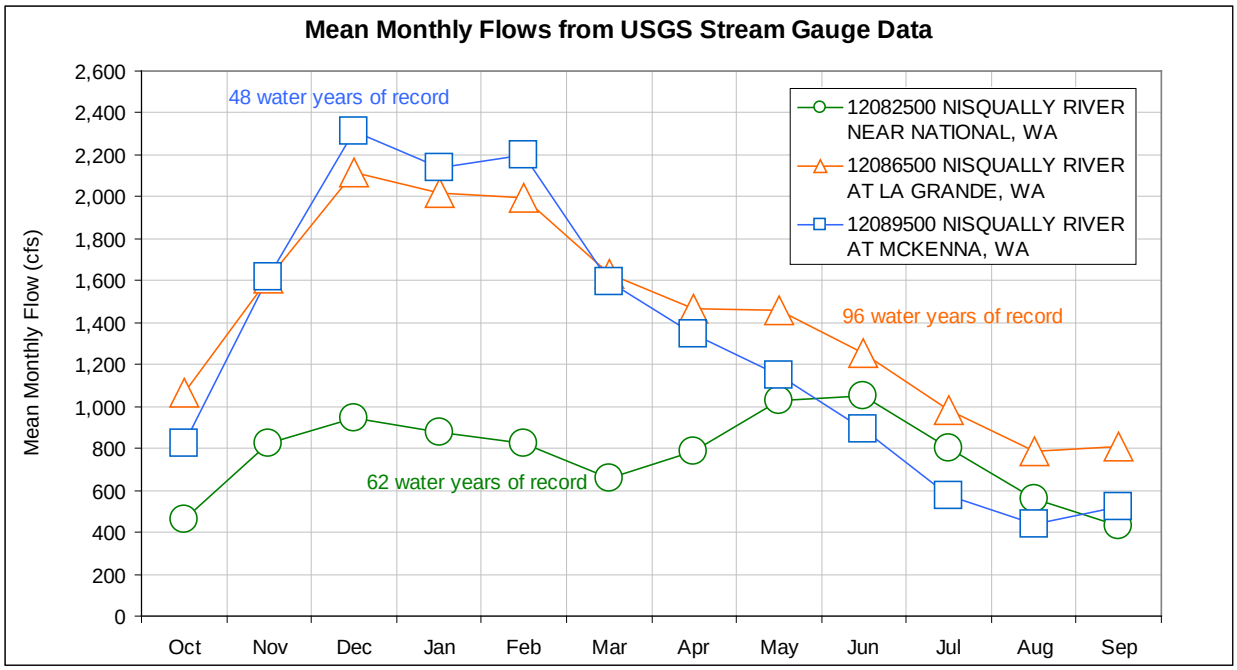


Figure 4-13. Mean Monthly Stream Flow for USGS Gauges on the Nisqually River

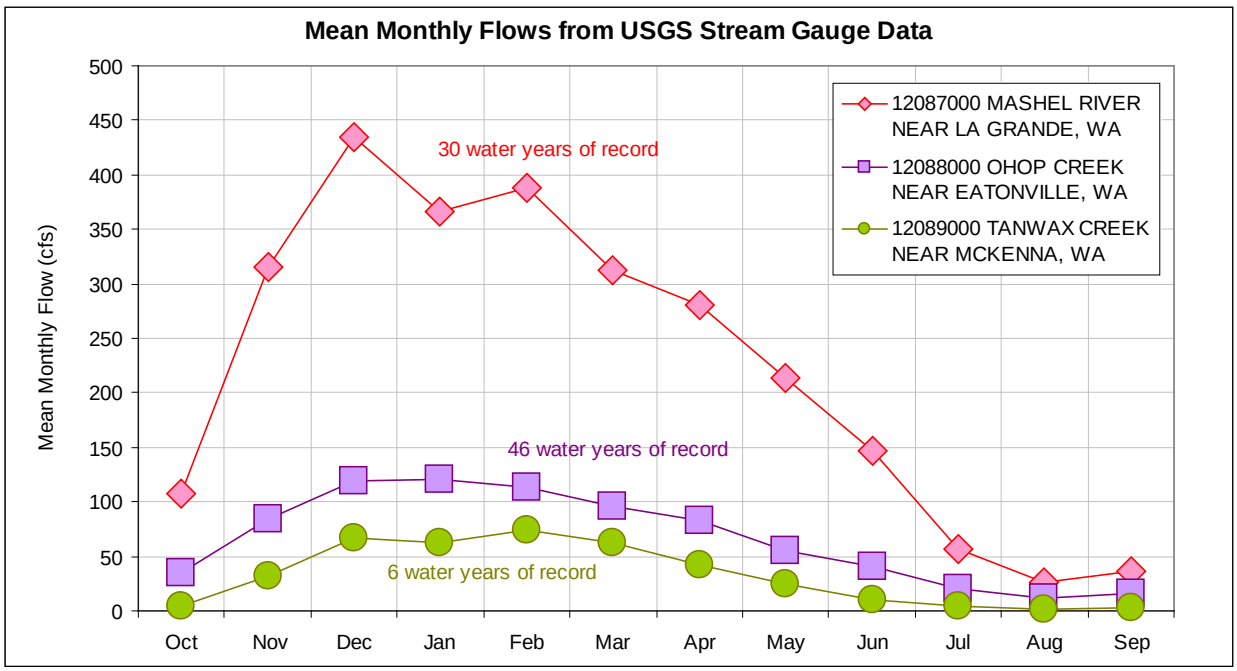


Figure 4-14. Mean Monthly Stream Flow for USGS Gauges on Tributaries

Peak Flow Estimates

The Federal Emergency Management Agency (FEMA) completed a flood insurance study for Pierce County (FEMA, 1987). As part of the flood insurance study, a hydrologic analysis was conducted to estimate peak discharge-frequency values. Table 4-11 summarizes the peak discharges estimated for streams in the Nisqually River Basin Planning area.

TABLE 4-11
Peak Discharge Frequency Estimates from Flood Insurance Study (FEMA, 1987)

Flooding Source and Location	Drainage Area (sq.mi.)	Peak Discharges (cfs)			
		10-Year	50-Year	100-Year	500-Year
Nisqually River					
At Mouth	711	21,500	29,000	33,000	45,000
Upstream of Horn Creek	488	21,000	28,000	32,000	44,000
Upstream of Tanwax Creek	446	20,500	27,000	31,000	43,000
At Skate Creek Road	79	6,250	9,080	10,400	13,600
At Mt. Rainier National Park	66	5,400	7,910	9,040	11,900
Horn Creek					
At Mouth	15	192	266	299	376
At Harts Lake Loop Road	7	113	155	174	217
Ohop Creek					
At Mouth	44	953	1,345	1,518	1,945
At Kapowsin Eatonville Road	35	893	1,259	1,421	1,820
Upstream of Confluence with Lynch Creek	18	440	615	690	880
Upstream of Confluence with Ohop Lake	13	364	507	572	724
Downstream of Confluence with Twenty-five Mile Creek	10	334	465	524	663
Upstream of Confluence with Twenty-five Mile Creek	2	71	97	109	135
Mashel River					
Upstream of Confluence with Little Mashel River	56	3,650	5,020	5,620	7,070
Little Mashel River					
At Mouth	24	1,450	1,940	2,140	2,630
Upstream of Confluence with Midway Creek	15	1,010	1,370	1,520	1,890
Kreger Creek					
At Silver Lake Outlet	2	31	39	42	51
Tanwax Creek					
Downstream of Mud Lake Outlet	14	270	375	425	535
Upstream of Mud Lake Outlet	9	196	271	306	384
At 352nd Street East (Golden Road)	6	143	197	222	278
At State Highway 161	4	128	177	198	248

4.3.5 Flood Hazard Areas

Pierce County regulates the following potential flood hazard areas per the "Critical Areas Ordinance," Chapter 18E.70 of the Pierce County Code (PCC, 2004):

- **Detailed Study Areas** – FEMA Flood Insurance Rate Map and Floodway Map numbered A zones and V zones. This also includes areas within 300 feet horizontal distance from the base flood elevation established for the mapped A and V zones, and areas within 5 feet of vertical height from the base flood elevation established for mapped A and V zones.
- **Unstudied Areas** – FEMA Flood Insurance Rate Map unnumbered A zones and B zones and areas within 300 feet horizontal distance from the mapped areas of the mapped A and B zones.
- **Natural Waters/Watercourse** – Areas within 65 feet horizontal distance from the ordinary high water mark of an identified natural watercourse.
- **Groundwater Flooding Areas** – Areas within 300 feet horizontal distance from a mapped groundwater flooding area.
- **Potholes** – Areas not mapped as a flood hazard area, but within 10 feet of vertical relief from the bottom of an identified pothole or within 2 feet of vertical relief of a potential surface water outlet.

FEMA flood zones are delineated on *Flood Insurance Rate Maps* (FIRM). FEMA has recently made these data available in an electronic format referred to as a Digital Flood Insurance Rate Map (DFIRM). DFIRM data was obtained by the County for use in mapping the detailed study areas and the unstudied areas.

Flood hazard areas that are based on detailed studies (numbered A and V zones) were developed by FEMA using detailed methods, which result in flood profile plots and base flood elevations specified along the stream reach studied. Other flood hazard areas that have been mapped by FEMA (unstudied areas) were developed by approximate methods, which provide no specific data such as peak discharges, flood profiles, or base flood elevations.

The following reaches within the Nisqually River Basin Planning area have been studied by FEMA using detailed methods:

- Nisqually River from the mouth upstream to the confluence with Ohop Creek
- Nisqually River from the Snoqualmie National Forest boundary to the Mount Rainier National Park boundary
- Horn Creek from the mouth to Harts Lake Loop Road 3.5 miles upstream
- Ohop Creek from the mouth upstream to Kapowsin Lake
- Mashel River from the confluence with the Little Mashel River upstream for 2.4 miles
- Little Mashel River from the confluence with the Mashel River upstream for 2.4 miles
- Kreger Creek between Kreger Lake and Silver Lake
- Tanwax Creek from 0.5 miles upstream of Eatonville Cutoff Road upstream to Tanwax Lake

- Harts, Kreger, Silver, Rapjohn, Tanwax, Ohop, and Clear Lakes

FEMA flood hazard areas designated as A and V zones (both numbered and unnumbered) correspond to areas that have a 1% annual probability of being inundated by a flood event. Flood hazard areas designated as B zones are areas with a 0.2% annual probability of being inundated by a flood event. Figure 4-15 shows the 1% annual chance flood inundation areas and the 0.2% annual chance flood inundation areas within the planning area based on the DFIRM data.

An evaluation of flood hazard areas is included in Chapter 6 as part of the flood risk assessment.

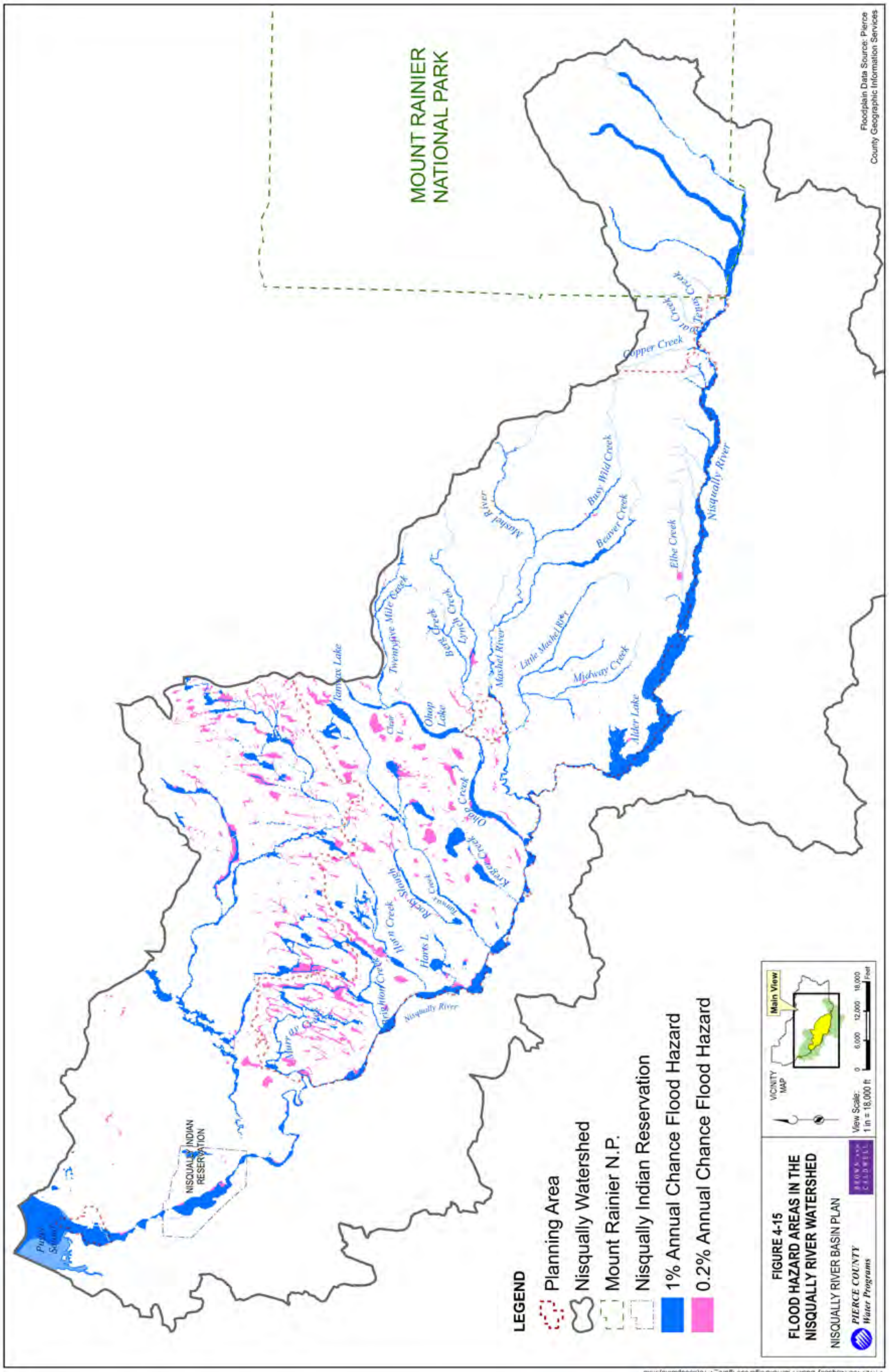
4.3.6 Groundwater

The following sections describe the major geohydrologic units, groundwater recharge, and groundwater flow in the Nisqually River Basin. Much of this information was derived from the recently completed WRIA 11 assessment; therefore, the discussion is organized according to the WRIA subbasins.

Major Geohydrologic Units

Seven major geohydrologic units (areas with similar groundwater-related characteristics) have been described that affect the depth, distribution, and quantity of groundwater. The estimated location of these units in the watershed can be inferred from well logs and other information; however their precise locations are unknown.

Two of these geohydrologic units were combined for the purposes of the Level I assessment because they are very similar. These two units, known as the Holocene alluvium and Vashon recessional outwash, are relatively shallow and are typically 10 to 40 feet thick. They are found under the Tanwax/Kreger/Ohop and Mashel WRIA subbasins, where they can be a significant source of water. They are also present around the Nisqually delta.


MOUNT RAINIER
NATIONAL PARK
Floodplain Data Source: Pierce County Geographic Information Services
Copper Creek
Tenas Creek
Nisqually River
Mashel River
Busy Wild Creek
Beaver Creek
Elbe Creek
Twentyfive Mile Creek
Lynch Creek
Little Mashel River
Midway Creek
Alder Lake
Tanwax Lake
Ohop Lake
Ohop Creek
Harts L.
Horn Creek
Muck Creek
Puget Sound
NISQUALLY INDIAN RESERVATION
LEGEND
Planning Area
Nisqually Watershed
Mount Rainier N.P.
Nisqually Indian Reservation
1% Annual Chance Flood Hazard
0.2% Annual Chance Flood Hazard
FIGURE 4-15
FLOOD HAZARD AREAS IN THE NISQUALLY RIVER WATERSHED
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
View Scale: 1 in = 18,000 ft
VICINITY MAP
Main View

Water generally flows freely through these deposits. However, the presence of fine- grained sediment in these deposits can act to restrict flow of water. This may especially be true of the delta deposits. The degree to which flow is restricted by these fine-grained sediments is currently unknown.

Another geohydrologic unit, known as the Vashon till, lies at or near the ground surface in the northwest portion of the watershed. This unit is a poor source of water. The Kitsap formation is another low unit with low permeability. It typically is found below the Vashon till and can be between 20 and 150 feet thick. The Vashon advance outwash geohydrologic unit is an important aquifer in the watershed.

Numerous domestic wells have been completed in this unit. These wells tend to have moderate to high yield. The unit is generally between 10 and 45 feet thick and is located between 50 and 400 feet above sea level. There is a set of sediment deposits located beneath the Tanwax/Kreger/Ohop WRIA subbasin as well.

The final major hydrogeologic unit in the watershed is the unconsolidated glacial and non-glacial sediments, which have been coded Tertiary-Quaternary (TQu). These sediments are located beneath the Quaternary clay (Qc) unit. Hundreds of wells apparently tap this unit throughout Thurston County; however, the unit has not been extensively developed in the watershed. Groundwater tends to be confined in the TQu unit. The unit can be several thousand feet thick in the northwestern portion of the watershed.

The entire watershed is underlain by bedrock. Small quantities of groundwater can be obtained from fractures and joints in this rock. Yield is generally poor, but the unit can be an important source of domestic waters in some areas, particularly in the Tanwax/Kreger/Ohop and Mashel WRIA subbasins, where the more permeable, water-bearing sediments are not present.

As was mentioned earlier, much of the watershed is underlain by a substantial thickness of permeable sediments containing several aquifers. Many of these sediment layers and aquifers extend beneath portions of adjacent watersheds to the north and south. Therefore, it is highly likely that some natural groundwater exchange occurs between these watersheds. The extent of the exchange of water between the watersheds is currently unknown, although there is evidence that it may be substantial.

Groundwater Recharge

Recharge to the groundwater system in the study area is primarily through the infiltration of precipitation, secondarily as seepage from surface water (lakes, ponds and streams), and from anthropogenic affects (septic systems, irrigation return flow, water reuse, etc.). Estimated recharge through precipitation ranges from 0 to over 80 inches per year. The highest recharge areas are located in the upper Basin where rainfall is also higher. The rates of recharge are uncertain in most areas.

Most streams are fed by groundwater. Hence, the water leaving the groundwater system to become surface water exceeds the amount of water seeping out of streams and lakes and into the groundwater system. In the Nisqually watershed, however, there are numerous areas where surface water seeps into the groundwater system. This is particularly true in the lower

Basin, where the lower sections of a number of streams go dry or nearly dry in summer. These streams flow over the highly permeable, unconsolidated deposits discussed earlier.

Human induced recharge also occurs in many locations of the WRIA from septic systems, irrigation, leakage from water/sewer lines, and direct infiltration of surface water runoff (infiltration ponds, dry wells, etc.). Groundwater recharge due to infiltration of effluent beneath septic drain fields was assumed to be 87% of the water used by single family residences. Other assumptions were made regarding recharge from these sources to support estimates of the total water budget.

Groundwater Flow Direction

Regional information regarding groundwater flow direction and elevations is missing for much of WRIA 11. The flow of groundwater is generally to the northwest and towards the mainstem. Variations in this flow pattern are discussed under the WRIA subbasin summaries. Primary aquifers in the study area include the Qvr, Qva, Qc, and TQu geohydrologic units. Fracture zones within the Tb unit may also be locally important aquifers in the Tanwax/Kreger/Ohop and Mashel WRIA subbasins.

Murray

Groundwater elevations in the Qva and Qc aquifers range from over 600 feet above mean sea level in the eastern portion of the Murray WRIA subbasin to generally less than 75 feet above mean sea level near Puget Sound. Groundwater flow in both the Qva and Qc aquifers is generally toward marine bodies and major streams (Nisqually Level 1 Watershed Assessment Summary Report, 10 July 2002).

Tanwax/Kreger/Ohop

Groundwater characteristics of the western half of the WRIA subbasin can be inferred from information on similar areas to the west. Detailed regional hydrogeologic studies have not been completed in the Tanwax/Kreger/Ohop WRIA subbasin. Therefore, the understanding of the regional hydrogeology is limited to information available on water well reports and various consulting reports for well installations.

Much of the eastern area in the subbasin is underlain by bedrock. Aquifers in these areas are limited to small areas near the fractures and joints in bedrock. The western end of the subbasin has areas of coarse-grained deposits that can support highly productive wells. Little is known about the depth or direction of groundwater flow in this subbasin. Groundwater likely flows towards the mainstem Nisqually River.

Annual groundwater recharge is estimated in the range of 16 to 23 inches. The estimate of recharge may not be accurate due to the large amount of bedrock in the subbasin and the lack of adequate information on surface water runoff. Approximately 36 to 51% of the annual precipitation is estimated to contribute to groundwater recharge. Water rights in the WRIA subbasin have been estimated at approximately 0.14 inches per year. Therefore, current allocated surface/groundwater rights could comprise approximately 0.8% of the estimated groundwater recharge in this subbasin. Therefore, the potential influence of water use on recharge and streamflow is low at the watershed scale in this subbasin.

Mashel River

Detailed, regional hydrogeologic studies have not been completed in the Mashel subbasin. Therefore, the understanding of the regional hydrogeology is limited to information available on water well reports and various consulting reports for well installations.

More than 60% of the Mashel subbasin was not covered by continental glacial ice. The surficial geology in these areas consists of sedimentary and volcanic bedrock. Aquifers in these areas are limited to small areas near the fractures and joints in bedrock. The western end of the subbasin has areas of coarse-grained deposits, which can contain confined aquifers.

Annual groundwater recharge is estimated in the range of 22.5 to 36.9 inches. The estimates of recharge may not be accurate due to the large amount of bedrock in the subbasin and the lack of adequate information on surface water runoff. The water balance and water use analysis completed for this Level I assessment indicate that the net depletion to water resources in the Mashel subbasin due to the allocated water rights and net residential use will be less than 1% of the estimated groundwater recharge in the Basin through 2020. Therefore, the potential influence of water use on recharge and streamflow is low at the watershed scale in this subbasin.

Upper Nisqually River Basin

According to the WRIA 11 Technical Assessment Report, there is an annual groundwater discharge of roughly 36,000 acre-feet per year from the Upper Nisqually River Basin. The most plentiful groundwater resources in the upper Basin are located in the Nisqually valley from Ashford to Alder Lake. The aquifers occur in fluvioglacial units, which consist of material (primarily sand and gravel), deposited from flowing glacial meltwater. The aquifers are believed to occur in two principal units:

1. The upper fluvioglacial unit, which extends from near the surface to the top of the middle confining zone.
2. The lower fluvioglacial unit is separated from the upper unit by an 80-foot section of hard, brittle clay.

The upland, non-alluvial areas of this subbasin are mainly underlain by bedrock. The aquifers in these areas are limited to small areas near fractures and joints in bedrock (*Nisqually Watershed Management Plan,* Nisqually Indian Tribe, 2003). Groundwater follows the Nisqually River valley.

4.3.7 Impervious Surface Analysis

Impervious surface area is often used as an indicator of potential for drainage and water quality problems associated with stormwater runoff. Therefore, the existing and future total impervious surface area of the Nisqually River Basin Planning area was estimated as part of the Basin Planning effort. This estimation will be incorporated into hydrologic computer modeling efforts that may be performed for analyses. A conceptual hydrologic model requires accurate quantification of the amount of impervious surfaces to simulate rainfall-runoff relationships and predict flow patterns within a watershed (USGS, 1994). One of the primary physical

attributes used for a hydrologic model is the "Effective Impervious Area" (EIA). As described in *Appendix D* of Pierce County's *Guidance for Basin Planning* (Pierce County Surface Water Management, 2000), the EIA represents impervious areas hydraulically connected to water courses resulting in a quicker response to rainfall events.

The basic principles of the hydrologic cycle include precipitation falling over the watershed, some storage at the land surface, overland flow from hillsides to streams, groundwater flow to lakes and streams, and flow in the streams to the mouth. As a Basin becomes developed, hydrologic characteristics are altered due to construction of impervious surfaces and structures, removal or alternation of vegetation, compaction of soils, and replacement of natural drainage features with man-made pipes and channels and stream modifications. When precipitation falls on the land surface, the amount of natural infiltration and storage is reduced, increasing the volume and rate of overland flow into streams, increasing the potential for erosion and flooding.

The existing percent EIA for the 23 subbasins in the Nisqually River Basin Planning area was computed assuming the land uses shown on Figure 4-1, and the future percent EIA was estimated assuming zoning shown in Figure 4-2 would be fully realized. Table 4-13 shows the existing and future land-use condition EIA for each subbasin. The table also shows the percent of the subbasin that is water. Water bodies and streams were included in the analysis as 100% impervious areas in both the existing and future impervious area estimates. The analysis indicates that the existing EIA percentages are relatively low. Only five of the 23 subbasins are projected to experience EIA increases of more than 1%

TABLE 4-12
Effective Impervious Areas for
Existing and Future Land Use Conditions

Subbasin	Water[1]	Existing EIA	Future EIA	Increase in EIA
Alder Lake	5.5%	18.6%	19.0%	0.4%
Ashford Reach	< 1.0%	8.1%	9.3%	1.3%
Brighton Creek	1.0%	14.9%	15.3%	0.4%
Clear Lake	20.3%	32.5%	32.5%	0.0%
Copper Creek	< 1.0%	5.5%	5.8%	0.3%
Elbe Creek	1.0%	10.6%	10.6%	0.0%
Goat Cr-Tenas Cr	< 1.0%	5.0%	5.6%	0.6%
Harts Lake	6.2%	14.2%	14.5%	0.3%
Horn Creek	< 1.0%	12.9%	13.4%	0.5%
Kreger Creek	1.2%	10.2%	10.7%	0.5%
La Grande Reach	< 1.0%	13.8%	13.9%	0.2%
Little Mashel River	< 1.0%	6.1%	6.3%	0.2%
Lower Mashel River	< 1.0%	11.6%	16.9%	5.3%
Lower Ohop Creek	< 1.0%	12.5%	13.8%	1.2%
Lower Tanwax Creek	< 1.0%	3.7%	4.9%	1.2%
Lynch Creek	< 1.0%	3.2%	4.0%	0.8%
Mashel Prairie	3.2%	7.6%	8.3%	0.7%
Middle Mashel River	< 1.0%	3.0%	3.0%	0.0%
Murray Creek	< 1.0%	13.6%	14.5%	0.9%
Red Salmon Creek	20.5%	28.2%	34.0%	5.8%
Upper Mashel River	< 1.0%	1.6%	1.6%	0.0%
Upper Ohop Creek	2.3%	6.3%	6.4%	0.1%
Upper Tanwax Creek	2.9%	14.1%	14.5%	0.4%
TOTAL	1.6%	8.6%	9.3%	0.7%

1- Water bodies and streams were included in the existing and future EIA as 100% EIA.

4.3.8 Deforestation Surface Analysis

Effective impervious area is one indicator of the potential impacts of land use changes. The change in forest cover may also be useful in this regard. Forested areas play an important role in the hydrologic cycle. Tree cover intercepts rainfall. This intercepted rain can evaporate or be transpired by the trees. The forest duff layer absorbs large amounts of runoff, releasing it slowly to the streams through shallow groundwater flow. When deforestation occurs, more precipitation reaches the ground, increasing the potential for erosion and deposition of sediment in waterways. In addition, the forest duff layer is disturbed and or removed, eliminating its contribution to erosion protection and flow attenuation.

As previously mentioned, forested areas in the Basin are being developed into rural residential parcels. These parcels are zoned for rural residential development 5 acres (Rural 5), 10 acres (Rural 10), 20 acres (Rural 20) and 40 acres (Rural 40) in size. In some cases, these areas are being developed into 20-acre parcels even though the zoning allows for smaller parcels (i.e., Rural 10 zoned areas). The County has fewer rules and regulations for the development of parcels 20-acres, or larger, in size.

In an effort to understand the potential impact, the potential change in forested areas was estimated. Existing forested areas were estimated with the University of Washington land classification dataset, based 1998 Landsat satellite images (Hill et. al, 2000).

Table 4-14 shows that 43% of the subbasin area is not zoned for development and half of the Basin is zoned for Rural 5, 10, 20, and 40. The rural residential zoned areas account for 45% of the forested areas, according to the Landsat data.

TABLE 4-13
Estimated Loss of Forested Area

Zoning Classification	Percent of Basin Area	Percent of Forested Area	Percent of Forested Area Lost
Rural 5/ Rural 10/ Rural 20/ Rural 40	50	45	30-55
Designated Forest Land/ Mt. Rainier National Park	43	52	0

The loss of forested areas was estimated for zoning classifications only Rural 5, 10, 20, and 40, since they will be the most impacted. Based on interviews with PALS staff, the loss of forested areas was estimated by assuming all areas were developed into 20-acre parcels.

It was assumed the typical development of a 20-acre parcel results in a 1-acre home and 5 to 10 additional acres of cleared land, resulting in 30-55% loss of forested area. The estimated change, by subbasin, is shown in Table 4-14.

TABLE 4-14
Estimated Decrease in Forested Area

Subbasin	Existing Forested Area (% of Subbasin)[1]	Estimated Loss of Forested Area (% of Subbasin)[2]
Alder Lake	44	13-24
Ashford Reach	36	11-20
Brighton Creek	52	16-29
Clear Lake	55	17-30
Copper Creek	27	8-15
Elbe Creek	32	10-18
Goat Cr-Tenas Cr	23	7-12
Harts Lake	48	14-26
Horn Creek	62	18-34
Kreger Creek	60	18-33
La Grande Reach	77	23-42
Little Mashel River	40	12-22
Lower Mashel River	50	15-27
Lower Ohop Creek	53	16-29
Lower Tanwax Creek	64	19-35
Lynch Creek	3	1-2
Mashel Prairie	72	22-40
Middle Mashel River	3	1-2
Murray Creek	23	7-13
Red Salmon Creek	2	1
Upper Mashel River	<1	<1
Upper Ohop Creek	31	9-17
Upper Tanwax Creek	60	18-33
TOTAL	32	10-18

1 - Existing forested areas based on 1998 Landsat data (Hill et. al, 2000).

2 - Loss estimated assuming areas zoned rural residential will lose 30-55% of existing forest.

4.4 AQUATIC AND RIPARIAN HABITAT

The condition of stream health and fish habitat in the Nisqually watershed has been studied extensively through fieldwork and analysis for over twenty-five years. Much of the major work to evaluate Nisqually streams during that time has been conducted by Nisqually Tribal scientists working in partnership with other scientists from federal, state, and local agencies. The primary purpose in gathering this information has been to improve the understanding of stream conditions and fish habitat so that key habitat issues can be identified, prioritized, and addressed.

The establishment of a co-management agreement between the Tribe and the State of Washington in the late 1970's necessitated a greater understanding of salmon and salmon habitat in order to effectively manage the salmon resource. This meant that in the Nisqually watershed, biologists were hired by the Tribe in the late 1970s to begin surveying the salmon streams in Nisqually, looking for spawning fish, researching juvenile salmon usage, and evaluating habitat. Some of the first detailed surveys of Nisqually streams were conducted by these new Tribal biologists as they searched the watershed looking for spawning salmon and gathering information about the condition of salmon streams. This survey work continued for five years until, in 1985, the Tribe published *Nisqually Tribe Technical Report 15* for the Nisqually River Management Taskforce, which summarized the survey work of the past five years, characterizing the condition of stream habitat and salmon usage of Nisqually streams.

In the latter half of the 1980s, the Tribe hired additional biologists to survey streams in forestry areas of the watershed to understand the condition of habitat in those streams. These studies included sedimentation sampling and then detailed watershed analyses which were conducted from the late 1980s into the mid 1990s. The watershed analyses collected detailed information at regular intervals along Nisqually streams, including the Mashel, Ohop, and Tanwax, that were used to evaluate mass wasting potential, surface erosion, hydrology, riparian function, stream channel condition, fish habitat, water quality, and water supply/public works impacts. The Mashel study alone included field data collection at 63 separate stream reaches. These studies were conducted for the entire watershed, even though only part of the watershed was in forestry use. Some of these study areas that were at the time in forestry have now been converted to rural residential areas.

Surveyed stream areas have been broken into defined stream reaches. Figure 4-16 shows the stream reaches within the Nisqually River Basin Planning area. Table 4-15 lists each of these reaches and describes the surveying that has been completed for each reach.

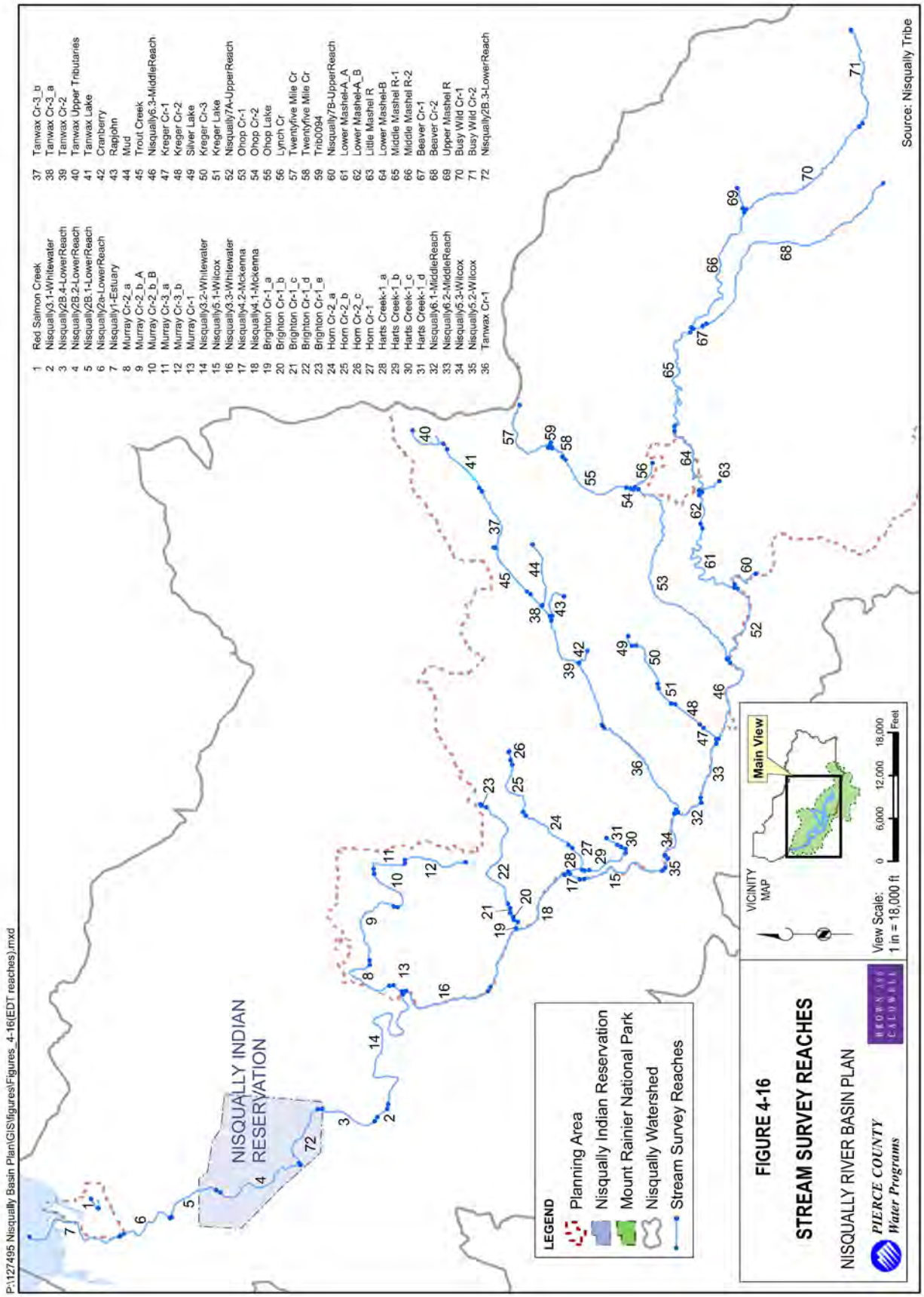

1 Red Salmon Creek
2 Nisqually3.1-Whitewater
3 Nisqually2B.4-LowerReach
4 Nisqually2B.2-LowerReach
5 Nisqually2B.1-LowerReach
6 Nisqually2a-LowerReach
7 Nisqually1-Estuary
8 Murray Cr-2_a
9 Murray Cr-2_b_A
10 Murray Cr-2_b_B
11 Murray Cr-3_a
12 Murray Cr-3_b
13 Murray Cr-1
14 Nisqually3.2-Whitewater
15 Nisqually5.1-Wilcox
16 Nisqually3.3-Whitewater
17 Nisqually4.2-Mckenna
18 Nisqually4.1-Mckenna
19 Brighton Cr-1_a
20 Brighton Cr-1_b
21 Brighton Cr-1_c
22 Brighton Cr-1_d
23 Brighton Cr-1_e
24 Horn Cr-2_a
25 Horn Cr-2_b
26 Horn Cr-2_c
27 Horn Cr-1
28 Harts Creek-1_a
29 Harts Creek-1_b
30 Harts Creek-1_c
31 Harts Creek-1_d
32 Nisqually6.1-MiddleReach
33 Nisqually6.2-MiddleReach
34 Nisqually5.3-Wilcox
35 Nisqually5.2-Wilcox
36 Tanwax Cr-1
37 Tanwax Cr-3_b
38 Tanwax Cr-3_a
39 Tanwax Cr-2
40 Tanwax Upper Tributaries
41 Tanwax Lake
42 Cranberry
43 Rapjohn
44 Mud
45 Trout Creek
46 Nisqually6.3-MiddleReach
47 Kreger Cr-1
48 Kreger Cr-2
49 Silver Lake
50 Kreger Cr-3
51 Kreger Lake
52 Nisqually7A-UpperReach
53 Ohop Cr-1
54 Ohop Cr-2
55 Ohop Lake
56 Lynch Cr
57 Twentyfive Mile Cr
58 Twentyfive Mile Cr
59 Trib0094
60 Nisqually7B-UpperReach
61 Lower Mashel-A_A
62 Lower Mashel-A_B
63 Little Mashel R
64 Lower Mashel-B
65 Middle Mashel R-1
66 Middle Mashel R-2
67 Beaver Cr-1
68 Beaver Cr-2
69 Upper Mashel R
70 Busy Wild Cr-1
71 Busy Wild Cr-2
72 Nisqually2B.3-LowerReach
NISQUALLY INDIAN RESERVATION
LEGEND
Planning Area
Nisqually Indian Reservation
Mount Rainier National Park
Nisqually Watershed
Stream Survey Reaches
VICINITY MAP
Main View
View Scale: 1 in = 18,000 ft
0 6,000 12,000 18,000 Feet
FIGURE 4-16
STREAM SURVEY REACHES
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
Source: Nisqually Tribe
P:\127495 Nisqually Basin Plan\GIS\figures\Figures_4-16(EDT reaches).mxd

TABLE 4-15
Stream Surveying Completed by Stream Reach

Reach Name	Surveyed Last 5 Years	Surveyed last 15 Years	Figure Reference Number
Beaver Cr-1	Occasional stream surveys	Intensive multiple surveys	67
Beaver Cr-2	Not surveyed	Intensive multiple surveys	68
Brighton Cr-1_a	Intensive multiple surveys	--	19
Brighton Cr-1_b	Occasional stream surveys	--	20
Brighton Cr-1_c	Not surveyed	--	21
Brighton Cr-1_d	Not surveyed	--	22
Brighton Cr-1_e	Not surveyed	--	23
Busy Wild Cr-1	Intensive multiple surveys	Intensive multiple surveys	70
Busy Wild Cr-2	Not surveyed	Intensive multiple surveys	71
Cranberry	Spot checked at access points	Intensive multiple surveys	42
Harts Creek-1_a	Intensive multiple surveys	--	28
Harts Creek-1_b	Occasional stream surveys	--	29
Harts Creek-1_c	Occasional stream surveys	--	30
Harts Creek-1_d	Occasional stream surveys	--	31
Horn Cr-1	Intensive multiple surveys	Intensive multiple surveys	27
Horn Cr-2_a	Spot checked at access points	--	24
Horn Cr-2_b	Spot checked at access points	--	25
Horn Cr-2_c	Spot checked at access points	--	26
Kreger Cr-1	Occasional stream surveys	Intensive multiple surveys	47
Kreger Cr-2	Spot checked at access points	Intensive multiple surveys	48
Kreger Cr-3	Spot checked at access points	Intensive multiple surveys	50
Kreger Lake	Not surveyed	Intensive multiple surveys	51
Little Mashel R	Intensive multiple surveys	Intensive multiple surveys	63
Lower Mashel-A_A	Intensive multiple surveys	Intensive multiple surveys	61
Lower Mashel-A_B	Intensive multiple surveys	Intensive multiple surveys	62
Lower Mashel-B	Intensive multiple surveys	Intensive multiple surveys	64
Lynch Cr	Occasional stream surveys	Intensive multiple surveys	56
Middle Mashel R-1	Not surveyed	Intensive multiple surveys	65
Middle Mashel R-2	Occasional stream surveys	Intensive multiple surveys	66
Mud	Spot checked at access points	Intensive multiple surveys	44
Murray Cr-1	Intensive multiple surveys	Intensive multiple surveys	13
Murray Cr-2_a	Spot checked at access points	--	8
Murray Cr-2_b_A	Spot checked at access points	--	9
Murray Cr-2_b_B	Spot checked at access points	--	10
Murray Cr-3_a	Spot checked at access points	--	11
Murray Cr-3_b	Spot checked at access points	--	12
Nisqually1-Estuary	Intensive multiple surveys	Intensive multiple surveys	7
Nisqually2a-LowerReach	Intensive multiple surveys	Intensive multiple surveys	6
Nisqually2B.1-LowerReach	Intensive multiple surveys	Intensive multiple surveys	5
Nisqually2B.2-LowerReach	Intensive multiple surveys	Intensive multiple surveys	4
Nisqually2B.3-LowerReach	Intensive multiple surveys	Intensive multiple surveys	72

TABLE 4-15
Stream Surveying Completed by Stream Reach

Reach Name	Surveyed Last 5 Years	Surveyed last 15 Years	Figure Reference Number
Nisqually2B.4-LowerReach	Intensive multiple surveys	Intensive multiple surveys	3
Nisqually3.1-Whitewater	Intensive multiple surveys	Intensive multiple surveys	2
Nisqually3.2-Whitewater	Intensive multiple surveys	Intensive multiple surveys	14
Nisqually3.3-Whitewater	Intensive multiple surveys	Intensive multiple surveys	16
Nisqually4.1-Mckenna	Intensive multiple surveys	Intensive multiple surveys	18
Nisqually4.2-Mckenna	Intensive multiple surveys	Intensive multiple surveys	17
Nisqually5.1-Wilcox	Intensive multiple surveys	Intensive multiple surveys	15
Nisqually5.2-Wilcox	Intensive multiple surveys	Intensive multiple surveys	35
Nisqually5.3-Wilcox	Intensive multiple surveys	Intensive multiple surveys	34
Nisqually6.1-MiddleReach	Intensive multiple surveys	Intensive multiple surveys	32
Nisqually6.2-MiddleReach	Intensive multiple surveys	Intensive multiple surveys	33
Nisqually6.3-MiddleReach	Intensive multiple surveys	Intensive multiple surveys	46
Nisqually7A-UpperReach	Intensive multiple surveys	Intensive multiple surveys	52
Nisqually7B-UpperReach	Intensive multiple surveys	Intensive multiple surveys	60
Ohop Cr-1	Intensive multiple surveys	Intensive multiple surveys	53
Ohop Cr-2	Intensive multiple surveys	Intensive multiple surveys	54
Ohop Lake	Occasional stream surveys	Intensive multiple surveys	55
Rapjohn	Occasional stream surveys	Intensive multiple surveys	43
Red Salmon Creek	Intensive multiple surveys	Intensive multiple surveys	1
Silver Lake	Not surveyed	Intensive multiple surveys	49
Tanwax Cr-1	Intensive multiple surveys	Intensive multiple surveys	36
Tanwax Cr-2	Spot checked at access points	Intensive multiple surveys	39
Tanwax Cr-2	Spot checked at access points	Intensive multiple surveys	38
Tanwax Cr-3_a	Spot checked at access points	Intensive multiple surveys	37
Tanwax Cr-3_b	Spot checked at access points	Intensive multiple surveys	41
Tanwax Lake	Intensive multiple surveys	Intensive multiple surveys	40
Tanwax Upper Tributaries	Occasional stream surveys	Intensive multiple surveys	59
Trib0094	Occasional stream surveys	Intensive multiple surveys	45
Trout Creek	Occasional stream surveys	Intensive multiple surveys	57
Twentyfive Mile Cr	Intensive multiple surveys	Intensive multiple surveys	57
Upper Mashel R	Occasional stream surveys	Intensive multiple surveys	69

Also during the 1990s, the Tribe conducted extensive water quality studies (which will be discussed in Section 4.6, Water Quality) of the streams of the watershed, publishing six different technical reports. These studies included establishing regular monitoring stations throughout the streams of the watershed.

In 1997, the Tribe began a new process to organize the extensive field data and experience that had been developed over the previous twenty years. A series of in-depth, technical workshops were organized that brought together all of the scientists that had a familiarity with streams and salmon habitat in the Nisqually watershed. This group of scientists was called the Nisqually Chinook Recovery Team. Members included representatives of the Tribe, the Northwest Indian

Fisheries Commission, Washington Department of Fish and Wildlife, and the National Marine Fisheries Service. The meetings were organized and facilitated by Mobrand Biometrics, Inc. (MBI). The Tribe contracted with MBI to use their Ecosystem Diagnosis and Treatment (EDT) model to organize the data and knowledge of Nisqually streams into one database and to prioritize salmon habitat projects.

The EDT model records the best available habitat information for all salmon stream reaches in the watershed and then uses biological rules about how salmon are impacted by changes in habitat to evaluate which changes have caused the greatest impacts to salmon population parameters. The tool is more robust and reliable when care is taken to ensure the data loaded into the model is defensible and that the model results for current population conditions are close to what is really being seen in the field. In Nisqually, every effort was made to ensure that use of the EDT model was robust and defensible.

From 1997 to 1999, the Nisqually Chinook Recovery Team met at eleven separate workshops to discuss 47 different stream reaches in the watershed and rate the current vs. historical condition of 46 different environmental attributes of each stream reach. Participants used the information gathered from the previously completed watershed analyses, spawning survey observations, and water quality and sediment studies. In between workshops, select team members did further analysis of key questions and clarified areas of uncertainty in preparation for the next workshop.

After the habitat data was loaded into the EDT model, it was run to look at predicted impacts on the Nisqually Chinook population. The model outputs for historical and current conditions were compared to actual salmon population data that had been collected by the Tribe and Washington Department of Fish and Wildlife since the late 1970's. The model generated comparable numbers with the actual data, so the Nisqually Chinook Recovery Team participants felt they could trust the model with confidence.

Once the first Nisqually Chinook EDT model was completed, the Tribe published the *Nisqually Chinook Recovery Plan* in 2001. The Tribe then began work to update the model as part of its adaptive management process and to include additional stream reaches not used by Chinook but used by other Nisqually salmon including coho, chum, steelhead, and pink. The data for these additional stream reaches was compiled from habitat surveys where available and the best judgment of local biologists where a detailed survey was not done. EDT model runs for Nisqually coho, chum, and steelhead have now been completed, and the EDT model run for Nisqually pink salmon is nearing completion. Each of the completed model runs has been compared to actual current population information to test the accuracy of the model.

In addition, the Tribe has continued since 2000 to update the EDT model with new habitat information as more studies are completed, further refining the accuracy of the model inputs. Key habitat studies that have been done since 2000 include new detailed habitat surveys of the lower and middle reach of the Mashel River. These surveys include depth of substrate scour during high flow events, habitat type (pool/riffle ratio), presence and abundance of large woody debris, residual pool depth, pool forming factors, channel cross-sections, flow studies, and juvenile salmon usage of habitat types. On Ohop Creek, a detailed habitat assessment was completed in 2002 that looked at historical impacts to Ohop Creek and collected detailed

information on watershed geology, channel cross-sections, in-stream habitat types, locations and sources of spawning gravels, presence of large woody debris, and riparian cover.

In addition, the Tribe has conducted extensive spawning distribution surveys over the last five years in both the specific index areas that are used for spawning escapement estimates by harvest managers and also in other areas to understand current spawning distribution throughout the watershed. Creeks surveyed for spawning fish and qualitative observations of habitat include Red Salmon, Murray, Brighton, Horn, Harts Lake, Tanwax, Kreger, Ohop, Twenty-Five Mile, Lynch, Mashel and Little Mashel.

Yearly macroinvertebrate sampling in the fall and summer high-temperature monitoring has also been organized by the Tribe in cooperation with its partners since 2001 in most of these streams. Two watershed-wide assessments were conducted by the Pierce Conservation District in cooperation with the Tribe since 2000–one was a fish passage barrier assessment of the watershed, and the other was a riparian vegetation condition assessment of the watershed. Along the mainstem Nisqually River, the South Puget Sound Salmon Enhancement Group worked in partnership with the Tribe to complete an off-channel habitat assessment.

The stream condition and fish habitat data summarized for this Basin plan is based on the Nisqually Tribe's collective understanding developed by these twenty-five plus years of field investigation of Nisqually streams. The Nisqually EDT model was used as a tool to organize and communicate that data in a way that helps to identify where habitat problems are probably having the greatest impact on Nisqually salmon populations.

Table 4-16 contains some of the key references that have been used to characterize stream health and fish habitat conditions.

TABLE 4-16
References Used for Stream Characterization

Watershed Analyses
Bohle, T., C.E. Cupp, R. Denman, R. Jackson, J. Kirtland, J. Metzler, E. Salminen, and K. Sargent. Jun 1996. Mashel Watershed Analysis Resource Assessment Report. Washington Department of Natural Resources, South Puget Sound Region, Enumclaw, WA.
Nisqually Indian Tribe. 1998. Ohop, Tanwax, Powell watershed analysis: final draft resource assessment report. Olympia, WA.
Studies of Related Flow, Sediment, and Other Issues Related to Hydroelectric Projects
CH2M Hill. 1990. Yelm hydroelectric project. Prepared for City of Centralia Light Department for submittal to the Federal Energy Regulatory Commission.
Culhane, T. Nov 2001. Flow Investigation of the Nisqually River Lower Reach Thurston County, Washington. Washington Department of Ecology, Water Resources Program. Olympia, Washington. Water Resource Inventory Area 11.
Cummans, J. 1974. Flood profiles and inundated areas along the Lower Nisqually River, Washington. Water Resources Division, Washington District, in cooperation with the State Department of Ecology. Tacoma, WA.
FERC, 1996. Final Environmental Impact Statement, Nisqually Hydroelectric Project (FERC Project Number 1862). Federal Energy Regulatory Commission, Office of Hydropower Licensing, Washington D.C.
Harza Northwest, Inc. 1991. Nisqually hydroelectric project FERC No. 1862. Prepared for City of Tacoma Department of Utilities Light Division for submittal to the Federal Energy Regulatory Commission. Tacoma, WA.
Harza Northwest Inc. 1994. Final Response to FERC request for additional information of April 11, 1994: Nisqually Hydroelectric Project, FERC project no. 1862. City of Tacoma, Department of Public Utilities. Tacoma, WA.
Nelson, L.M. 1974. Sediment transport by streams in the Deschutes and Nisqually river basins, Washington: November 1971-June 1973. US Geological Survey, Water Resources Division. Tacoma, WA.
Nisqually Indian Tribe. 1981. Final Report: Fish Loss Assessment Study. Submitted to Bureau of Indian Affairs.
Nisqually Tribe unpublished scour monitoring in the Mashel River.
Woody Debris and Channel Migration
Collins, B., D.R. Montgomery, and A.D. Haas. 2002. Historical changes in the distribution and functions of large wood in Puget Lowland rivers. Canadian Journal of Fisheries and Aquatic Sciences. 59: 66-76.

TABLE 4-16
References Used for Stream Characterization

Collins, B.D., D.R. Montgomery, and A. J. Sheikh. Reconstructing the historical riverine landscape of the Puget Lowland. pp. 79-128 in D. R. Montgomery, S. M. Bolton, D. B. Booth, and L. Wall, eds. Restoration of Puget Sound Rivers, University of Washington Press, Seattle, WA.
Collins, B. and D.R. Montgomery. 2002. Forest development, wood jams, and restoration of floodplain rivers in the Puget Lowland, Washington. Restoration Ecology 10: 237-247.
Earth Systems. May 1998. Assessment of Channel Changes and Geologic Processes At the Nisqually Indian Reservation, Washington. Nisqually River Channel Assessment.
Smith, D. 1997. Hazards from bank erosion and channel migration in the Nisqually River Basin. M.E. S. Thesis, The Evergreen State College, Olympia, WA.
Estuary Studies
Fresh, K.L., D. Rabin, C. Simenstad, E.O. Salo, K. Garrison & L. Matheson. 1979. Fish ecology studies for the Nisqually Reach area of southern Puget Sound, Washington: final report, March 1977-August 1978, Weyerhaeuser Company. Fisheries Research Institute, College of Fisheries, University of WA, Seattle.
Hodgson, Sayre, C. Ellings, K. Brakensiek, and R. Coshow. 2005. Juvenile salmon baseline studies in the Nisqually Estuary; 2002-2004 results. Proceedings of the Puget Sound Georgia Basin Research Conference. Puget Sound Action Team. Olympia, WA.
Pearce, T.A., J.H. Meyer and R.S. Boomer. 1982. Distribution and food habits of juvenile salmon in the Nisqually estuary, Washington, 1979-80. US Fish and Wildlife Service Fisheries Assistance Office, Olympia, Washington.
Juvenile Outmigration and Distribution
Harrington-Tweit, W. and P.H. Svoboda. 1980. Nisqually River 1980 Nisqually River juvenile salmonid outmigration study. Nisqually Indian Tribe Technical Report No. 2.
Harrington-Tweit, W. and P. H. Svoboda. Jan 1983. Nisqually River 1982 juvenile salmonid outmigration study. Nisqually Indian Tribe Technical Report No. 6.
Harrington-Tweit, W. and P.H. Svoboda. 1983. Nisqually River 1983 juvenile Salmonid outmigration study. Nisqually Indian Tribe Technical Report No. 10.
Harrington-Tweit, W. and E. J. Tierney. 1985. Nisqually River 1985 juvenile Salmonid outmigration study. Nisqually Indian Tribe Technical Report No. 13.
Scott, J.B. 1981. The distribution and abundance of juvenile salmonids in the Nisqually River from spring to midsummer. Final report for the period April 1 to August 30, 1980 to the City if Tacoma and the City of Centralia (FRI-UW-8102). Fisheries Research Institute, University of Washington, Seattle.

TABLE 4-16
References Used for Stream Characterization

Tierney, E. J. and P. Svoboda. 1982. Nisqually River 1982 Nisqually River Juvenile salmonid outmigration study. Nisqually Indian Tribe Technical Report No. 6.
Tyler, R.W. 1980. Nisqually River juvenile salmonid study. Final Report (FRI-UW-8009). Fisheries Research Institute, University of Washington, Seattle.
Water Quality
Walter, G. F. and T. Connor. 1991. Nisqually River Basin water quality monitoring project baseline water quality monitoring project design. Nisqually Indian Tribe, Olympia, WA.
Whiley, A. J., G. F. Walter, and T. H. Connor. Nov 1994. Water Quality Investigations of the Lower Nisqually River Basin 1991-93. Nisqually Indian Tribe Natural Resources Department.
Whiley, A. J. and G. Walter Aug 1996. Investigation of Fecal Coliform Sources within Drainage to the Nisqually Reach. Nisqually Indian Tribe- Nisqually Natural Resources Water Quality Program. Technical Report Number 2.
Whiley, A. J. and G. Walter. Feb 1997. Identification of Pollution Sources Impacting Salmon Habitat in the Mashel River and Ohop Creek Drainages. Nisqually Indian Tribe- Nisqually Natural Resources Water Quality Program. Technical Report Number 3.
Whiley, A. J. and G. Walter. Aug 1997. Ohop Lake Phase I Study Limnological Analysis, Phosphorus Loading, and Management Recommendations. Nisqually Indian Tribe- Nisqually Natural Resources Water Quality Program. Technical Report Number 4.
Whiley, A. J. and G. Walter. Mar 1998. Analysis of Fecal Coliform Concentrations in the Nisqually River Drainage. Nisqually Indian Tribe- Natural Resources Water Quality Program. Technical Report Number 5.
Whiley, A. J. and G. Walter. Jun 2000. The Review and Analysis of Water Quality for the Nisqually River and the Major Lakes of the Nisqually River Basin. Nisqually Indian Tribe- Natural Resources Water Quality Program. Technical Report Number 6.
Nisqually Tribe unpublished water temperature data.
Other Studies
Easter, L. Cooke, W. B. Southerland, T. Dring, M. Schuller, and D. Brower. Aug 2000. Yelm Creek Thurston County Washington Inventory and Analysis Report. USDA, Natural Resources Conservation Service.
Jones and Stokes Associates. 1991. Watershed characteristics and conditions inventory. Upper Mashel River Watershed, Charley Creek Watershed. TFW-AM10-91-003.

TABLE 4-16
References Used for Stream Characterization

PCD (Pierce Conservation District). 2002. Nisqually Fish Passage Inventory Project. Unpublished Data. Pierce Conservation District, Puyallup, WA.
PCD (Pierce Conservation District). 2004. Nisqually River Basin Riparian Conditions Inventory. Pierce Conservation District, Puyallup, WA.
Sargent, K. and E. Salminen. 1996. Nisqually Resource Management Plan wetland inventory. Headwaters Environmental Consulting, Seattle, WA, Nisqually Indian Tribe, Washington Department of Ecology, Olympia, WA.
Walter, G. 1978. Environmental degradation of the Nisqually River drainage. Report prepared for the Nisqually Indian Tribe and the US Fish and Wildlife Service.

The following sections summarize the stream conditions in the Nisqually River and Estuary, Red Salmon Creek, Brighton Creek and Horn Creek, Tanwax Creek, Kreger Creek, Ohop Creek, and Mashel River.

Each section describes the aquatic and riparian habitat, including land use, stream channel hydrology, and fish usage, based on the Tribe's extensive field data and the other sources cited above.

Known fish distribution within the Nisqually River Basin planning area for chinook, chum, pink, coho, sockeye, steelhead and cutthroat are shown on Figures 4-17 through 4-23.

4.4.1 Nisqually River and Estuary

Important data concerning the Nisqually River mainstem include the following:

- Stream Length: > 78 miles
- Drainage Area: 761 miles^2
- Gradient: Low to High (mostly >3%)
- Location: Pierce, Thurston, and Lewis Counties
- Tributaries: Numerous, including Mashel R., Ohop Cr., Muck Cr.,
- Dominant Land use: Forestry/ Agriculture/ Rural Residential
- Salmon species present: Chinook, Coho, Chum, Cutthroat, Pink, Steelhead

Description and Land Use

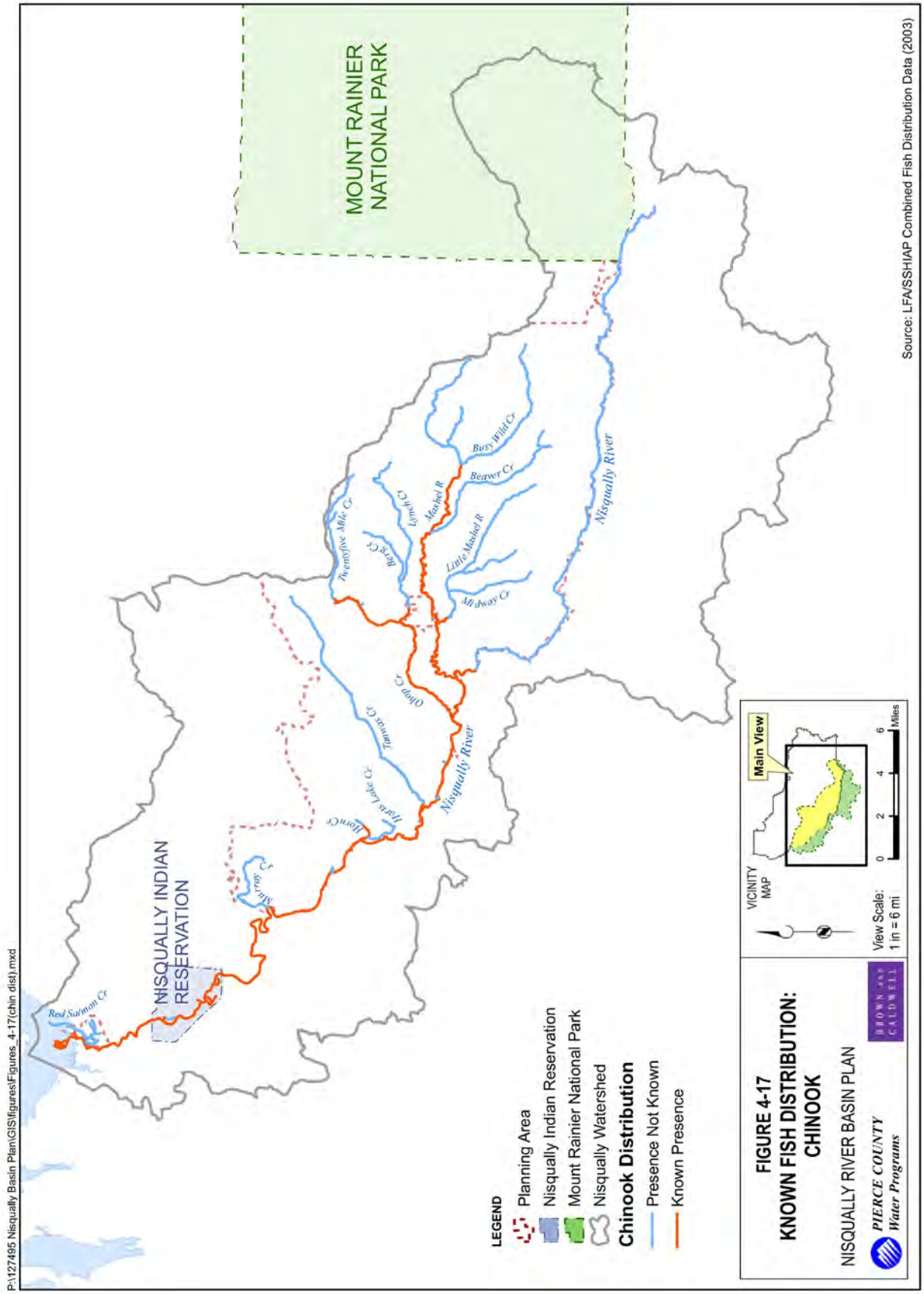
The Nisqually River originates from the Nisqually Glacier on the southern slope of Mount Rainier and flows west-northwest to meet salt water at the Nisqually Estuary in South Puget Sound.

River flows are determined primarily by rainfall, snow, and glacial melt. The LaGrande Canyon at river mile 42 divides the watershed into two distinct physiographic areas. Below the canyon, the watershed consists of low hills and prairie plains of glacial outwash. Above the canyon, volcanic rock and steeper mountainous terrain dominate the area. The canyon itself contains sheer cliffs extending upwards of 200 feet.

LaGrande Dam, operated by Tacoma Power at river mile 42.5 on the Nisqually River, is the likely upper extent of the historic distribution of anadromous salmonids in the Basin. LaGrande Dam definitely is the upstream limit of current anadromous fish usage in the Nisqually River today, so this section will only address the mainstem river below the dam.

Urban use in the Nisqually River Basin is much less than in other South Puget Sound rivers. The percent of land use in the lower Nisqually River Basin is summarized below (Watershed Professionals Network 2001):

- Agricultural 4%
- Forest 22%
- Forest/Prairie (military owned) 18%
- Parks/Open Space 2%
- Residential (medium - high density) 3%
- Rural/Residential 49%
- Urban/Commercial/Industrial 2%


MOUNT RAINIER NATIONAL PARK
NISQUALLY INDIAN RESERVATION
Red Salmon Cr
Mashel R
Busy Wild Cr
Beaver Cr
Little Mashel R
Midway Cr
Lynch Cr
Twentyfive Mile Cr
Bear Cr
Ohop Cr
Tanwax Cr
Alder Lake
Horn Cr
Nisqually River
Nisqually River
Source: LFA/SSHIAP Combined Fish Distribution Data (2003)
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
LEGEND
Planning Area
Nisqually Indian Reservation
Mount Rainier National Park
Nisqually Watershed
Chinook Distribution
Presence Not Known
Known Presence
FIGURE 4-17
KNOWN FISH DISTRIBUTION: CHINOOK
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
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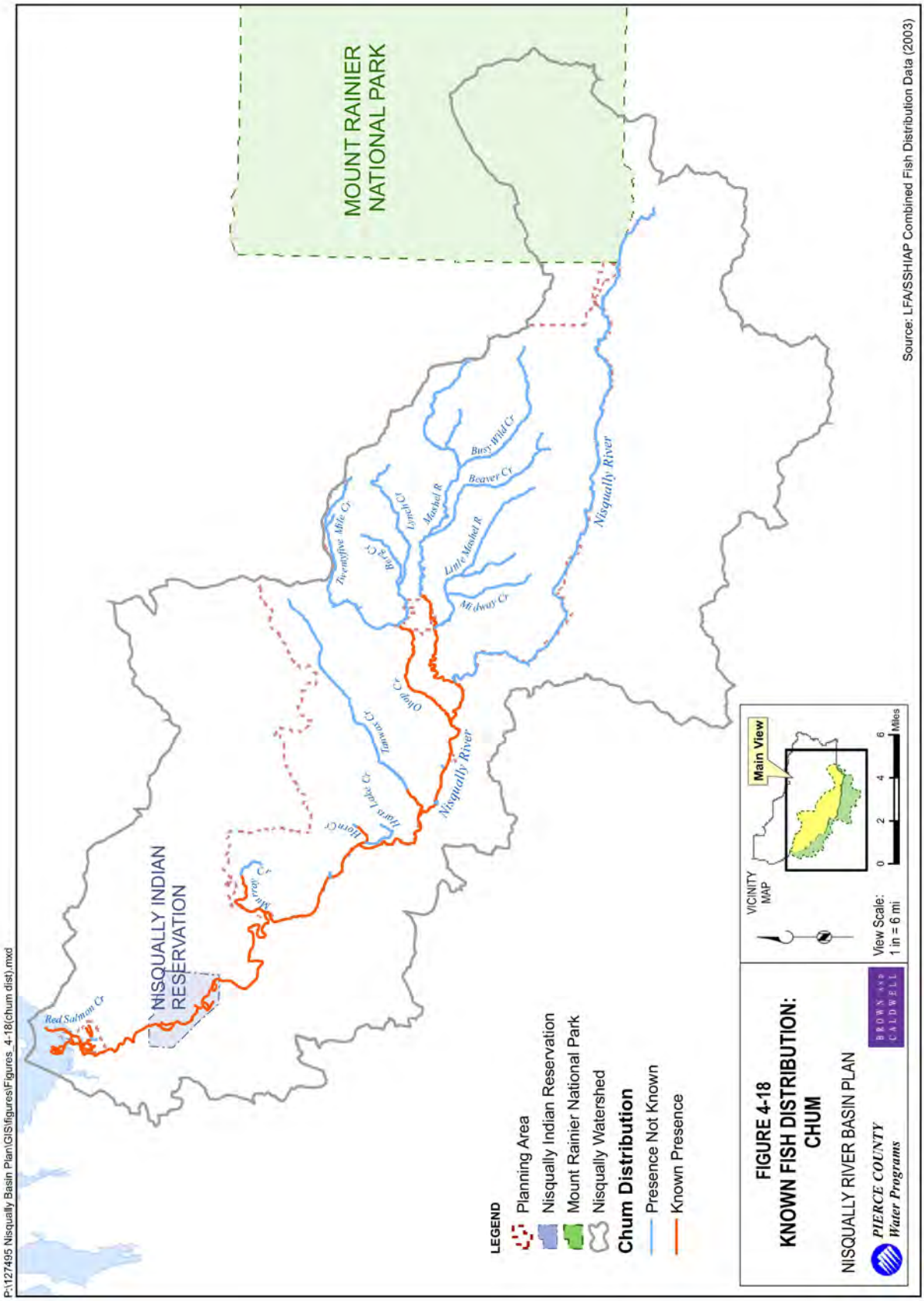
MOUNT RAINIER NATIONAL PARK
NISQUALLY INDIAN RESERVATION
Red Salmon Cr
Mashel R
Busy Wild Cr
Beaver Cr
Little Mashel R
Midway Cr
Twenty five Mile Cr
Ohop Cr
Tanwax Cr
Alder Lake
Nisqually River
Source: LFA/SSHIAP Combined Fish Distribution Data (2003)
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
LEGEND
Planning Area
Nisqually Indian Reservation
Mount Rainier National Park
Nisqually Watershed
Chum Distribution
Presence Not Known
Known Presence
FIGURE 4-18
KNOWN FISH DISTRIBUTION: CHUM
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
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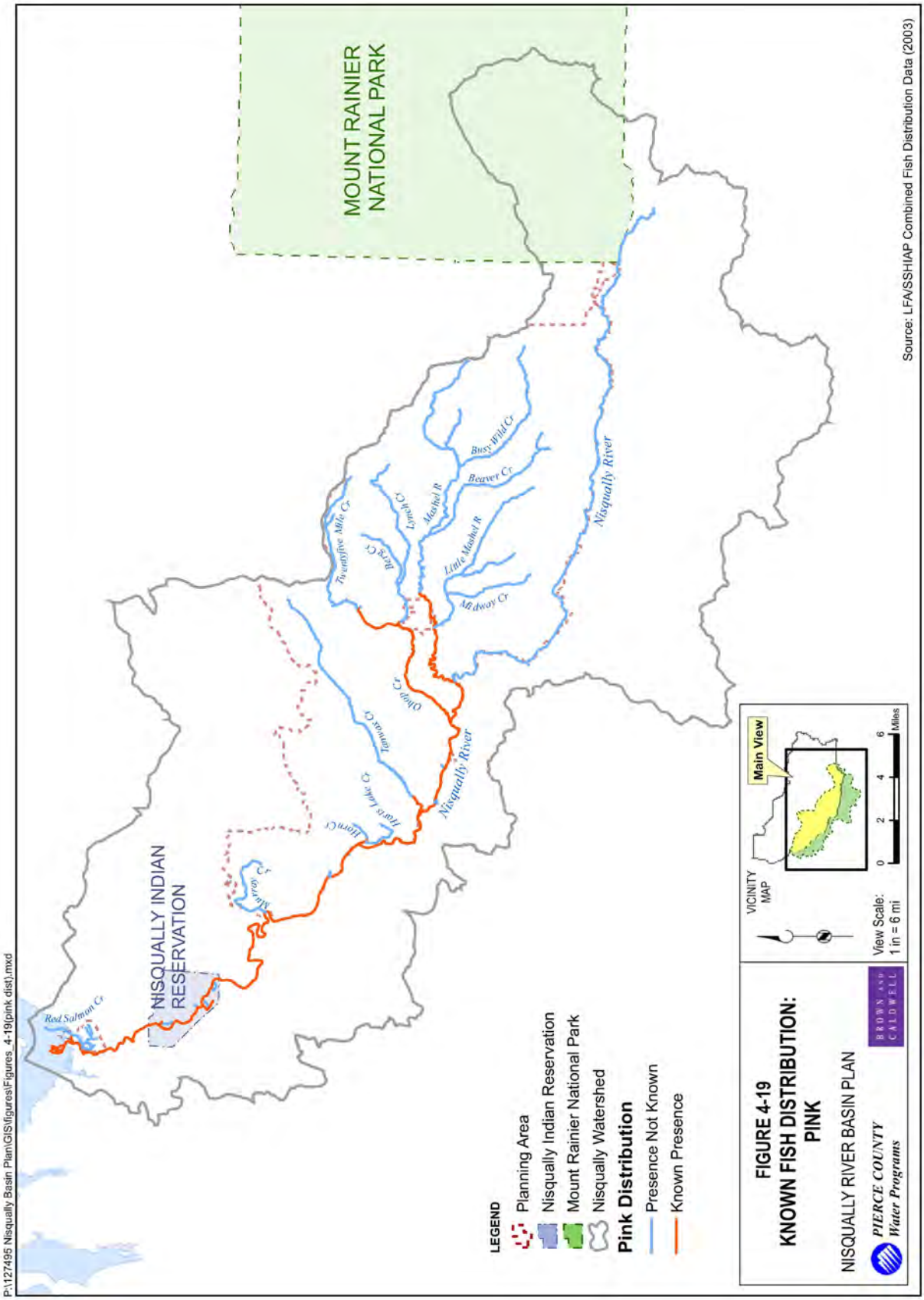
MOUNT RAINIER NATIONAL PARK
NISQUALLY INDIAN RESERVATION
Red Salmon Cr
Mashel R
Busy Wild Cr
Beaver Cr
Little Mashel R
Midway Cr
Nisqually River
Twenty-five Mile Cr
Lynch Cr
Ohop Cr
Tanwax Cr
Hart's Lake Cr
Horn Cr
Source: LFA/SSHIAP Combined Fish Distribution Data (2003)
LEGEND
Planning Area
Nisqually Indian Reservation
Mount Rainier National Park
Nisqually Watershed
Pink Distribution
Presence Not Known
Known Presence
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
FIGURE 4-19
KNOWN FISH DISTRIBUTION: PINK
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
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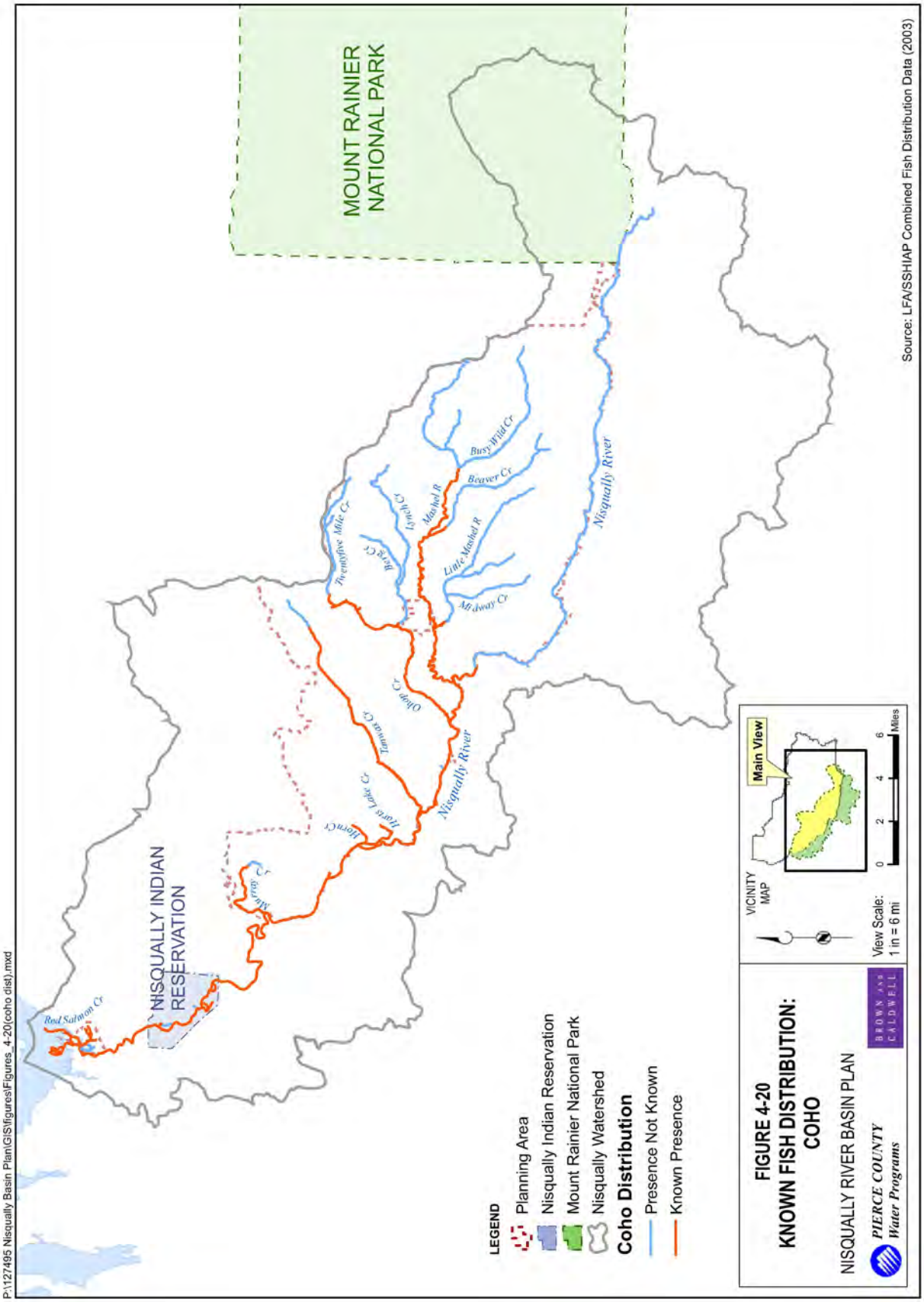
MOUNT RAINIER NATIONAL PARK
NISQUALLY INDIAN RESERVATION
Red Salmon Cr
Muddy Cr
Mill Cr
Ohop Cr
Alder Lake
Tanwax Cr
Nisqually River
Twenty-five Mile Cr
Busy Wild Cr
Beaver Cr
Lynch Cr
Mashel R
Little Mashed R
Midway Cr
Nisqually River
LEGEND
Planning Area
Nisqually Indian Reservation
Mount Rainier National Park
Nisqually Watershed
Coho Distribution
Presence Not Known
Known Presence
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
FIGURE 4-20
KNOWN FISH DISTRIBUTION: COHO
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
Source: LFA/SSHIAP Combined Fish Distribution Data (2003)
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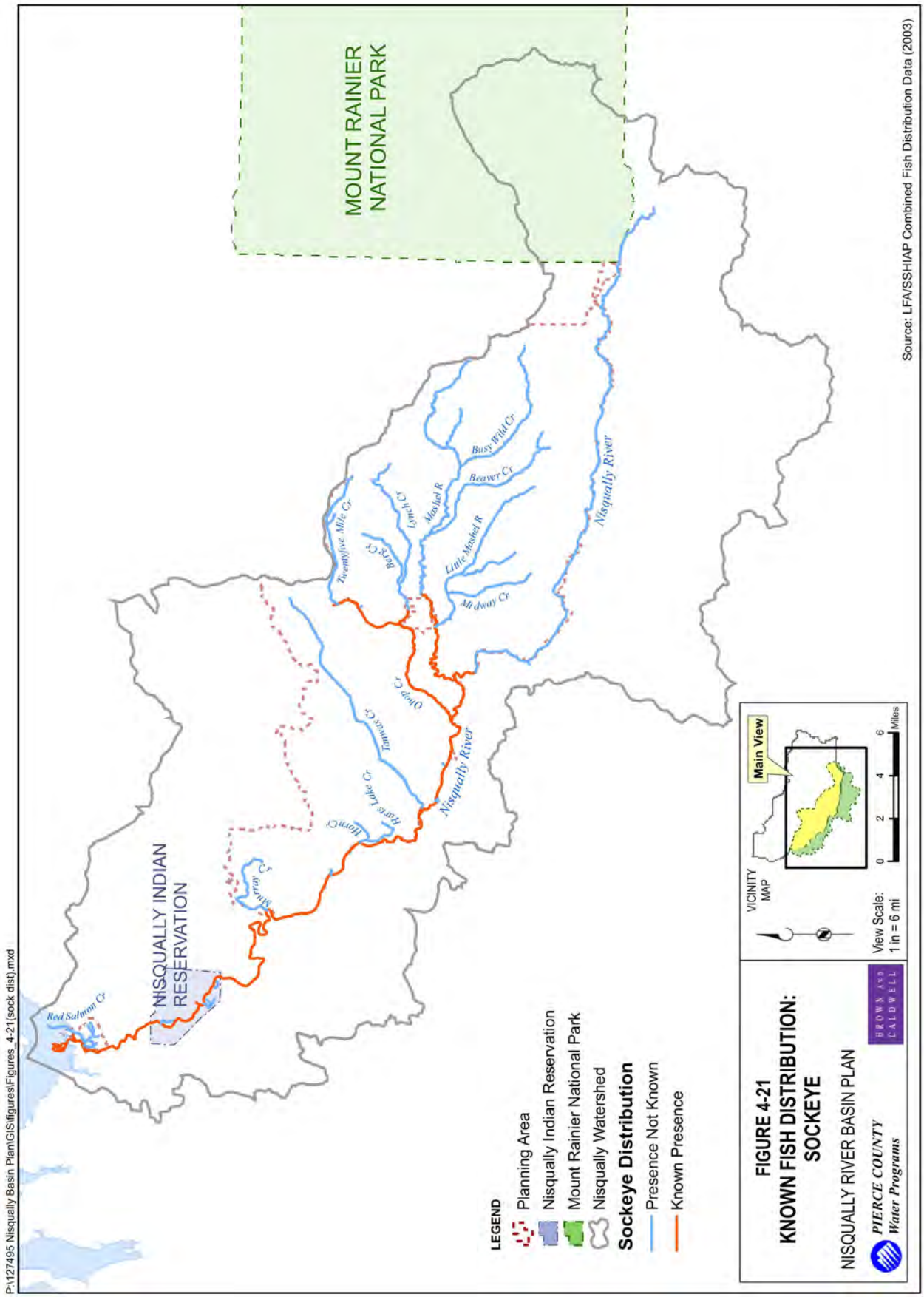
MOUNT RAINIER NATIONAL PARK
NISQUALLY INDIAN RESERVATION
Red Salmon Cr
Twentyfive Mile Cr
Busy Wild Cr
Beaver Cr
Mashel R
Little Mashel R
Alder Cr
Nisqually River
Source: LFA/SSHIAP Combined Fish Distribution Data (2003)
LEGEND
Planning Area
Nisqually Indian Reservation
Mount Rainier National Park
Nisqually Watershed
Sockeye Distribution
Presence Not Known
Known Presence
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
FIGURE 4-21
KNOWN FISH DISTRIBUTION: SOCKEYE
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
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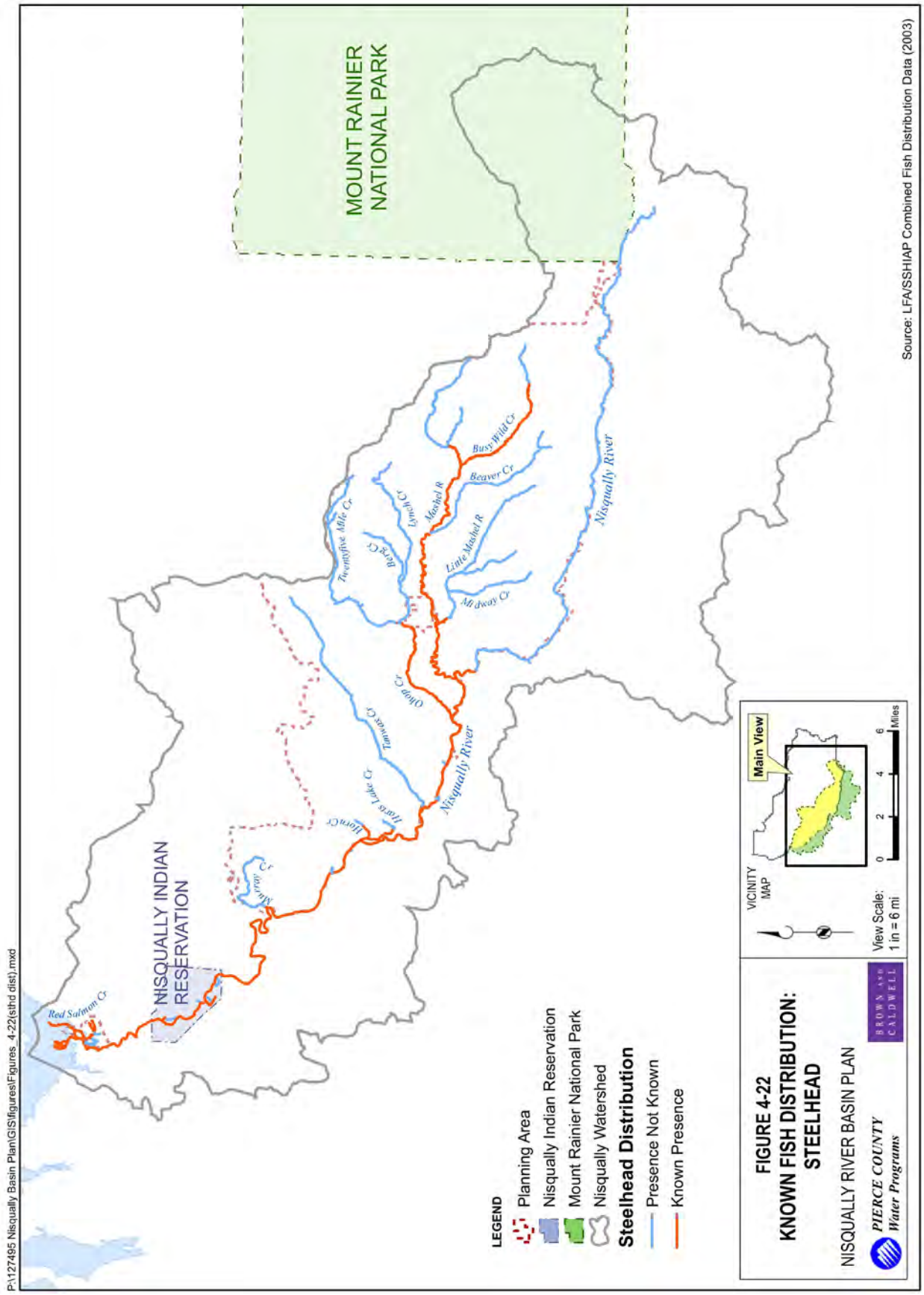
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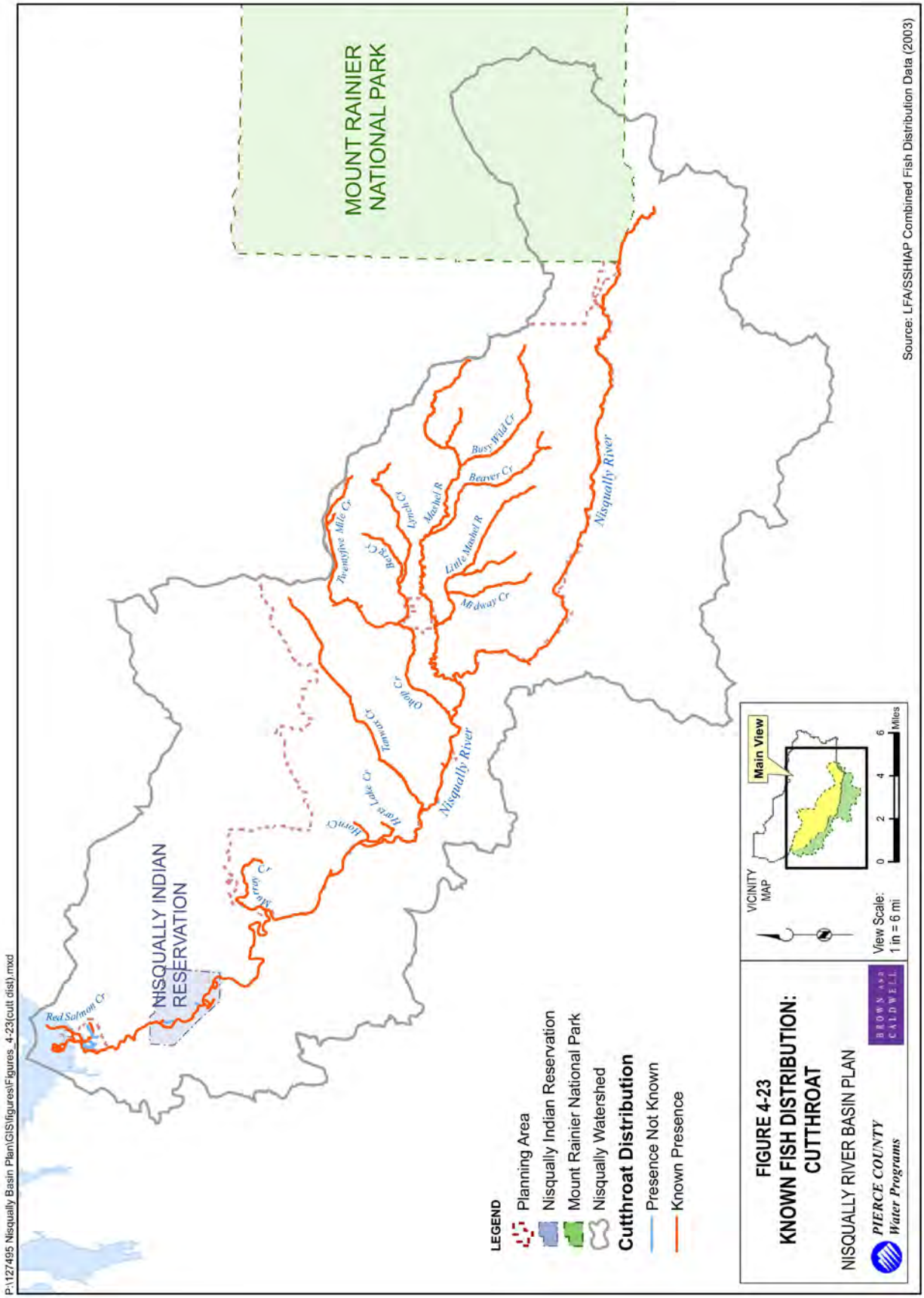
MOUNT RAINIER NATIONAL PARK
NISQUALLY INDIAN RESERVATION
Red Salmon Cr
Alder Cr
Mox Cr
Ohop Cr
Tanwax Cr
Twenty-five Mile Cr
Lynch Cr
Mashel R
Busy Wild Cr
Beaver Cr
Little Mashel R
Midway Cr
Nisqually River
LEGEND
Planning Area
Nisqually Indian Reservation
Mount Rainier National Park
Nisqually Watershed
Steelhead Distribution
Presence Not Known
Known Presence
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
FIGURE 4-22
KNOWN FISH DISTRIBUTION: STEELHEAD
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
Source: LFA/SSHIAP Combined Fish Distribution Data (2003)


MOUNT RAINIER NATIONAL PARK
NISQUALLY INDIAN RESERVATION
Red Salmon Cr
Alder Cr
Horn Cr
Hart Lake Cr
Tahoma Cr
Ohop Cr
Nisqually River
Twenty Five Mile Cr
Beaver Cr
Lynch Cr
Mashel R
Busy Wild Cr
Beaver Cr
Little Mashel R
Midway Cr
Nisqually River
LEGEND
Planning Area
Nisqually Indian Reservation
Mount Rainier National Park
Nisqually Watershed
Cutthroat Distribution
Presence Not Known
Known Presence
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
Source: LFA/SSHIAP Combined Fish Distribution Data (2003)
FIGURE 4-23
KNOWN FISH DISTRIBUTION: CUTTHROAT
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
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Stream Channel

The Nisqually River channel and hydrology is described in the following paragraphs and is divided into sections by river reach.

Estuary (from the river mouth to Interstate 5)

The Nisqually River channel enters Puget Sound at the Nisqually Estuary. Only near the mouth is the river able to freely meander over the delta fan. In the upper half of this reach, the river is confined to its present location by various bank hardening, flood control dikes, and the large Interstate 5 bridge and highway fill that maintain the river channel's present location. The flood control dikes in this area are part of an extensive system that was once used for the reclamation of land for agriculture. These dikes are now owned by the Nisqually Indian Tribe and are no longer maintained.

The channel increases in width substantially in the downstream portion of this reach, due to tidal backwater effects. Some limited side and distributary channels provide some channel network complexity. Much of the sediment and woody debris from upstream get deposited within this reach. The channel substrate is dominated by small gravel near the upstream end of the reach and slowly decreases in size to fine silts at the mouth and mudflats. Most woody debris settles in the lower half of this reach and the mudflat, and does not influence the channel development substantially.

Lower Reach (from Interstate 5 to BNSF railroad grade)

Between the Interstate 5 bridge and the Burlington Northern Santa Fe (BNSF) railroad bridge the river meanders through an open valley though the channel is confined along much of its right bank. Substantial bank hardening in the form of a riprap wall protects the properties along the left bank (Thurston County side), and bridges control the channel location in several places. The tide still has some limited influence on the river in this reach, and the gradient is low (approximately 0.1%). Large-woody debris (LWD) is fairly absent for this reach and mostly concentrated to the right bank due to extensive bank hardening and riparian forest removal along the left bank which prevents any wood recruitment and retention of wood from upstream sources.

Reservation Reaches (from BNSF railroad grade to Centralia powerhouse)

Upstream of the BNSF railroad bridge the river is allowed, with a few exceptions, to freely meander and occupy the entire valley. This reach of the river is one of the last best examples of a free flowing unaltered lowland Puget Sound river. The broad valley is consistently between 0.6 – 0.8 miles wide and includes many forms of side-channels, backwater sloughs, oxbows, and riverine wetlands. The river channel location has moved substantially back and forth as a result of large floods. This migration of the river channel helps to maintain these valuable off-channel wetland habitats. The river bottom material is gravel dominated and spawning areas are plentiful throughout this reach. The pool-riffle configuration is dominant in this low gradient reach (between 0.1 and 0.3%). LWD debris is common and primarily found in log jam accumulations. In this reach LWD and log jams are so frequent that it is believed that it almost

mimics historic condition. The frequent jams highly influence the location and shape of the river channel.

Whitewater Reaches (from Centralia powerhouse to Centralia diversion dam)

Most of this section of the river is confined in a canyon, with the valley only two times the width of the channel or less. Towering cliffs define the active channel in many areas. The gradient is higher than anywhere else along the mainstem Nisqually River downstream of the Mashel River (between 0.4 and 0.6%). Therefore the river bottom material is coarser than in most mainstem reaches, with many boulders and less of the smaller gravel material that is suitable for spawning salmonids. Most substantial spawning areas are found in the lower part of this section of the river. In the past, large wood jams were found in this reach, but currently LWD is only present in fair numbers and smaller accumulations. This has resulted in a significant decrease in habitat diversity in the reach. The reason for the lack of wood accumulation in this mostly undeveloped area is unknown, probably a combination of long lag time after past disturbance, riparian vegetation composition and recruitment rate.

McKenna Reaches (from Highway 507 to Centralia diversion dam)

The broad valley in this section of the river historically facilitated wide channel migration. In the lower half of this reach where the valley is over 2000ft wide on average, several remnant historic channels are still visible throughout the historic channel migration zone. Currently, however, the channel is confined and migration limited due to flood-control modifications, mostly on the left bank of the river. These modifications consist of bank protection and flood control dikes that have been constructed by various private landowners. The historic pool-riffle morphology is still present in some areas, but the channel lacks gravel bars in this low gradient channel (between 0.1 and 0.2%). In-channel boulders are common and make up a lot of the roughness in the channel, with large woody debris being relatively absent in this reach. Bank development and riparian forest removal along the left bank prevents LWD recruitment and retention of LWD from upstream sources. The diversion dam at the upstream end of this reach also prevents some wood from moving to downstream areas.

Wilcox Reaches (from Centralia diversion dam to Tanwax Creek)

The channel in these reaches still exhibits pool-riffle morphology throughout its length, although some channel constrictions have limited the channel migration. The valley in this section of the river is broad, but the channel has been confined by various channel modifications to both sides of the river such as riprap bank protection and flood control dikes. These modifications are not only intended to control flooding of private lands, but also prevent the river from bypassing the Centralia Diversion Dam. The modifications effectively keep much of the channel in the lower half of these reaches confined to only a portion of the valley. Side-channels, sloughs, connected oxbows, remnant channels and spawning areas still exist but their creation and maintenance has been compromised by the bank and channel modifications. The gradient in this reach is between 0.1 and 0.2%. Large woody debris is moderately abundant in this reach, plays an active role in channel maintenance, and provides essential roughness to the channel. LWD recruitment is somewhat limited by artificial bank hardening and constriction of the channel migration zone in the lower end of the reach.

Middle Reaches (from Tanwax Creek to Ohop Creek)

The river freely meanders through the entire width of the valley in this section of the river, with no or minute artificial restrictions to channel migration. The alluvial valley *(valley formed by and consistent of extensive cobble, gravel, sand and silt deposits transported by the river)* is similar to the valley in the Wilcox reaches (i.e. between 0.25 and 0.75 miles in width) but it includes and is allowed to create and maintain more oxbows and side channels than the downstream reaches. The stream exhibits mostly classic pool-riffle morphology with extensive gravel bars and plentiful spawning habitat. The gradient in this reach is between 0.2 and 0.3%. The channel is responsive to large woody debris, especially in larger wood jams, although wood is fairly scarce in most of these reaches. Only near the downstream end of this section of the river is wood more frequent, and there it plays a larger role in channel and habitat maintenance. The reason for the lack of wood accumulation in the mostly undeveloped upper part of the reach is unknown, probably a combination of long lag time after past disturbances (such as wood clearings, the large "Ohop slide" in 1990, and streamside logging) and natural wood recruitment rate. The Alder/LaGrande dam complex is located three miles upstream and it prevents any downstream passage of wood and might exaggerate the problem.

Upper Reaches (Ohop Creek to LaGrande Powerhouse)

Between the LaGrande Powerhouse (RM 40.8) and the confluence with Ohop Creek (RM 37.8) the Nisqually River flows through a confined valley with steep canyon walls. The one exception is near the mouth of the Mashel River where the valley opens up and side-channels, wood formed pools and gravel bars are found. Throughout much of the rest of this reach, pools are formed by the channel bedform and canyon walls and wood does not play a significant role in habitat creation. The gradient is 1.5%; hence the substrate is somewhat larger than in the rest of the system in this sediment transport reach. Gravel bars are very rare and spawning areas are limited to the channel margins and some pool tail-outs. In-stream LWD is fairly absent this transport reach, which does not retain wood easily and is most likely a natural occurrence due to the natural canyon and stream confinement.

Hydrology

Hydrology was studied extensively during licensing and relicensing of the two hydroelectric projects; the following hydrology and water quality information is excerpted from the Chinook Recovery Plan (NCRT 2001).

The major sources of water in the Nisqually River are rainfall, snow, and glacial melt. River flow is generally highest from November through February due to rainfall and rain-on-snow events. Although river flow is generally lowest during the late summer months (August-October), flows remain relatively high during summer because of glacial melt.

Fine sediment (rock flour) in glacial melt causes the river to run a milky green during the summer and early fall months. Flash flooding events occur in the upper Basin as a result of Jokulhlaups. A Jokulhlaups, or glacial burst, is a flash flood caused by glacial melt water collecting behind an ice dam and then being released suddenly as the dam collapses. In the Nisqually River, these flood events occur every 3 to 10 years. Each event results in large

deposits of sediment and debris in the mainstem of the upper Nisqually River. Historically, these flood events would have impacted the entire river to a much greater extent than they do today, adding significantly to the amount of fine sediment in the mainstem throughout its length.

Since construction of the Nisqually Hydroelectric Project in 1944 (Alder and LaGrande dams), glacial flour is not as evident in the lower river (river miles 0–42.5) due to the presence of Alder Reservoir. The reservoir stores the glacial melt throughout the summer. Consequently, water clarity in the lower river is much higher during the summer months than it was historically.

Some glacial flour settles out in the reservoir; the portion that remains suspended finally enters the lower river by September and is present throughout the fall and into the early winter. Furthermore, the Alder reservoir generally attenuates the worst sediment impacts of Jokulhlaups events.

A second hydroelectric project on the Nisqually River is operated by Centralia City Light. The Yelm Project diversion dam at river mile 26.2 diverts water into a canal that re-enters the Nisqually River at a powerhouse at river mile 12.7.

As a condition of its license from the Federal Energy Regulatory Commission (FERC), Tacoma Power is required to meet certain minimum flows downstream of the Nisqually Project (Alder and LaGrande dams). Tacoma Power is also required to provide water to meet a portion of Centralia's water rights at the Yelm Project Diversion Dam. As a result, flows in the lower Nisqually River often exceed the fisheries habitat minimum flow numbers required by the FERC license.

The average monthly river flow above and below the Nisqually Hydroelectric Project is approximately 1350 cfs. However, because this hydroelectric project is operated to capture annual snowmelt runoff, monthly spring flows are generally higher in the upper river than in the lower (Figure 4-24). In the summer, this trend is reversed between the two river reaches. Summer flows (August 1–September 30) below the LaGrande Powerhouse are managed for a minimum flow of 575 cfs (measured at the Centralia Diversion Dam) (FERC 1994).

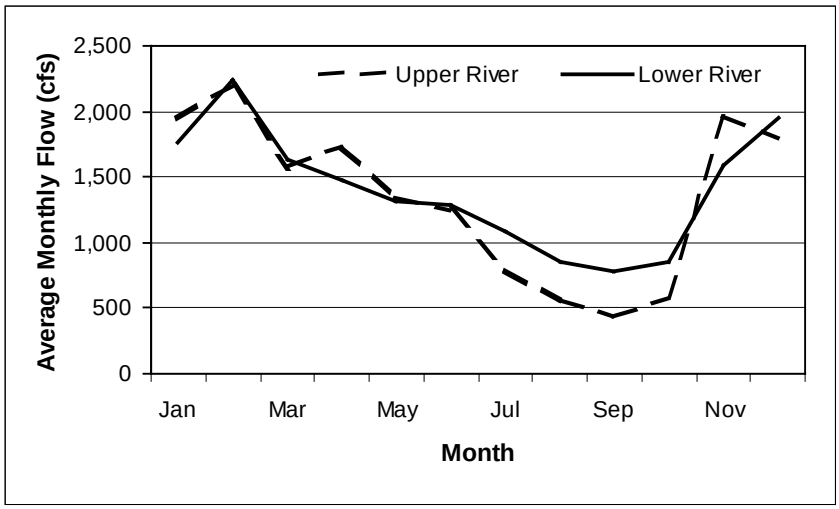

Figure 4-24. Average Monthly Flows in the Upper and Lower Nisqually River

The Nisqually Hydroelectric Project has had an even more pronounced effect on peak flows in the lower river, as can be seen from the data presented in Figure 4-25. The data indicate that monthly peak flows have been reduced in virtually all months due to project operations.

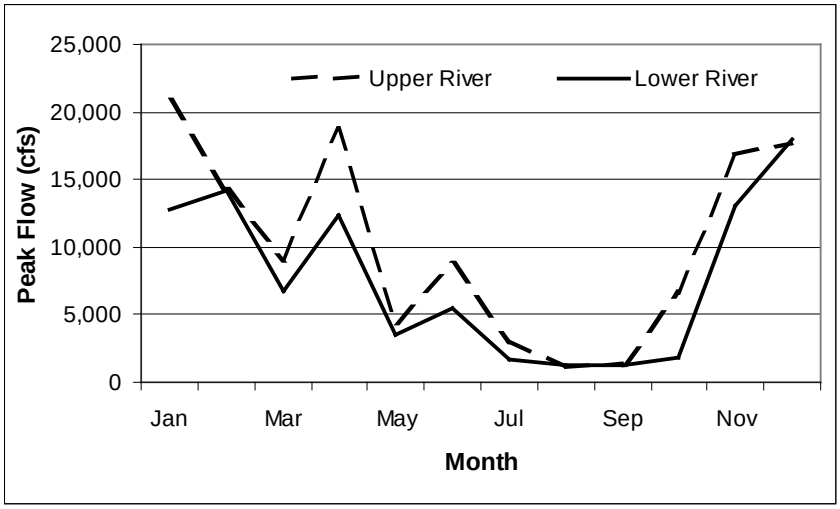

Figure 4-25. Average Peak Flow by Month in the Upper and Lower Nisqually River

The Nisqually River is designated by Washington State Department of Ecology as a Class AA stream (extraordinary water quality) above the Alder-LaGrande Hydroelectric Project (RM 44.2) and a Class A stream (excellent water quality) below RM 44.2. Most of the major tributaries to the Nisqually in the lower Basin are designated as Class A streams. A recent water quality study conducted by the Nisqually Tribe (Whiley and Walter 2000) suggests that water quality in the river meets the Class AA and Class A standards most of the time. Elevated water temperatures were detected in the Centralia Diversion bypass reach of the mainstem but they did not chronically exceed the Washington state water quality standards. The study recommends further monitoring of temperature in areas of concern as well as expanded research on nutrient concentrations and their relationship to land use activities.

Fish Usage and Introductions

The Nisqually River mainstem is utilized extensively by multiple salmon species for spawning and rearing, and as a migration corridor. A large portion of the spawning of chinook, pink salmon, and steelhead trout in the watershed occurs in the Nisqually mainstem. Coho, chum salmon and cutthroat trout also spawn in the mainstem Nisqually River.

Chum salmon spawn heavily in the mainstem primarily below the Centralia Diversion Dam at river mile 26.2, but some do pass upstream of this dam via the fish ladder. Resident rainbow and cutthroat trout are found throughout the mainstem Nisqually River. Other native species such as sculpin and three-spine stickleback can be found throughout the Basin.

Non-native species such as bass and pumpkinseed are present in the Nisqually mainstem, and other non-natives such as bluegill, brook trout, catfish, kokanee and yellow perch are present in

lakes of tributaries or above LaGrande Dam, and are likely present in the mainstem Nisqually River as well.

The distribution and abundance in the Nisqually River of non-salmonid fish species (both native and introduced) is not well known or well documented.

Bull trout are no longer present in the freshwater portion of the Nisqually watershed; however, the Estuary is believed to be a potential forage area for Puyallup River bull trout. One potential bull trout sighting has been reported in the Nisqually Estuary recently.

Habitat Alterations

Although much of the mainstem Nisqually is still in very good condition and is primarily in need of protection, there have been some human caused impacts to habitat. Major habitat alterations that have occurred in the mainstem Nisqually River include:

- Loss of large trees along the river banks and large wood in the river
- Decreased channel complexity and increased channel confinement
- Loss of estuary habitat
- Changes in flow and sediment regimes
- Reduced streamside vegetation buffers
- Reduced off-channel habitat

Agriculture and Rural Residential Development

Compared to neighboring watersheds, the Nisqually river Basin has experienced low development pressure in most of its subbasins, except the McAllister, Yelm and Muck Creek subbasins. Some significant rural development has occurred along the mainstem in the Lower and McKenna reaches. Agricultural development mostly occurred along the McKenna and Wilcox reaches, and near the mouth of Powell Creek (river mile 31.9) in the Middle Reach. These developments have affected salmonid habitat of the Nisqually River by altering the river, the banks, the valley and the watershed. This includes riparian removal and clearing, encroachment into the floodplain and channel migration zone, bank hardening, simplifying the off-channel refuge network, and other changes.

Reduction of Riparian Habitat

Changes in the riparian habitat along the Nisqually River and in its floodplain have dramatically affected salmon habitat. Many riparian forests were cleared and are now either converted to non-forest areas or are in a recovery state, dominated by younger hardwoods. With these changes came a reduction in the amount of shade, large-woody debris, bank stabilization, and run-off filtration. In turn this had the potential to increase stream temperature, reduce in-stream wood, increase bank erosion where bank stability was reduced, and increase direct run-off.

Wood Removal

In addition to reduction in sources of large wood for the river channel due to timber harvest, wood was actively removed from the channel to aid navigation, trade, and reduce localized flooding. Although the Nisqually River never had a systematic wood removal program earlier

this century, such as to aid navigation in the Snohomish or Skagit River, it reasonable to assume that localized wood removal took place in many areas, especially in the McKenna and Lower reaches. Some of this wood clearing, now illegal, is still continuing today, mostly near residences. The river historically was used to float logs and wood downstream, hence it is reasonable to assume that some clearing of log jams took place to facilitate passage. No documentation of old splash dams on the Nisqually River has been found.

Estuary Habitat Reduction

Conversion of estuary habitat to diked agricultural land in the late 1800's and early 1900's profoundly altered salmon habitat in the Nisqually River Basin. This loss has resulted in the greatest impact to habitat for Nisqually salmon in the entire watershed. The estuary lost almost 50% of its former total area mostly due to the diking of salt marsh areas and conversion to pastures.

The historic estuary habitat has been classified into four different habitat types: forested riverine tidal, transition (between salt and fresh), salt marsh, and mudflat/ delta and some areas have been more affected than others. The mudflat areas have not changed considerably, but more than 75% of the former salt marshes and associated tidal channels have been lost. The fill associated with Interstate-5 also resulted in a reduction in estuary habitat and functions, as well as the loss of distributary channels. Over 60% of the transition estuary habitat type has been lost, mostly due to fill for the highway.

Hydropower Development

As discussed in Section 4.3, there are two major hydropower projects are located along the Nisqually River: City of Tacoma's Nisqually Project (two dams, Alder and LaGrande, and a major reservoir) and City of Centralia's Yelm Project. Both projects now operate under minimum flow agreements and operate with set ramping rates.

Due to the Basin geology, tributary flow below the Alder/LaGrande project only contributes a small portion of the mainstem discharge, especially in the summer months. Therefore the majority of the flow in the mainstem Nisqually is dependent on hydropower project operations. As outlined in the Hydrology and Water Quality section, the dam operation likely has softened the low flows and high flow peaks in the hydrographs and therefore has decreased the direct negative effects on fish by those low flows and peaks.

The FERC license minimum flows requirements have substantially increased the available rearing habitat during summer low flow periods. They also have reduced the impacts of occasional winter droughts and the resulting low natural flows. The impacts on salmon habitat of dam operations and high flow peaks are less straightforward. The reduction of those peaks may have lessened flood induced channel migration and hence the ability of the river to maintain its salmon habitat.

The Alder/LaGrande project stores all but the finest sediment and all large woody debris recruited from the upper Nisqually watershed in Alder reservoir. This has eliminated the natural transport of gravel and wood beyond the project, and all recruitment for salmon habitat now occurs locally below the dams.

The transport of sediment from the upper Nisqually River, except the finest suspended, i.e. glacial flour, is interrupted by storage in the Nisqually Project's Alder reservoir. Suspended glacial flour still moves through the project, but its occurrence downstream is delayed by several months and may be likely prolonged in occurrence as a result of reservoir storage. This sediment is most likely too fine to negatively influence salmonids, especially during the incubation period. Fine sediment that is capable to entomb salmon redds now only originates from tributaries, especially the Mashel River, and local bank erosion. It is unknown whether or not the current fine sediment load from tributaries plus potentially increased recruitment from bank erosion and others in the mainstem is equal to, less than, or exceeds historic fine sediment conditions and, if so, what impacts that change may have on salmonid productivity.

Alder reservoir prevents any upstream coarse sediment from reaching potential spawning grounds below the hydroelectric project. However, local geology is conducive to major contribution of coarse sediment immediately below the project and that local contribution may off-set somewhat the negative impacts to salmonid habitat from the coarse sediment loss from upstream. If there is a coarse sediment deficiency, this is probably limited to the first few miles below the project.

Further downstream, significant bank erosion has occurred, but it is unclear whether this bank erosion has significantly balanced the sediment budget, especially downstream of the mouth of Ohop Creek (Smith, 1994). Localized coarse sediment deficiencies exist, due to hydro-modification such as bank hardenings that cause bed load coarsening. The lower Wilcox reach, the McKenna reach, and the Lower Nisqually reach are the only reaches that include extensive bank hardening modifications that could affect the sediment and therefore the spawning environment.

The Yelm Project lets all entrained sediment pass its dam, but wood has occasionally been observed to settle at the dam where it becomes trapped and destroyed in the hydraulic pressure of the "keeper hydraulic currents".

The Alder/LaGrande dams sit in a deep gorge where the gradient is high and cascades are the main bedform. It is reasonable to presume that the cascades or a waterfall eliminated any historical passage of anadromous fish past the gorge into the upper watershed. Therefore no artificial adult or juvenile fish passage exists at the dams. The Yelm project includes an adult fish ladder for upstream migration, although some passage over the dam is assumed by some salmonids. Downstream migration is provided over the dam and, to eliminate any diversion into the canal, an elaborate fish screen and by-pass tunnel was constructed for juvenile fish in 1998.

River Diking and Loss of Meander Zone

As described in the Stream Channel section, the river has been diked and the banks have been hardened in some river reaches. This negatively affected many elements of the in-stream and off-channel habitat. The dikes and other structures redirect the river and eliminate creation of new off-channel habitat and channel complexity by limiting meander cut-offs, other channel abandonment, and side-channel development.

These channel modifications also reduce the active channel migration zone and the potential for recruitment of large wood debris in the floodplain. Structures that are meant to keep the river in one place also keep and increase erosive forces inside the channel which slowly downgrades leading to a loss of in-stream habitat. Often these structures are riprap walls which are also not favorable to healthy riparian forest.

Barriers

The Centralia Diversion Dam at Nisqually river mile 26.2 has a ladder for upstream fish passage, and a juvenile bypass system for preventing juvenile migrants from getting into the canal. The dam and fish ladder are assumed to impede fish passage, especially for chum salmon, to a small extent but adult fish are regularly seen passing up the ladder. Upstream passage delay at the ladder has not been intensively examined.

4.4.2 Red Salmon Creek

Important data concerning Red Salmon Creek include the following:

- Stream length: >1 mile
- Drainage area: 5.1 square miles
- Gradient: Low to medium
- Location: Pierce County, west of the City of Dupont
- Tributaries: Washburn Creek, Interstate 5 wetland
- Dominant land use: Residential/ Agricultural
- Salmon species present: Chinook, Coho, Chum, Cutthroat, Pink, Steelhead
- Alternate creek name: Red Salmon Creek is also known as Mounts Creek
- Major habitat issues: Increase in impervious surfaces, loss of riparian forests, uncontrolled livestock access.

Description and Land Use

Red Salmon Creek is a short, low elevation (0 to 360 feet), independent stream that drains directly into Red Salmon Slough, which is tidally influenced and part of the Nisqually River estuary. This section only addresses the freshwater areas of the creek. (Refer to the mainstem Nisqually section for descriptions of the intertidal areas). Land use in this small subbasin is mostly residential with some agricultural use. A large golf course is located at the headwaters of the creek. Most areas in the lower part of the creek are in protective ownership. Cattle graze intermittently in Red Salmon Creek floodplain and estuary.

Stream Channel and Hydrology

Above the zone of tidal influence, Red Salmon Creek is very shallow. It is broad near the mouth and deeper and narrower near the headwaters. Pool habitat is limited, but spawning habitat is plentiful. Springs feed Red Salmon Creek (at a pond at the headwaters) and its main tributary, Washburn Creek. A large wetland between the Interstate 5 southbound and northbound lanes also drains to the creek at a confluence within the intertidal salt marsh area. This wetland is

also spring fed and receives constant and year-round flow. Several tide gates keep the tide from entering the wetland.

Fish Usage and Introductions

All species of salmon have been found in the intertidal areas of Red Salmon Creek, but only sea-run cutthroat trout, coho, and chum salmon spawn in the creek. Winter chum salmon are the most prevalent species, with several hundred fish returning to the creek each year to spawn.

Habitat Alterations

Major habitat alterations that have occurred in the Red Salmon subbasin include:

- Removal of trees (source of large in-stream woody debris) and other streamside and overhanging vegetation
- Alterations of creek channel and confinement, draining of wetlands
- Removal of beavers and beaver dams
- Use of streamside areas as pasture with unrestricted grazing
- Degradation of water quality (nutrient enrichment from human activities)
- Somewhat accentuated high flows

Agriculture

Several settlers established farms in the general vicinity of this subbasin over 100 years ago. With the establishment of agriculture, wetlands were cleared of woody vegetation and beaver dams, drained, and ditched. This effectively eliminated a large amount of rearing habitat for several species of salmonids. In many cases, farm waste entered the stream either through run-off or directly from livestock with access to the creek. Livestock access to the creek has damaged the creek channels. Beaver populations and woody vegetation are still controlled by the landowners to keep the fields in high agricultural production. Only one farm is still being operated today.

Residential Development

The stormwater run-off from the increasing residential communities and the golf course drain to Washburn and Red Salmon Creeks. This has altered the run-off regime of the creek, making it more 'flashy' after winter storms. This can lead to increased bank and channel erosion in the winter.

Barriers

The construction of the Interstate 5 lanes converted what was a tributary of Red Salmon Creek to the extensive wetlands that exist now between the I-5 lanes. Whether this tributary had been man-made and how much the area had historically been a wetland is unknown. The culverts under the southbound lanes of Interstate 5 and the series of tide gates are partial fish blockages that effectively keep juvenile salmon from migrating into these functional wetlands.

4.4.3 Brighton Creek and Horn Creek

Important data concerning Brighton and Horn Creeks include the following:

- Stream length: Brighton Creek is 2 to 4 miles long (note that Brighton and Murray creeks drain from a common wetland area and references differ on which way the areas above the wetlands drain), Horn Cr. length is >5 miles.
- Drainage area: Brighton square miles, Horn 19 square miles
- Gradient: Low
- Location: Pierce County near McKenna
- Tributaries: Harts Creek is a tributary of Horn Creek
- Lakes: Harts Lake
- Dominant land use: Agriculture/ Rural Residential/ Timber Production
- Salmon species present: Chinook, coho, chum, cutthroat, pink, steelhead

Description and Land Use

Brighton Creek and Horn Creek are two right bank tributaries to the Nisqually River, McKenna reaches, at river mile 23.6 and 25.8, respectively. The subbasins are at low elevation, ranging from 320 feet at the mouth of Brighton Creek to 720 feet at the headwaters of Horn Creek. Both subbasins have a mix of land use, including mixed use agriculture, rural residential, and timber production. The subbasin of Harts Creek, a tributary of Horn Creek, incorporates Wilcox Farms, a large, industrial agricultural operation.

Stream Channel and Hydrology

Both creeks exhibit rather extensive wetlands near their mouths, some of which provide good off-channel habitat for over-wintering juvenile salmonids.

Above the wetlands, the creeks cut through the canyon walls of the Nisqually valley, through which the creeks become fairly steep (<8% gradient). Horn Creek has a waterfall at river mile 1.0 that is several feet high, is a serious barrier to fish passage, and was formed as a result of a dam that was built in the creek for an old mill operation. Upstream of the high gradient sections, the low gradient channels alternate with a pool/riffle channel morphology type and some wetlands. Both creeks flow year-round, with mean winter month flow between 5 to 10 cubic feet per second (cfs) and mean summer month flow between 3 and 5 cfs. The creeks are fed by several wetlands and by springs in the headwater areas, and Horn Creek is fed by Harts Lake (109 -acres).

Harts Creek, the outlet of Harts Lake, is being used for irrigation in the summer months. The exact divide between the Brighton and Murray Creek subbasins is somewhat unclear due to human manipulations of the channel and the relatively flat topography between the two basins. The location of the divide may also depend on flow manipulations, especially by beavers.

Fish Usage and Introductions

Coho and chum salmon are the primary anadromous species in these creeks. Occasional fall Chinook salmon, pink salmon, and winter steelhead trout are found spawning in the Lower Horn and Lower Brighton reaches. The waterfall below Harts Lake Loop Road on Horn Creek

(river mile 1.0) was made somewhat passable by a South Puget Sound Salmon Enhancement Group project in the 1990s that created some steps into the falls, but it is still a problem for fish passage. Only steelhead trout, coho salmon, and resident fish can be found above this partial barrier in the Upper Horn reach.

A poorly installed culvert under Harts Lake Loop Road, combined with a high gradient section of the creek, prohibits any passage of anadromous fish into most of the subbasin of Brighton Creek. Very little spawning habitat can be found below this culvert, but a large wetland near the mouth of the creek allows refuge for a variety of anadromous species from Brighton Creek and the Nisqually River mainstem.

For several decades, coho fry were stocked heavily above the falls on Horn Creek, but this practice has been abandoned. The Washington Department of Fish and Wildlife annually stocks Harts Lake with rainbow trout for recreational fisheries. Exotic, warm water species such as bass are very prolific and prevalent in Harts Lake.

Habitat Alteration

Major habitat alterations that have occurred in the Brighton and Horn subbasins include:

- Access to upstream habitat is blocked by impassable or only partially passable culverts and other barriers
- Decrease of large wood in the creek
- Removal of streamside and overhanging vegetation, including standing trees that would have provided a source of large wood and shade
- Excess fine sediments in the water
- Channelization and ditching of the creeks
- Decrease in the number of salmon returning (lowers nutrient input and food available for juveniles)
- Draining of wetlands

Timber Harvest Activities and Timber Land Conversion

As with most of the lower Nisqually River Watershed, the Horn and Brighton Creek subbasins were deforested in the late 1800's or early 1900's. Many areas, especially along Highway 702, were taken out of timber production and converted to agriculture.

The remaining areas are now in their third rotation of timber harvest, after which many are now being converted to small residential lots. Reduction of overhanging streamside vegetation, fewer pieces of large wood in the stream, and increased bank erosion were the earliest impacts of the timber harvest activities.

With this also came an increase of in-stream sediment and water temperature. Many areas have not recovered from these past impacts. Harvest activities and recent development of residential areas have both contributed to an extensive network of roads. Road crossings are a problem in these watersheds, impacting fish passage and increasing sediment input and storm water run-off.

Agriculture

Several areas in both the Horn and Brighton Creek subbasins are dominated by agricultural land use, including Wilcox Farms at the mouth of Horn Creek, the valley between 8th Ave S. and Harts Lake Rd., and the areas around highway 702.

In all of these areas, the creek and associated wetlands have been ditched, channelized, and cleared of streambank vegetation and in-stream wood. Ditching has effectively connected the headwater wetlands of Brighton Creek to the headwater wetlands of Murray Creek, a neighboring independent tributary to the Nisqually River.

Livestock have access to several areas in these sections, which damage the stream banks and the channel, increases sedimentation, and increases levels of nutrients in the water to unnatural amounts.

Culverts and Other Passage Barriers

There are major barriers to fish passage on both Horn and Brighton Creeks. On Brighton Creek, a culvert under Harts Lake Loop Rd., only a half mile upstream of the mouth of the creek, completely blocks passage of fish upstream. On Horn Creek, a man-made waterfall at river mile 1.0 severely limits upstream migration of salmon. There are other barriers, some partial and some complete, upstream of these major barriers. In Harts Creek, there are several dams that collect water for summer-time irrigation which might hinder upstream movement of fish substantially. Other irrigation diversions in other areas are conceivable but unknown.

In addition to these barriers, several natural barriers such as beaver dams and intermittent flow reaches might pose passage barriers to fish as well.

Brighton Creek Barriers

1) Harts Lake Loop Rd. culvert, river mile 0.5, total barrier
2) Private culvert, river mile 0.7, 33% passable
3) 62nd Ave S. culvert, river mile 0.9, 67% passable
4) Highway 702 culvert, river mile 4.2, total barrier

Horn Creek Barriers

1) Waterfall at river mile 1.0 (below Harts Lake Loop Road) is a partial barrier and has a ladder that presumably allows some fish by (coho and steelhead) but is known to block most or all chum, pink, chinook and cutthroat passage. This waterfall is the result of a dam built years ago that has led to scouring below the dam and trapping of sediment above it.
2) Harts Lake Loop Road culvert, river mile 1.2, 33% passable.
3) 368th St. S. culvert, river mile 2.5 is a total barrier
4) Private culvert at river mile 3.9, 0% passable

Harts Creek Barriers

1) Private culvert, Harts Cr. river mile 0.2, on Wilcox farm, 67% passable.
2) Harts Lake Valley Rd. culvert at Harts Cr. river mile 1.2 is a total barrier.
3) Harts Cr. private culvert, Harts Cr. river mile 1.3, 67% passable.

4.4.4 Murray Creek

Important data concerning Murray Creek include the following:

- Stream length: 12.25 miles (note that Brighton and Murray creeks drain from a common wetland area and references differ on which way the areas above the wetlands drain)
- Drainage area: 16.4 square miles
- Gradient: Low
- Location: Thurston and Pierce Counties, near Yelm
- Dominant land use: Rural Residential/ Agricultural/ Industrial
- Salmon species present: Chinook, Coho, Chum, Cutthroat, Pink, Steelhead
- Alternate creek name: Murray Creek is also known as Graiville Creek
- Major habitat issues: Alteration of wetlands/channelization of creeks, fish passage problems, reduction in riparian forests

Description and Land Use

Murray Creek drains from prairies which are defined by their unique vegetation (not dominated by coniferous trees, unlike most areas in western Washington) and by their very porous soils. Creeks flowing over these porous, glacial outwash soils are highly connected to groundwater and therefore often have long intermittent stream reaches.

Murray Creek is a right bank tributary in the diversion reach of the Nisqually River and empties into the river at river mile 19.1. The elevation range in the subbasin is small, ranging from 240 to 440 feet. Land use in the subbasin is a mix of rural residences and agriculture, with one large industrial gravel mine operated by Miles Sand and Gravel.

Stream Channel and Hydrology

Murray Creek is a low gradient creek throughout its course. Due to the unique hydrology of prairie streams, the stream channel is less dynamic than typical western Washington creek channels. Lateral channel movement happens extremely slowly, and any manipulations of the channel are permanent and slow to naturally recover. Stream flow is highly connected to and dependent on the groundwater of the subbasin. Only the lower mile of the creek near the mouth flows year-round, due to the presence of springs in that area.

Most upstream areas, except where channels were created in otherwise stagnant wetlands, go dry every year, and do not start flowing until late fall or early winter after significant groundwater recharge has occurred.

The Murray Creek Subbasin includes an unnamed 15 acre lake downstream of Highway 507. The exact divide between the Murray Creek and the Brighton Creek subbasins is somewhat unclear due to human manipulations of the channel. The location of the divide may also depend on flow manipulations, especially by beavers.

Fish Usage and Introductions

Winter chum salmon are the primary anadromous species in Murray Creek, while occasionally fall Chinook salmon, pink salmon, coho salmon, and winter steelhead trout are found spawning in the lower part of the creek near the mouth. Fish usage and distribution in Murray Creek is highly dependent on flow.

Due to the intermittent nature of the creek, in some years the creek is dry during the salmon spawning season upstream of the Lower Murray reach (near the railroad crossing at river mile 0.4 downstream of Miles Sand and Gravel). The creek generally has several dozen spawning chum in years when the creek is not flowing above the Lower Murray reach.

In years with adequate flow in the Upper Murray reach, several hundred chum salmon have been observed migrating upstream of Highway 507.

Habitat Alterations

Major habitat alterations that have occurred in the Murray Creek Subbasin include:

- Decrease of large wood in the creek
- Removal of streamside and overhanging vegetation, including standing trees that would have provided a source of large wood and shade
- Excess fine sediment input
- Ditching and channelization of the creek and its tributaries
- Unrestricted grazing along streams and wetlands
- Water diversions
- Changed run-off and groundwater hydrology due to development of the subbasin
- Introduction of invasive plants such as reed canary grass
- Draining of wetlands

Agricultural, Residential, and Commercial Development

Since most of the Murray Creek subbasin is a prairie-type ecosystem that never had significantly large stands of forest, deforestation and timber harvest have not had a large impact on the creek. However, some of the few trees that were growing along the creek were removed to make way for agricultural and residential development. In many areas, the channel has been cleared of vital woody debris, and in some reaches, the creek has been ditched and channelized. In some reaches livestock have been given free access to the creek, which damages the stream banks and the channel and increases sedimentation and nutrient loading.

Many sections of the headwater reaches of Murray Creek have been severely altered to control flooding. The creek is highly dependent on groundwater for its flow, and withdrawals and manipulations of the groundwater in the subbasin have occurred in the past and are increasing. These activities might have a tremendous effect on the flow patterns in the creek and therefore could greatly affect salmon usage of the creek. Upstream of Highway 507, small water

diversions have been used to create private ponds for recreational use. How these ponds affect the system is unclear.

Wetland and Stream Plant Invasion

With the advent of land clearing for agriculture and development came invasive plant species. Ground disturbance and sedimentation of streamside areas, especially in wetlands and lowland pastures, have led to an explosion of invasive plant species, including reed canary grass, Scotch broom, and Himalayan blackberry.

Reed canary grass appears to have the most direct influence on the stream habitat. Dense stands have become established along significant portions of the creek. The smaller channels and off-channel areas have become effectively choked with nearly pure stands of reed canary grass. This in turn has led to retention of both fine sediment and organic livestock waste. Subsequent effects to salmonids are largely unknown, but in some cases it appears to have effectively removed potential spring and fall spawning habitats.

Culverts and Other Passage Barriers

In addition to the man-made barriers below, natural barriers such as beaver dams and intermittent flow reaches sometimes impede fish passage.

1) Railroad crossing, river mile 0.4, passage problems have been noted here at certain flows in the past but not at others. Exact passability is unknown.
2) Railroad crossing, river mile 2.3, 33% passable in side channel.
3) Culvert at Hinkleman Road, river mile 4.7, 0 to 67% passable (PCD, 2004 lists 0%, but Marc Marcantonio (pers. comm.) indicated 67%).
4) Culvert at 48th Ave S., river mile 6.2, complete barrier until maintenance is done to remove the gravel in culvert, then it will be 33% passable (Marc Marcantonio, Pierce Conservation District, personal communication).
5) Pipeline crossing at river mile 7.2, 33% passable.

Gravel Mine Operation

In 1996, a dam break occurred on a gravel operation, which spilled millions of gallons of silt-laden water and sediment into Murray Creek and the wetlands near the mouth. These flows scoured and filled the channel bed, with resultant loss of fish. Large amounts of coarse sediment from the spill are still visibly located in the wetlands, but have since stabilized. Fine sediment is visible in the wetlands and the lower part of the creek, but it is unknown how much of this sediment is natural and how much is a result from the spill.

4.4.5 Tanwax Creek

Important data concerning Tanwax Creek include the following:

- Stream length: 13.3 miles
- Drainage area: 27 square miles
- Gradient: Low
- Location: Pierce County, north and west of Eatonville

- Lakes: Mud, Rapjohn, Cranberry, Trout, Tanwax, Whitman, South and North Twin, Byron, Stidham
- Tributaries: Outlet creeks from the above lakes
- Dominant land use: Rural Residential/ Agriculture/ Forestry
- Salmon species present: Chinook, chum, coho, pink, cutthroat, steelhead
- Major habitat issues: Alteration of wetlands/channelization of creeks, reduction in riparian forests, alteration of flow patterns.

General Description and Land Use

Tanwax Creek is over 13 miles long and drains an area of about 26 square miles of mixed forest, farmland, and rural residential development in southern Pierce County. The subbasin geology consists of continental glacial till and outwash and some sedimentary rock. The headwaters consist of a series of lakes, with Tanwax Lake being the largest. The subbasin has a number of other lowland lakes, including Rapjohn, Cranberry, Mud, and Trout Lakes.

Below Highway 7, the lower 6.5 miles of Tanwax Creek (the lower Tanwax and most of the middle Tanwax reach) was commercial forestry land that is now being converted into rural 20-acre residential/small forest lots, while the upper Tanwax reach (Highway 7 up to Tanwax Lake) is mostly rural farmland that is also gradually being converted into rural residential use. The Tanwax Lake area has primarily residential use with dense suburban and recreation homes along Tanwax Lake and along some of the small lakes above Tanwax Lake.

Stream Channel and Hydrology

Tanwax Creek has a low gradient throughout, with elevations in the subbasin ranging from 400 to 920 feet. Active channel widths range from 25 to 40 feet. Historically, this low gradient channel meandered freely throughout its broad valley, which was carved during glacial times. Due to land use practices the channel is now more channelized and straightened. Wetlands are common in this stream type, and beaver activity is prevalent throughout the subbasin. The stream channels are dominated by long, uniform reaches with no significant gravel bars or pools intermittently separated by short riffles. The stream channel bed material is typically a thin layer of small and large cobbles on top of a dense material of sedimentary or clay deposits.

The creek has year-round flow but some of its tributaries have intermittent flow. Water quality has been degraded by development, especially along lakes in the upper drainage, and by livestock access to the stream banks. Tanwax Creek is used for irrigation, but this need has been reduced in recent years with the conversion of agricultural lands to rural residential use.

Fish Usage and Introductions

Coho, fall chinook, pink, and chum salmon and winter steelhead trout are the anadromous species known to use the creek and a limited number of its tributaries. Coho salmon are the dominant anadromous species in the creek and can be found throughout the system. Chinook, pink and chum salmon and steelhead trout can be found in small numbers, mostly in the lower Tanwax reach.

Sea-run coastal cutthroat trout may occur, but their current status in this subbasin is unknown. Similarly, resident coastal cutthroat and resident rainbow trout likely inhabit the creek, but their presence has not been documented. Other native species such as sculpin and three-spine stickleback are found throughout the subbasin. Self-sustaining populations of various non-native, warmwater species, including yellow perch, largemouth bass, brown bullhead, bluegill, black crappie, and pumpkinseed exist in many of the lakes.

The Washington Department of Fish and Wildlife annually stocks Tanwax Lake with rainbow trout but has never attempted to establish and maintain warmwater fish in these traditionally native salmonid or non-fish bearing waters. All warmwater species introductions into the watershed have been made through indiscriminate planting by landowners and recreational anglers in an effort to establish warmwater sport fishing. In the past, coho salmon were stocked in Tanwax Creek just below Tanwax Lake, but this practice has been abandoned.

Habitat Alterations

Major habitat alterations that have occurred in the Tanwax subbasin include:

- Removal of trees (source of large in-stream woody debris) and other streamside and overhanging vegetation
- Ditching and channelization of creeks, draining of wetlands
- Use of streamside areas as pasture with unrestricted grazing
- Introduction of non-native fish species
- Degradation of water quality
- Water withdrawals in summer months
- Changed run-off hydrology due to development of the subbasin
- Introduction of invasive plants such as reed canary grass
- Increased erosion and sediment input

Timber Harvest Activities

In the Upper Tanwax Reach, the land was deforested and converted to mostly agricultural and rural residential use in the early 1900s. The lower 3.5 miles of the creek were not deforested until the 1960s and 1970s. These timber harvests have reduced the availability of large wood along and in the stream and have reduced the amount of cover over pools and other important stream habitats.

Several miles of former logging roads that are now being used for a combination of residential access and small forest land owner logging access cross the subbasin in the lower and middle Tanwax reaches. The subbasin has a low gradient compared to other industrial logging areas in western Washington, so the roads presumably do not have a major impact on fish habitat. Still, potential adverse impacts associated with these gravel roads, such as increased fine sediment input, should be evaluated and reversed.

Agriculture and Rural Residential Development

Early agriculture in the subbasin was associated with wetland ditching and draining, stream channelization, wood removal, water diversion, and conversion of riparian forest to pasture. The effects of these changes continue to influence the stream channel and habitat forming

processes today, and many of the grazing and ditch maintenance practices are still occurring. Unrestricted grazing along stream banks throughout much of the lowland areas has reduced the amount of riparian vegetation and shade. In recent years, many of the farms in the subbasin have ceased operations, some converting to rural residential development.

Mud, Cranberry, Rapjohn and Trout Lakes and the lakes above Tanwax Lake are popular for recreational use and in some areas are densely lined with homes. Cranberry and Rapjohn Lakes are the only two lakes in the subbasin without substantial residential development along their shorelines. Water quality is being degraded by the relatively high degree of development along lakes in the upper drainage, and by livestock access to stream banks. An increase in the sediment load in the creek has occurred, probably from a variety inputs including development, bank erosion, and pastures with uncontrolled creek access for livestock.

On paper, over-allocation of water was once considered a major limiting factor for salmon, leading to low summer flows (Walter 1986), but the actual water use as compared to allocated rights remains largely unknown. Irrigation has been reduced over the past with the conversion of agricultural lands to rural residential use.

Wetland and Stream Plant Invasion

Land clearing, ground disturbance, and sedimentation have led to the introduction and spread of invasive plant species in streamside areas, especially in wetlands and lowland pastures.

Of these introduced plants, reed canary grass appears to have the most direct influence on the stream habitat. Dense stands have become established along significant portions of Tanwax Creek and its tributaries. The extensive riverine wetlands in the lower and middle Tanwax reaches are dominated by invasive reed canary grass, and the smaller channels and off-channel areas of the primary tributaries have become choked with reed canary grass. This in turn has led to retention of both fine sediment and organic livestock waste. Subsequent effects on salmon are largely unknown, but in some cases, stream plant invasion appears to have removed potential spring and fall spawning habitats.

Lowland Lake Habitat

No information is available on the contribution the lakes in the Tanwax subbasin historically had (if any) to the production of anadromous and resident salmonids. Historical presence of adfluvial forms of cutthroat trout (i.e., trout that mature in lakes and return to streams to spawn) in Tanwax Lake would be consistent with patterns seen in other lake systems within the range of the coastal cutthroat trout.

Information is not available on the current status of naturally-reproducing salmonids in the lakes, but it is plausible that some trout ascend the tributary streams at maturity to spawn and that juvenile coho may use the lakes for rearing. For a number of years, the outlet of Tanwax Lake had a screen, which eliminated access of anadromous fish to the lake and upstream tributaries, but it is currently not operating.

The effects of the introduced fish species present in the lakes on salmonid populations are largely unknown. Competitive and predatory interactions likely occur, but the influence the

introduced fish have on recruitment to the anadromous and resident salmonid populations has not been studied.

Tributary Habitat

Many of the small lowland streams that are tributaries of Tanwax Creek have intermittent flow problems and probably also have elevated stream temperatures due to the lack of a forest canopy. These tributaries provide limited habitat capacity to anadromous salmonids due to their small size, intermittent flows, and inaccessibility.

Habitat alterations similar to those in the mainstem have taken place in most of these tributaries. Lack of wood and riparian vegetation and substantial fine sediment input also limit the function of this habitat. The over-wintering refuge and migration pathway potential gives these tributaries unique importance, especially for coho, steelhead, and cutthroat.

Barriers

In addition to the man-made barriers below, natural barriers such as beaver dams and intermittent flow reaches sometimes impede fish passage.

1) Tanwax Creek, Eatonville Cutoff Road culvert, river mile 7.8, passability 0-50% (PCD inventory lists 0% but Marc Marcantonio, pers. comm. Indicated 50% passable)
2) Mudd Creek at Eatonville Cutoff Road culvert, river mile 1.3, passability 67%
3) Trout Creek at 352nd St. E. culvert, river mile 0.2, passability 0%

4.4.6 Kreger Creek

Important data concerning Kreger Creek include the following:

- Stream length: 3.6 miles
- Drainage area: 7.8 square miles
- Gradient: High near mouth, very low in the Upper Kreger Reach
- Location: Pierce County, north and west of Eatonville
- Lakes: Kreger Lake, Silver Lake
- Dominant land use: Agriculture, residential and forestry
- Salmon species present: Chum, Coho, Steelhead, Cutthroat
- Major habitat issues: Alteration of wetlands/channelization of creeks, reduction in riparian forests, increased fine sediment

General Description and Land Use

Kreger Creek is a right bank tributary to the Nisqually River in the Nisqually River middle reach at river mile 34. It is likely the smallest independent Pierce County tributary to the Nisqually that supports adult salmon. The subbasin is low in elevation, ranging from 440 feet at the mouth to 880 feet at the headwaters. The land use historically was mostly agricultural, especially along the creek itself. Now the subbasin hosts a mix of agriculture, rural residences, and timber production.

Stream Channel and Hydrology

This small independent tributary of the Nisqually River can be split into two distinct sections, morphologically speaking. Upper Kreger Creek is very low in gradient, contains mostly sandy substrate, and historically was mostly wetland rather than a defined stream channel. The stream channels are mostly straight, man-made ditches that drain many wetlands and two lakes, Kreger Lake and Silver Lake. Lower Kreger Creek is a steep reach that is less than a mile long, is dominated by cobbles and boulders, and flows through a steep canyon to the Nisqually River.

The flow in this small stream is spring dominated and is estimated at less than 5 cfs average winter and less than 3 cfs average summer flow. Beaver activity influences the channel and hydrology to a modest degree.

Fish Usage and Introductions

Salmon usage in this subbasin is considered very low, mostly due to the small size of the stream and the high gradient reach very low in the system. However, little information is available on salmon utilization in Kreger Creek.

Silver Lake is a major component of the system, and it receives high numbers of stocked trout, including rainbow and brown trout from on-site net-pens and off-site hatcheries. The lake also supports a healthy population of non-native, warm water species, such as bass, bluegill, and catfish. The fish utilization of Kreger Lake is unknown, although resident trout and introduced warm water species most likely utilize this estimated 40 acre lake.

Habitat Alterations

Major habitat alterations that have occurred in the Kreger Creek subbasin include:

- Decrease of large fallen trees in the creek
- Removal of streamside and overhanging vegetation, including standing trees that would have provided a source of large wood and shade
- Excess fine sediments in the water
- Channelization and ditching of the creek, draining of wetlands
- Decrease in the number of salmon returning (lowers nutrient input and food available for juveniles)
- Draining of wetlands
- Reduction in the amount of backwater pool, beaver pool, small cobble/gravel riffle, and off-channel habitat types

Timber Harvest Activities

Most substantial timber harvest occurred in the early part of the 1900s. As in other streams in the lower Nisqually River Watershed, timber activities are decreasing due to conversion to agriculture and residential development. Effects of past harvest activities are still evident, with reduced streamside vegetation and less large fallen trees in the stream.

Agriculture and Rural Residential Development

Agricultural development in the subbasin has probably had the largest negative impact on salmon habitat in the stream. To facilitate dry pastures and fields, the creek channel and associated wetlands were ditched extensively. This degraded the habitat substantially, similar to the effect of changes in the lower Ohop valley. Past management practices of beaver control and removal of large fallen trees in the stream also reduced habitat quality.

Much of the agricultural activity has decreased with some of the land now not actively farmed or converted to residential land use. Some residential development has occurred on former timber land, but most has occurred along the shores of Silver Lake. Silver Lake is a popular fishing destination and receives substantial plantings of trout and also hosts a number of self-sustaining, non-native, warm water species.

Barriers

There are no known fish passage barriers in Kreger Creek, but the habitat upstream of river mile 0.6 was not inventoried by the Pierce Conservation District Barrier Inventory. The WRIA 11 stream catalog (Williams et al. 1975) lists an impassible natural cascade near the mouth of Kreger Creek, but impressions of biologists that have visited the creek recently are that this area could be passable for salmon, especially coho salmon and cutthroat and steelhead trout.

4.4.7 Ohop Creek

Important data concerning Ohop Creek include the following:

- Stream length: 11.9 miles
- Drainage area: 43.6 square miles
- Gradient: Low
- Location: Pierce County, north and west of Eatonville
- Lakes: Ohop Lake
- Tributaries: Lynch Creek, Twenty-five mile Creek, unnamed tributaries
- Dominant land use: Agriculture/ rural residential.
- Salmon species present: Chinook, chum, coho, cutthroat, pink, steelhead,
- Major habitat issues: Channelization of lower Ohop Creek, loss of the upper watershed, reduction in riparian forests

General Description and Land Use

Ohop Creek is the second largest Nisqually tributary below LaGrande Dam, second only to the Mashel River, in terms of flow. It is an area of historic agricultural use that is being converted to rural residential use. There is dense residential and recreational development surrounding Ohop Lake. Areas above the anadromous zone on Lynch and Twenty-Five Mile Creeks (tributaries of Ohop Creek) are mostly used for timber production. Elevations vary from 480 to 3,720 feet in the Ohop subbasin.

Stream Channel and Hydrology

Due to some early settlers' attempt at flood management (see habitat alterations section), a quarter of this subbasin run-off was diverted into the Puyallup watershed and no longer contributes to the flow of Ohop Creek (in the Nisqually River Basin). Therefore it is assumed that the creek used to have higher year-round flows. Ohop Creek has fairly stable flows that are hydrologically moderated by Ohop Lake and by the extensive wetlands in the Twenty-Five Mile and Lynch Creek subbasins. At the mouth of the creek, the average winter flow is about 150 cfs, and the average summer flow about 20 cfs.

The mouth of Ohop Creek is located within the channel migration zone of the mainstem Nisqually River, and its morphology is determined by the river processes rather than as a function of Ohop Creek. Gravel deposits are present and habitats alternate between pool and riffle habitat types. A large portion of the lower Ohop reach channel between river miles 0.2 and 4.5 is severely incised, disconnected from its floodplain, and dominated by sandy substrate and very long glides. Riffles are only present at artificial constrictions such as bridges. The channel above Ohop Lake (river mile 9-10) is also dominated by sandy substrate with long glides and few pools or riffles. It is moderately incised but still has some connection to its floodplain.

Areas with a healthier channel configuration (connected to the floodplain and with alternating pool and riffle habitats) are Ohop Creek below Ohop Lake (river mile 4.5 to 6.1), the mouth of Lynch Creek, and Twenty-Five Mile Creek (below the waterfall where the anadromous zone ends). These areas have gravel substrate and the stream channels are allowed to freely meander, except for in some areas of bank hardening on Ohop Creek between Highway 161 and Ohop Lake (river mile 5.8 - 6.1), where large gravels and cobbles dominate the substrate, and the channel has been confined to its present location.

Lower Lynch Creek (river mile 0.2 – 0.9) has a higher gradient than any other stream in the anadromous portion of the Ohop subbasin, and therefore the substrate is composed of mostly cobbles, with some pockets of gravel and boulders. It is the main source of gravel for Lower Ohop Creek because there are not very significant sources of gravel within the Ohop valley. Artificial confinement of the stream channel due to residential development restricts movement of the channel to some degree, but the channel is fairly stably situated in this canyon reach.

Fish Usage and Introductions

Coho, fall chinook, and pink salmon are anadromous species known to use Ohop Creek and its tributaries. Chum and winter steelhead are presumed to be present, but their distribution in Ohop Creek has not been well documented. Many coho salmon spawn in Twenty-Five Mile Creek, a tributary above Ohop Lake, and smaller numbers of coho spawn in Ohop Creek below the lake and in lower Lynch Creek. Chinook and pink salmon, and presumably chum salmon and steelhead trout, can be found in smaller numbers, mostly below Ohop Lake.

Sea-run coastal cutthroat trout may occur, but their current status in this watershed is unknown. The Washington Department of Fish and Wildlife also releases an average of about

20,000 rainbow trout (≥8 inches long) into Ohop Lake each spring. Other native species such as mountain whitefish, Northern squawfish, three-spine stickleback, river lamprey, Western brook lamprey, sculpin, and largescale sucker can be found within the subbasin.

Introduced species are dominant in Ohop Lake, especially warm water species such as largemouth bass, yellow perch, bluegill, black crappie, pumpkinseed, and brown bullhead. Although these are mostly found within Ohop Lake, they might be found within Ohop Creek itself in low numbers. The effects of these introductions on the native salmonid populations remain largely unknown. Competitive and predatory interactions certainly occur, but the impacts these fish have on recruitment to the anadromous and resident salmonid populations have not been investigated.

All anadromous fish that spawn in Twenty-Five Mile Creek or the upper Ohop watershed need to migrate out through Ohop Lake. Although usually lake environments are beneficial to rearing coho, heavy interspecies competition in Ohop Lake may actually limit the coho production of these upstream tributaries.

Habitat Alterations

Major habitat alterations that have occurred in the Ohop Subbasin include:

- Decrease in the amount of large wood in the creek
- Removal of streamside and overhanging vegetation, including standing trees that would have provided a source of large wood and shade
- Ditching and channelization of Ohop Creek (river miles 0.3 - 4.5)
- Degradation of water quality including excess nutrients in Ohop Lake
- Water withdrawals in summer months
- Town of Eatonville stormwater system discharges into Lynch Creek
- Changed run-off hydrology due to development of the subbasin

Diversion of Upper Ohop Creek

In the 1800s, the upper Ohop Creek watershed included an additional 15.1 square miles of drainage area. This additional area was removed from the watershed by diverting the stream, upstream of its confluence with Twenty-Five Mile Creek, into Lake Kapowsin, and thus into the Puyallup River drainage. This effectively reduced the streamflow by an estimated 30 to 40% and made extensive high quality spawning areas no longer accessible to Nisqually salmonids.

Channelization of the Ohop Creek Valley

During the 1930s, Ohop Creek was widened, straightened, and deepened by the Works Progress Administration[3] as a means of drainage and flood control in the Ohop Valley. It appears that historically the entire valley was heavily used by beavers and extensive emergent wetlands dominated the landscape.

[3] Works Progress Administration was a program funded by US Congress to provide jobs and income to the unemployed during the Great Depression. It was the largest and most comprehensive New Deal agency.

The creek itself meandered throughout the entire width of the valley and included abundant logjams, most of which were removed during the channelization. This removal of the wood, channelization of the creek, and draining of wetlands still determine the shape of the channel today, and is the biggest habitat problem in the Ohop subbasin. The channel is deeply incised, shortened, and simpler than the historic channel and has little habitat value to local salmon and trout. Although the channel is slowly re-establishing meander bends, the consequences of the channel deepening are still progressing today and will negatively influence the habitat for decades to come if nothing is done to restore stream conditions.

Timber Harvest Activities

The majority of timber in the watershed was harvested by the early part of the 1900s, with the exception of the higher-elevation, steeper areas along headwater creeks such as Twenty-Five Mile and Lynch creeks. Timber harvest in these commercial timberland areas occurred in the 1960s and 1970s and continues into the present.

An extensive network of forest roads crosses the hill slopes in the 450 to 3,700 foot elevation range. Analysis of the effects of the present timber harvest and related management of the upper watershed show small changes in peak flow (flooding), mass wasting events (erosion), and fine sediment input. The most apparent influence of past timber harvest has been the reduction of large woody debris recruitment sources.

Agriculture and Residential Development

Settlement of the area began in the 1880s, with associated land clearing and ditching to support agricultural activities. Numerous wetlands were ditched and drained for agriculture. Unrestricted grazing along stream banks has reduced the effectiveness of riparian habitat throughout much of the lower Ohop reach. In many cases these grazing and ditch maintenance practices are still active, though many farms have ceased operations in recent years, some converting to rural residential development.

Residential development is a major future threat to Ohop Creek. The associated riparian land clearing, creek and bank modification, landscaping with chemicals, and “stream cleaning” (removal of wood, beaver dams, etc.) degrade the salmon habitat, especially near Highway 161 and lower Lynch Creek. Ohop Lake is popular for recreation, and its shoreline is densely lined with homes. Loss of lakeside vegetation has been a problem, and a healthy riparian buffer exists only along the north end of the lake.

Eatonville Stormwater Ditch

Stormwater from Eatonville’s stormwater collection system is released into Lynch Creek, a tributary of Ohop Creek. This addition of stormwater may increase the ‘flashiness’ of the creek, with higher and ‘spikier’ high flows. It may also convey suspended solids, bacteria, nutrients, and other common urban runoff constituents to Lynch Creek.

Barriers

Natural barriers determine most upstream limits of anadromous salmon distribution in the Ohop watershed. Natural waterfalls on Lynch Creek (river mile 0.9) and Twenty-five Mile Creeks (river mile 0.5) preclude salmon from the majority of the upper watershed. Although

considered the upper extent of migrating salmon, the waterfall on Twenty-five Mile Creek (half a mile upstream from its confluence with Ohop Creek) might potentially be passable to steelhead trout. An unnamed tributary (#0094) that drains the eastern valley wall upstream of Ohop Lake flows through a collapsed fish-blocking culvert under the Tacoma Eastern Railroad.

The Pierce Conservation District's barrier inventory did not identify any other problem barriers in the anadromous portion of the Ohop watershed.

4.4.8 Mashel River

Important data concerning Mashel River include the following:

- Stream length: >32 miles
- Drainage area: 83.5 square miles
- Gradient: Low to High (mostly >3%).
- Location: Pierce County, near the town of Eatonville.
- Tributaries: Busywild Creek, Beaver Creek, Little Mashel River, Midway Creek, unnamed tributaries.
- Dominant land use: Forestry/ Agriculture/ Rural Residential.
- Salmon species present: Chinook, coho, cutthroat, pink, steelhead.
- Major habitat issues: Increase in fine sediment, loss of juvenile salmon habitat, change in high and low flow regime.

General Description and Land Use

The Mashel River is the largest tributary to the Nisqually River downstream of La Grande Dam. It joins the Nisqually River at river mile 39.6 and is the farthest upriver of all the tributaries of the Nisqually with anadromous fish use. The elevation of the subbasin ranges from 520 feet to about 4,840 feet. The subbasin is not fed by runoff from Mount Rainier; rather it is separated from the mountain by the Deer Creek and Copper Creek drainages.

Most of the subbasin is in commercial forestry use. Significant exceptions are the town of Eatonville and surrounding rural residential areas near river mile 5.1 to 6.0, the agricultural areas in the Little Mashel River subbasin, and parts of the Nisqually-Mashel State Park (still in development) at the mouth of the river.

Stream Channel and Hydrology

From river mile 3.2 (Highway 7) to its mouth, the Mashel River flows through a natural canyon with some room to allow the channel to migrate. From river mile 3.2 up to Eatonville, the canyon becomes more confined. A large section of the Mashel to Eatonville Reach is unconfined, but the channel is lined with riprap along many places and active channel meandering is restricted. A combination of mostly naturally confined and some unconfined reaches extend from Eatonville up to the confluence of the Mashel River and Busywild Creek. Channel widths below Busywild Creek range from 35 to 100 feet. Wetlands are uncommon and most are inaccessible to fish, mostly due to the confined nature of many of the reaches. Plane

bed channel morphology dominates, with some interspersed pool/riffle sequences. The channel bed material is typically cobbles and large gravel with some bedrock outcrops.

The Mashel River has the highest overall flows of any of the Nisqually tributaries below the LaGrande Dam. However, it also has very low flows in the summer that are lower than historic summer flows. The river's flow is also 'flashy,' responding rapidly to precipitation. The Mashel River's mean flow in the winter months ranges between 300 and 400 cfs, and its mean flow in the summer months is between 20 and 50 cfs. The flow peaks during the winter months with a mean annual flood of approximately 1,284 cfs. Late summer seven-day minimum flows average approximately 5 cfs.

Fish Usage and Introductions

Coho salmon, fall Chinook salmon, pink salmon, and winter steelhead trout are anadromous species known to use the Mashel River and a limited number of its tributaries. Chum salmon tend to stay below the Centralia diversion dam at the Nisqually River at river mile 26.2. Some chum do migrate past the dam, but chum usage of the Mashel has not been documented and would presumably be limited to the lower Mashel reach below the cascades at river mile 3.5. Coho, chinook, and steelhead can be found throughout the system (except above the barrier waterfalls on the Little Mashel and Mashel Rivers and Beaver and Busywild Creeks) but most fish stay below Boxcar Canyon at river mile 6.0. Pink salmon stay mostly in the lower Mashel reach below a waterfall at river mile 3.5, less than half a mile above Highway 7.

Sea-run coastal cutthroat trout may occur, but their current status in this watershed is unknown. Resident salmonids, including self-sustaining populations of coastal cutthroat and resident rainbow trout, likely inhabit some stream reaches, but their presence has not been documented. Other native species such as sculpin and three-spine stickleback can be found throughout the subbasin. The Washington Department of Fish and Wildlife annually stocks one small pond in the watershed with rainbow trout. Juvenile coho salmon were stocked in Beaver Creek in years past, but this practice has been abandoned.

Habitat Alterations

Major habitat alterations that have occurred in the Mashel subbasin include:

- Decrease of large fallen trees in the creek
- Removal of streamside and overhanging vegetation, including standing trees that would have provided a source of large wood and shade
- Excess fine sediment input from increased soil erosion
- Channelization of the Mashel River near Eatonville
- Decrease in the number of salmon returning (lowers nutrient input and food available for juveniles)
- Draining of wetlands

Timber Harvest Activities

The subbasin around the Town of Eatonville and near Midway Creek was deforested and converted mostly to agricultural and rural residential use in the early 1900's. Upstream and

downstream of this area, the land is mostly still in timber production. The most apparent influences of past timber harvests on salmon habitat are the increased sediment production, the increased peak flow, and the reduction in the amount of large wood available to fall into the stream.

Due to a combination of floods and timber harvest activities in the upper watershed, large amounts of sediment from landslides were moved into the channel of the Mashel River about 20 to 30 years ago. Much of that sediment still controls the form of the channel seen today. The channel has mostly shallow pools, unconsolidated substrate, and is generally fairly wide. The river is now slowly reworking those deposits, leading to narrowing of the channel and consolidation of gravel.

Although timber harvest practices have changed, leading to a decrease in forestry-related landslides/mass wasting events, fine sediment still drains into the river through a complex network of logging roads. The Mashel Watershed Analysis (Bohle et al. 1996) concluded that timber harvest has increased the "flashiness" of the system. Removal of mature timber from the watershed has increased the magnitude and frequency of high flows.

Agriculture and Rural Residential Development

Development of the Mashel subbasin has had a significant influence on salmon habitat in the Mashel River, specifically in the Mashel-Eatonville reach. Eatonville is located near river mile 5.5 of the Mashel River, and there is residential development along the river approximately between river mile 4.0 and river mile 6.2.

Throughout this reach, streamside vegetation cover has been reduced, and the river has been isolated from its floodplain by the use of bank hardening. The bridges at road crossings over the Mashel River in some cases also constrict the stream channel in their vicinity and often lead to decreased habitat diversity. Water is diverted from the river for domestic consumption, and a sewage treatment plant discharges treated water back into the river. In addition, poaching and harassment of spawning salmon has been observed within the Eatonville area and is likely to occur in that area in the future.

Most agriculture in the subbasin consists of small hobby farms except for some larger areas in the Midway Creek subbasin. Midway Creek is a tributary of the Little Mashel River that is not accessible to anadromous fish, but the effects of ditching and draining of wetlands and removal of riparian vegetation still has negative effects on the salmon populations downstream, such as reduced summer low flow due to loss of wetland storage.

The flows in the Little Mashel River Basin are naturally "flashy" since large parts of the subbasin are in the "rain-on-snow" zone. Past draining and ditching of wetlands, areas which used to act as flood storage areas, now exaggerates this condition. The dramatically reduced riparian area associated with development also has a negative effect on water quality, especially water temperature, nutrient loading, and sediment.

Barriers

The Pierce Conservation District's barrier inventory did not document any unnatural impassible barriers in the Mashel subbasin. The anadromous zone ends at natural waterfalls on the

Mashel River at river mile 15.4 and on the Little Mashel at river mile 0.8. It is unknown whether there is any passage and if so the extent of it (for steelhead and coho) at a natural waterfall on Beaver Creek at river mile 0.3.

4.5 WETLANDS AND UPLAND HABITAT

The following sections describe wetland and upland habitats of the Nisqually River Basin based on review of aerial photographs and Pierce County GIS data.

The Nisqually River Basin supports several plant communities including conifer, deciduous, and mixed conifer-deciduous forests, grassland (agriculture), and shrub land. These plant communities can be divided into three types: upland, riparian, and wetland. Aquatic and riparian habitat was described in Section 4.4. The wetland and upland habitats are described in this section.

4.5.1 Wetland Habitat

In addition to flood storage, wetlands provide important habitat for plants and animals. Fish, amphibians, waterfowl, birds of prey, and wetland mammals, such as beaver and muskrat, depend on various types of wetlands for food, forage, nesting, and cover. Wetlands also help to maintain water quality through biofiltration and groundwater recharge for streams. Figure 4-26 shows the wetlands in the Nisqually River Basin. These data include wetlands delineated by survey, verified by field checking, identified (but unverified) from aerial photos, and shown (but unverified) on National Wetlands Inventory maps.

Most wetlands are located in the northwestern half of the Basin in areas were lakes exist. There are approximately 11,000 acres of wetlands, which represents approximately 7% of the Basin area. Table 4-17 summarizes the wetland areas by subbasin.

4.5.2 Near-Shore Habitat

The Nisqually Reach is the near-shore area where the Nisqually River flows into Puget Sound. The Reach provides habitat for shellfish, including clams, oysters, geoducks, and mussels; however, the Washington State Department of Health has currently closed the Nisqually Reach adjacent to the mouth of the Nisqually River and McAllister Creek to harvesting of shellfish due to high fecal coliform levels.

The Nisqually Reach shellfish harvesting areas are primarily located within Thurston County. State law required Thurston County to address the water quality problems within the framework of a "Shellfish Protection District" created in early 2001 (Thurston County homepage, 06/26/2001). The shellfish protection district is a geographic area designated by Thurston County to protect water quality and tideland resources.

4.5.3 Upland Habitat

Upland habitat in the Nisqually River Basin includes primarily coniferous and deciduous forestland, grassland, and landscaped areas associated with residential, commercial, and light industrial development. Most of the uplands in the Basin have been disturbed, leaving fragmented patches of forest land and grassland in a matrix of suburban development. With these changes in land use, invasive plants, most notably Scotch broom and bent grass, have established themselves throughout the Basin.

Forest Land

Douglas fir dominates most of the upland forest in the Basin. The understory is dominated by salal, serviceberry, and red osier dogwood, with red alder saplings in open pockets. The dominant species in the forest edge are young Douglas fir, western red cedar, red alder, big leaf maple, and Himalayan blackberry. Most of the conifer and deciduous forest in the Basin has been changed from its pre-European settlement condition by two to three timber harvests and over the last century conversion to agriculture and residential land uses.

Grassland

Grass species dominate the agricultural areas in the Basin. Trees are sparse and are limited mainly to certain riparian areas and to wetlands with soils that are too wet to farm. Agricultural and developmental disturbances have significantly modified the species composition in the Basin.

Landscaped Areas

Vegetation in residential and commercial areas is dominated by non-native ornamental trees and shrubs. Turf and non-native grasses are also a prevalent ground cover in the non-forested areas.

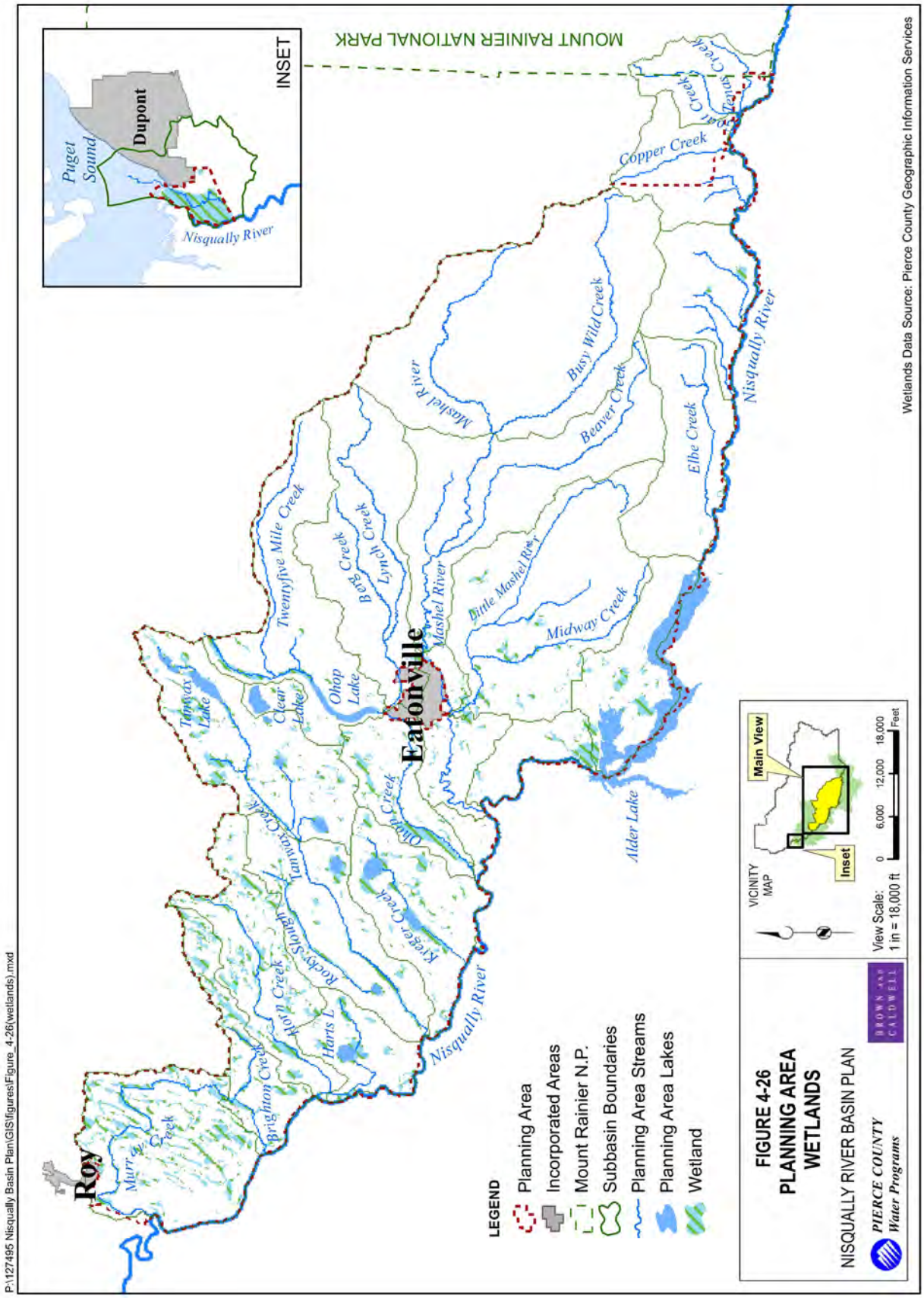
INSET
Puget Sound
Dupont
Nisqually River
MOUNT RAINIER NATIONAL PARK
Copper Creek
Busy Wild Creek
Beaver Creek
Elbe Creek
Nisqually River
Mashel River
Little Mashel River
Midway Creek
Twentyfive Mile Creek
Bald Creek
Lynch Creek
Ohop Lake
Clear Lake
Tanwax Lake
Eatonville
Alder Lake
Ohop Creek
Kiesel Creek
Tanwax Creek
Rocky Shaugh Creek
Horn Creek
Harts L
Brighton Creek
Murray Creek
Roy
Nisqually River
LEGEND
Planning Area
Incorporated Areas
Mount Rainier N.P.
Subbasin Boundaries
Planning Area Streams
Planning Area Lakes
Wetland
VICINITY MAP
Main View
Inset
View Scale: 1 in = 18,000 ft
0 6,000 12,000 18,000 Feet
FIGURE 4-26
PLANNING AREA
WETLANDS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL
Wetlands Data Source: Pierce County Geographic Information Services
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TABLE 4-17
Wetland Areas by Subbasin

Subbasin Name	Wetland Area (acre)	Basin Area (acre)	% of Wetland in Basin
Alder Lake	426	6,060	7.0%
Ashford Reach	74	5,203	1.4%
Brighton Creek	823	4,175	19.7%
Clear Lake	205	796	25.7%
Copper Creek	0	5,163	< 0.1%
Elbe Creek	17	7,117	0.2%
Goat Cr-Tenas Cr	2	3,765	< 0.1%
Harts Lake	510	3,659	13.9%
Horn Creek	1,214	7,375	16.5%
Kreger Creek	990	6,963	14.2%
La Grande Reach	243	2,665	9.1%
Little Mashel River	463	15,154	3.1%
Lower Mashel River	201	3,989	5.0%
Lower Ohop Creek	622	4,485	13.9%
Lower Tanwax Creek	776	8,160	9.5%
Lynch Creek	23	10,871	0.2%
Mashel Prairie	18	911	2.0%
Middle Mashel River	85	12,672	0.7%
Murray Creek	1,834	10,460	17.5%
Red Salmon Creek	658	4,660	14.1%
Upper Mashel River	0	21,832	< 0.1%
Upper Ohop Creek	606	10,273	5.9%
Upper Tanwax Creek	1,439	9,719	14.8%
Total	**11,227**	**166,126**	**6.8%**

4.6 WATER QUALITY

The Nisqually River mainstem appears to be in good condition from a water quality perspective. According to the *Surface Water Quality Assessment Nisqually River Level I Watershed Assessment*(WPN, 2002), the minimum dissolved oxygen concentrations at stations used to collect data for the assessment were well above the state standard, even during late summer (See Table 4-18).

The stream temperature standard was occasionally exceeded at river mile 3.7, but the maximum recorded temperature was only slightly higher than the standard. Fecal coliform levels were occasionally exceeded in winter at river mile 3.7 and river mile 21.8, near the McKenna diversion. Levels at the lower station were slightly higher than the standard.

In November 2000, the Washington State Department of Health restricted harvest status on 74 acres of commercial shellfish beds in the marine waters near the mouth of the Nisqually River (Nisqually Reach) because fecal coliform bacteria concentrations exceeded standards for commercial shellfish harvest.

TABLE 4-18
Nisqually Mainstem Water Quality Summary
(Data Source: Nisqually Indian Tribe Water Quality Program database, WPN 2002)

Parameter/Location	Summer Range [1]					Winter Range [2]				
	min	max	mean [3]	% exceedance	N	min	max	mean [3]	% exceedance	N
DO (mg/L)										
La Grande RM 39.7	10	12.6	10.9	0%	9	9.8	15.6	12.5	0%	16
McKenna RM 21.8	10	13.8	11.3	0%	6	10.8	14.2	12.8	0%	11
Refuge RM 3.7	9.4	12.6	10.6	0%	15	9	14.3	12	0%	28
Temp (C)										
La Grande RM 39.7	10.8	16.4	14	0%	11	4.2	9.8	6.2	0%	19
McKenna RM 21.8	14.6	16.6	15.3	0%	6	3.8	9.7	6	0%	13
Refuge RM 3.7	11.1	18.2	15.8	11%	18	3.9	13.3	6.8	0%	33
Fecal Coliform (MPN/100ml)										
La Grande RM 39.7	2	20	7.7	0%	9	4	20	8.2	0%	6
McKenna RM 21.8	5	40	19.1	0%	6	5	500	24.2	7%	14
Refuge RM 3.7	5	200	21.9	0%	20	5	220	19.3	4%	28
Turbidity (NTU)										
La Grande RM 39.7	2	78	17.7		13	5.3	147	32.9		31
McKenna RM 21.8	1.6	78.2	24.3		12	4	503.4	61.1		29
Refuge RM 3.7	1.7	80	13		19	2.6	725.2	42.7		52
TSS (mg/L)										
La Grande RM 39.7	0.4	39.7	8.6		12	0.5	137.1	30.1		29
McKenna RM 21.8	1.6	39.5	12.8		12	1.9	1486.6	158		29
Refuge RM 3.7	1.3	65.5	8.8		20	2.6	1197.6	92.2		47
TP (ug/L)										
La Grande RM 39.7	2	38	15.8		11	7	228	55.9		16
McKenna RM 21.8	4	35	17.3		6	21	1280	225.6		14
Refuge RM 3.7	5	35	18.3		14	16	1280	121		22
NH_3 (ug/L)										
La Grande RM 39.7	10	16	12		3	15	40	26.3		3
McKenna RM 21.8	n/a	n/a	n/a		n/a	n/a	n/a	n/a		n/a
Refuge RM 3.7	14	42	30.8		6	10	24	17.6		7
Nitrate (ug/L)										
La Grande RM 39.7	15	49	29.3		10	46	205	127.6		16
McKenna RM 21.8	36	106	66.7		6	163	478	297.4		14
Refuge RM 3.7	92	172	135.1		14	153	1400	406.7		22

[1] Summer range calculated using July - September data.
[2] Winter range calculated using November - March data.
[3] Arithmetic mean calculated for all parameters, with the exception of Fecal Coliform which was calculated as the geometric mean value.

There are several areas in the subbasins where temperature, dissolved oxygen, and fecal coliform standards have been violated. Some of the temperature and dissolved oxygen situations are thought to be entirely or largely natural in origin.

4.6.1 2004 Washington State Assessment of Water Quality

Washington's 2004 water quality assessment characterizes water quality into five categories as follows:

Category 1. Meets tested standards for clean water. (Note that a water body can be Category 1 for certain parameters, but listed on the 303(d) list for impairment from a different pollutant).

Category 2. Waters of concern. Segments of streams that currently meet state water quality standards overall, but either where some exceedances have occurred, where there is a record of declining water quality even though the average is acceptable, or the expected level of urban development indicates that the stream is likely to become impaired unless remedial steps are taken.

Category 3. No data or no usable data is available.

Category 4. Polluted waters that do not require a total maximum daily load (TMDL):

- Category 4a – Has a TMDL
- Category 4b - Has a pollution control plan
- Category 4c - Impaired by a non-pollutant, such as containing a barrier to fish passage

Category 5. Polluted waters that require a TMDL [the 303(d) list].

Figure 4-27 shows the Category 2, 4c, and 5 waters in the Basin planning area. Table 4-19 lists the "waters of concern" (Category 2 waters) identified by Ecology in the planning area. According to Ecology, there are several reasons why a water body would be placed in Category 2. A water body might have pollution levels that are not quite high enough to violate the water quality standards, or there may not have been enough violations to categorize it as impaired according to Ecology's listing policy. There might be data showing water quality violations, but the data were not collected using proper scientific methods.

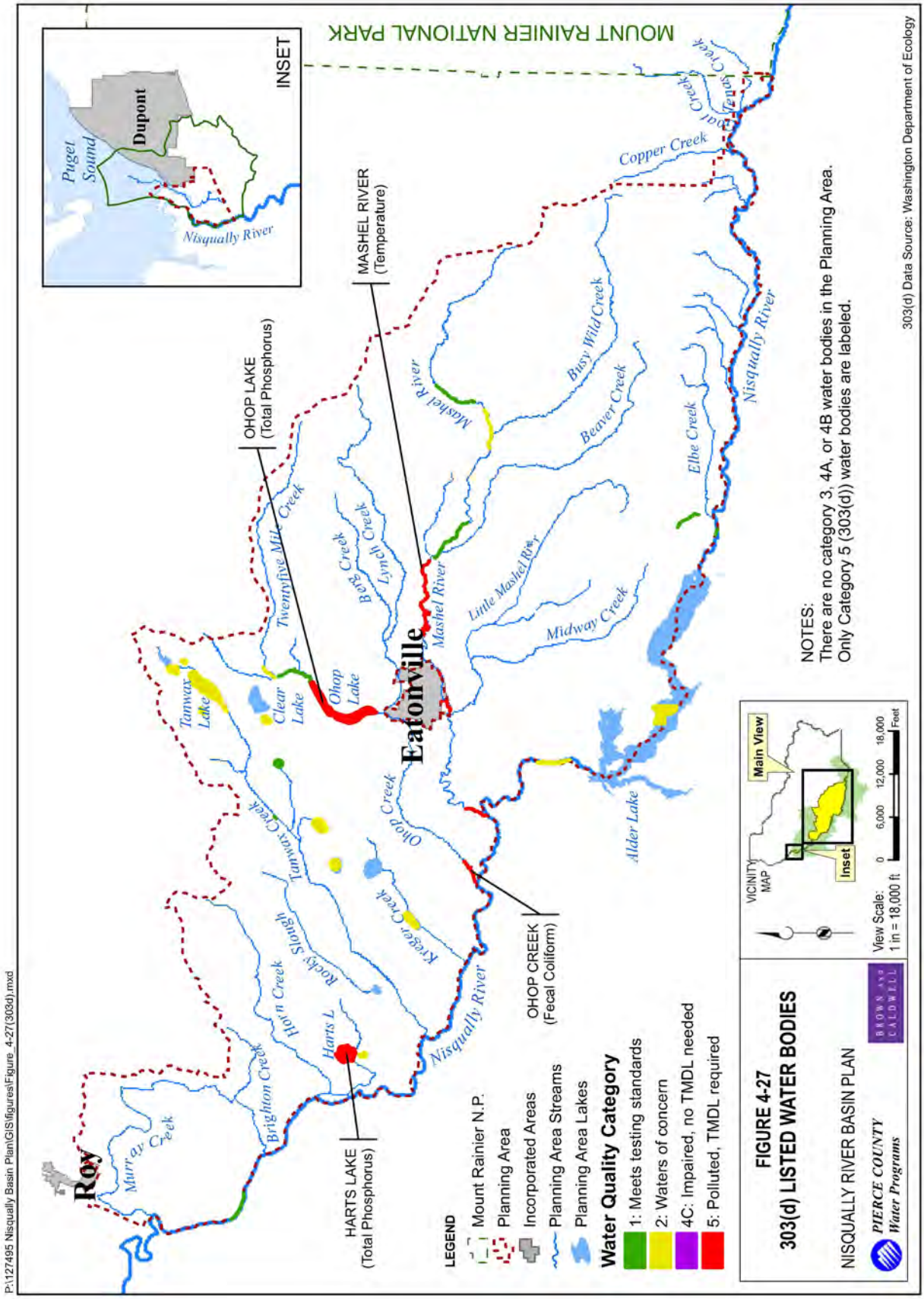

MOUNT RAINIER NATIONAL PARK
INSET
Puget Sound
Dupont
Nisqually River
MASHEL RIVER (Temperature)
OHOP LAKE (Total Phosphorus)
HARTS LAKE (Total Phosphorus)
OHOP CREEK (Fecal Coliform)
Eatonville
Roy
Copper Creek
Busy Wild Creek
Beaver Creek
Elbe Creek
Nisqually River
Mashel River
Little Mashel River
Midway Creek
Twenty-five Mile Creek
Bar Creek
Lynch Creek
Ohop Lake
Clear Lake
Tanwax Lake
Tanwax Creek
Ohop Creek
Kreger Creek
Rocky Slough
Hoh'n Creek
Harts L
Brighton Creek
Murray Creek
Alder Lake
LEGEND
Mount Rainier N.P.
Planning Area
Incorporated Areas
Planning Area Streams
Planning Area Lakes
Water Quality Category
1: Meets testing standards
2: Waters of concern
4C: Impaired, no TMDL needed
5: Polluted, TMDL required
FIGURE 4-27
303(d) LISTED WATER BODIES
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
VICINITY MAP
Main View
Inset
View Scale: 1 in = 18,000 ft
0 6,000 12,000 18,000 Feet
NOTES:
There are no category 3, 4A, or 4B water bodies in the Planning Area.
Only Category 5 (303(d)) water bodies are labeled.
303(d) Data Source: Washington Department of Ecology
P:\127495 Nisqually Basin Plan\GIS\figures\Figure_4-27(303d).mxd

TABLE 4-19
"Waters of Concern" in the Nisqually River Basin Planning Area

Water Name	Parameter(s) Listed in 2004
Alder Lake	Total phosphorus
Kreger Lake	Total phosphorus
La Grande Lake	Total phosphorus
Little Hart Lake	Total phosphorus
Mud Lake	Total phosphorus
Nisqually River	Fecal coliform, chromium, total PCBs
Rapjohn Lake	Total phosphorus
Stidham Lake	Total phosphorus
Tanwax Lake	Total phosphorus
Tule Lake	Total phosphorus
Twentyseven Lake	Total phosphorus
Twin Lake, North	Total phosphorus
Twin Lake, South	Total phosphorus
Whitman Lake	Total phosphorus

Ecology has identified a number of water bodies within the planning area as "polluted," based on past exceedances of water quality standards. Federal regulations require that Ecology develop TMDLs for the listed water bodies. Table 4-20 lists the water bodies in the Nisqually planning area that Ecology has identified as "polluted."

TABLE 4-20
303(d) Listed Waters in Planning Area

Water Name	Parameter(s) Listed in 1996	Parameter(s) Listed in 1998	Parameter(s) Listed in 2004
Clear Lake	Total Phosphorus	Total Phosphorus	
Harts Lake	Total Phosphorus	Total Phosphorus	Total Phosphorus
Mashel River			Temperature
Nisqually River	Fecal Coliform	Fecal Coliform, Temperature, Chromium	
Ohop Creek	Fecal Coliform		Fecal Coliform
Ohop Lake	Total Phosphorus		Total Phosphorus
Red Salmon Creek		Fecal Coliform	

Ecology recently established TMDLs for fecal coliform bacteria in Ohop Creek, Lynch Creek (a tributary to Ohop Creek), and Red Salmon Creek. See Section 5.3.2 for a further discussion of water quality problems in the Nisqually River Basin planning area.

4.6.2 Murray Creek

Dissolved oxygen levels of Murray Creek were often below standards, and fecal coliform data are not available (Watershed Professional Network, 2002).

4.6.3 Red Salmon Creek

Red Salmon Creek did not meet water quality standards for bacteria (Whiley and Walter, 1996). Fecal coliform concentrations were chronically elevated in the creek, particularly during storm events. Red Salmon Creek included in a TMDL report that was submitted to Ecology in June 2005. For a summary of this report, see Section 5.3.2 Water Quality Problems.

4.6.4 Clear Creek and Horn Creek

Water quality data are not available for the Clear and Horn Creeks.

4.6.5 Tanwax Creek

Water quality at the upper station of Tanwax Creek appears to be influenced by the lake outflow. Summer dissolved oxygen levels have been extremely low, however temperature met state criteria. Dissolved oxygen concentrations appear to recover between the upper and lower stations and have met the water quality standard at the lower station. Conversely, temperatures have often been higher at the lower station, exceeding the state criteria 39% of the time. Fecal coliform bacteria standards were occasionally exceeded in both summer and winter. Tanwax Creek has had low dissolved oxygen levels and high fecal coliform and temperature (Watershed Professional Network, 2002).

Samples taken from a Nisqually River Education Project station in 2001 and 2002 indicate that Tanwax Creek met all state water quality standards. Ecology has determined that Tanwax Creek meets standards for clean waters (303d Category 1). Benthic invertebrate sampling conducted by Surface Water Management in 2005 found a B-IBI score of 32, which is considered to reflect “fair” conditions. Area residents have observed elevated turbidity in the upper reaches of the creek (Hymel 2005).

4.6.6 Kreger Creek

Water quality data are not available for Kreger Creek.

4.6.7 Ohop Creek

A recent study of Ohop Creek found that the temperature criterion was exceeded 8% of the time. At the site downstream of the lake, dissolved oxygen and temperature do not meet water quality standards greater than 50% of the time during summer. Maximum stream temperatures and minimum dissolved oxygen levels recorded at this site were both within the typical lethal range for fish. The water quality situation here likely reflects the discharge of

warm water with low oxygen concentrations from the lake. Such conditions are common downstream of lakes.

Dissolved oxygen concentrations and temperature levels improved downstream of river mile 6.0. However, both dissolved oxygen criteria and temperature criteria were violated frequently at river mile 0.2. Fecal coliform levels were also quite high in summer at all stations on Ohop Creek, as are sediment loads. Ohop Creek was included in a June 2005 TMDL report. For a summary of this report, see Section 5.3.2 Water Quality Problems.

4.6.8 Ohop Lake

Ohop Lake lies on Ohop Creek. Phase I State Clean Lakes Restoration Project encountered impaired salmon rearing habitat, increasing algal blooms, and excessive macrophyte growth in 1997. Samples collected in 1985 showed high phosphorous.

4.6.9 Twenty-five Mile Creek

Twenty-five Mile Creek flows into Ohop Creek upstream of Ohop Lake. The Nisqually Tribe sampled the creek during its 1995-1997 study of Ohop Lake. They found that the creek was relatively cool and was not a major source of sediment for Ohop Creek (Whiley and Walter 1997).

4.6.10 Mashel River

Water quality in the Mashel River is generally considered good but with site specific areas of concern. Fecal coliform levels have occasionally exceeded the standards in the lower 3 miles. Recent sampling indicates that the state temperature standard was exceeded 30% of the time at the mouth of the river and 18% of the time at rive mile 60. This may be related to sparse shade along the stream. High suspended sediment and phosphorus loads have been observed at the mouth. The only measure of groundwater quality that exceeded the state standard for chloride was taken in the Little Mashel. The site had elevated levels in only one of four measurements.

4.6.11 Busy Wild Creek and Beaver Creek

No water quality data were available for these creeks.

4.6.12 Upper Nisqually River

The mainstem appears to be in good condition. Ecology has determined the river to meet standards for clean water.

4.6.13 Nisqually Reach

The Nisqually Reach provides habitat for shellfish. Shellfish eat by filtering the waters where they live, so their health is closely linked to ambient water quality. The Washington State Department of Health has currently closed the Nisqually Reach adjacent to the mouth of the Nisqually River and McAllister Creek to harvesting of shellfish due to high fecal coliform levels.

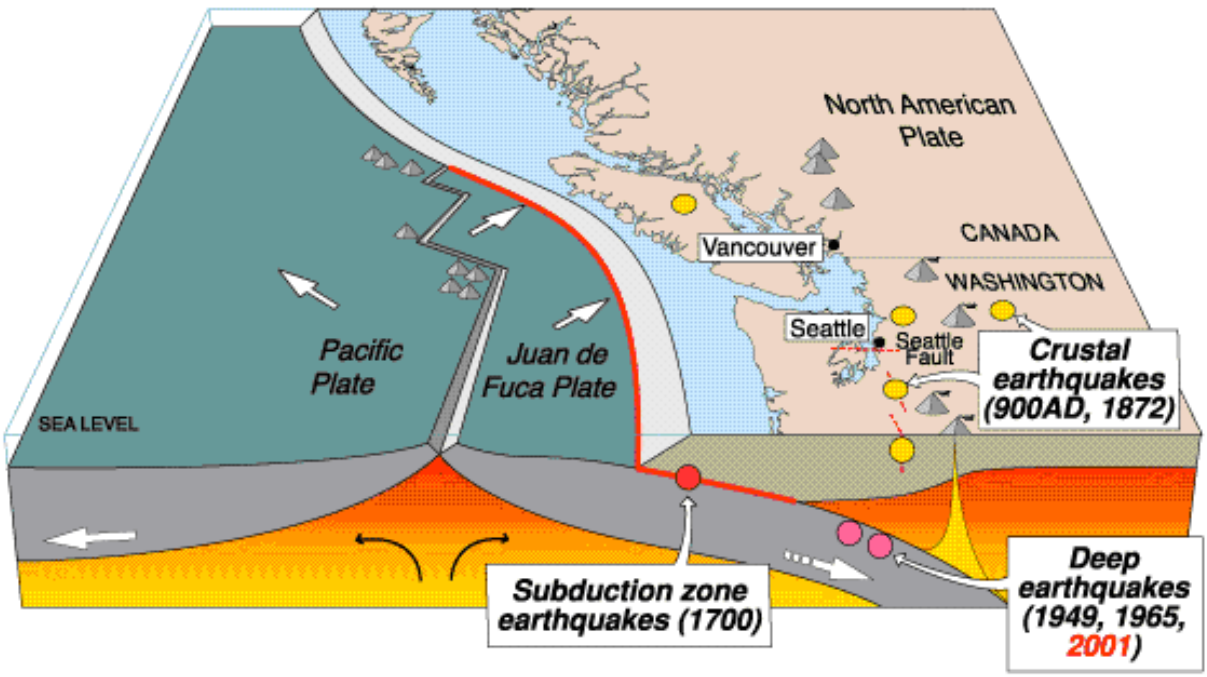
4.7 HAZARD AREAS

4.7.1 Earthquake Hazard Areas

The Nisqually River Basin is located in a seismically active region. Western Washington is located near the collisional boundary of two primary tectonic plates. The boundary where these two plates converge, the Cascadia Subduction zone, lines approximately 50 miles offshore and extends from the middle of Vancouver Island to northern California (Figure 4-28). The subduction of the Juan de Fuca oceanic plate underneath the North American Continental plate produces earthquakes, such as the 2001 Nisqually earthquake, a deep earthquake.

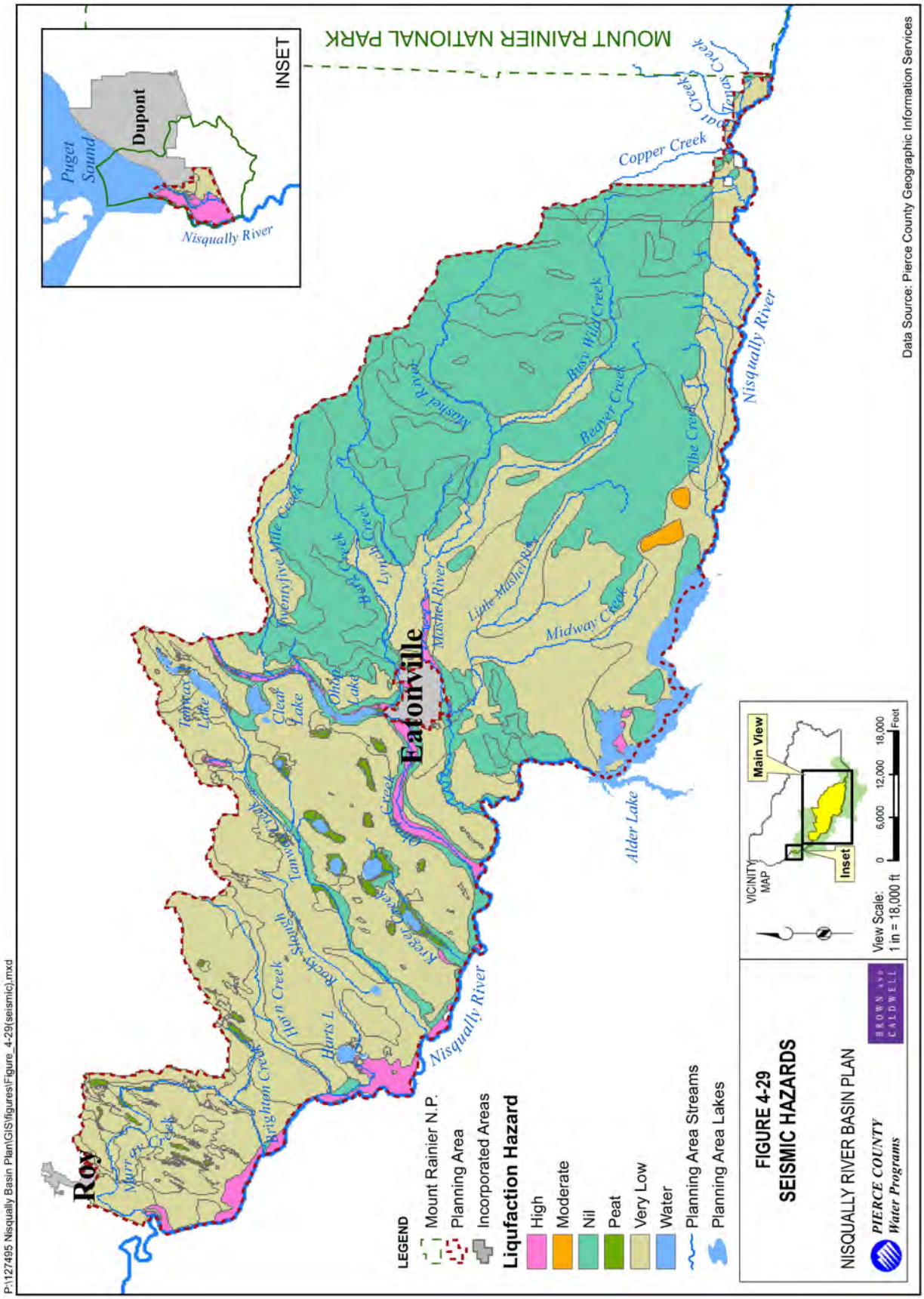
The energy released in an earthquake can cause landslides and rockfalls on steeply sloped areas. See Section 4.7.2 for landslide hazard areas within the Nisqually River Basin.

Another potential effect of earthquakes is liquefaction. Soft soils or human-made fills can subside or experience liquefaction in an earthquake. Liquefaction commonly causes ground failures, such as ground cracking or lateral spreading above liquefied layers. The Pierce County Natural Hazard Mitigation Plan (2004) indicates the Nisqually River Valley is a high liquefaction hazard area (see Figure 4-29).



Source	Affected area	Max. Size	Recurrence
Subduction Zone	W.WA, OR, CA	M 9	500-600 yr
Deep Juan de Fuca plate	W.WA, OR,	M 7+	30-50 yr
Crustal faults	WA, OR, CA	M 7+	Hundreds of yr?

Figure 4-28 Cascadia Earthquake Sources, United States Geological Survey, 2002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LEGEND
Mount Rainier N.P.
Planning Area
Incorporated Areas
Liquefaction Hazard
High
Moderate
Nil
Peat
Very Low
Water
Planning Area Streams
Planning Area Lakes
FIGURE 4-29
SEISMIC HAZARDS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL
VICINITY MAP
Main View
Inset
View Scale:
1 in = 18,000 ft
0 6,000 12,000 18,000 Feet
Data Source: Pierce County Geographic Information Services
MOUNT RAINIER NATIONAL PARK
INSET
Puget Sound
Dupont
Nisqually River
Roy
Eatonville
Copper Creek
Nisqually River
Alder Lake
Midway Creek
Little Mashel River
Mashel River
Busy Wild Creek
Beaver Creek
Ohop Lake
Clear Lake
Twelve Lake
Twenty-five Mile Creek
Lynn Creek
Tanwax Creek
Rocky Creek
Ohop Creek
Brighton Creek
Murray Creek
Harts L.
Kreger Creek

4.7.2 Landslide Hazard Areas

Although the majority of slopes in the area are relatively stable, due to the geology and soil conditions in the Nisqually River Basin, steep slopes along the river channels are considered to be landslide hazard areas. Figure 4-30 shows areas with steep slopes in the planning area.

4.7.3 Volcanic Hazard Areas

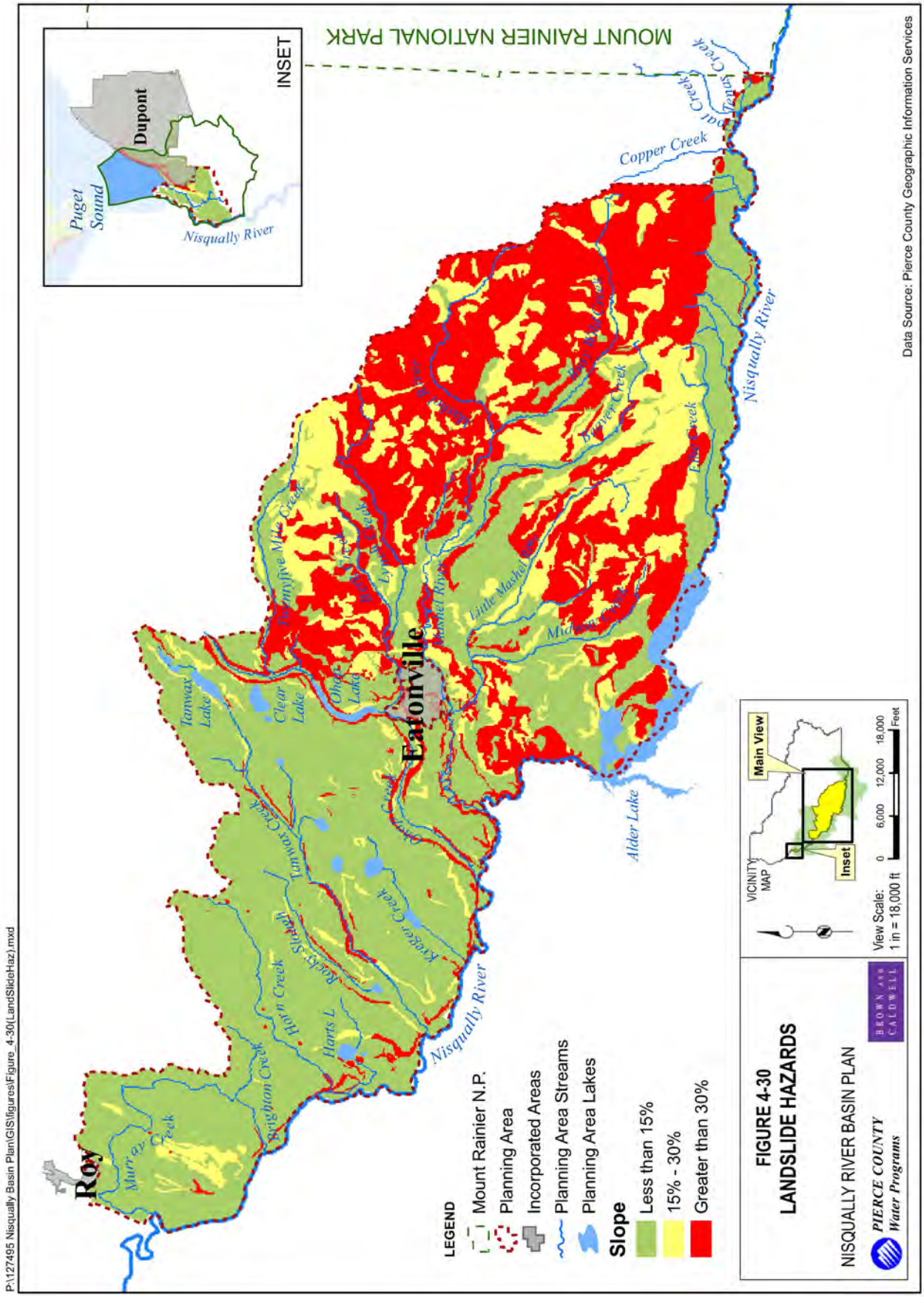
Mount Rainier, which is identified by USGS volcanologists as being in an active eruptive window, is located at the eastern edge of the Nisqually River Basin.

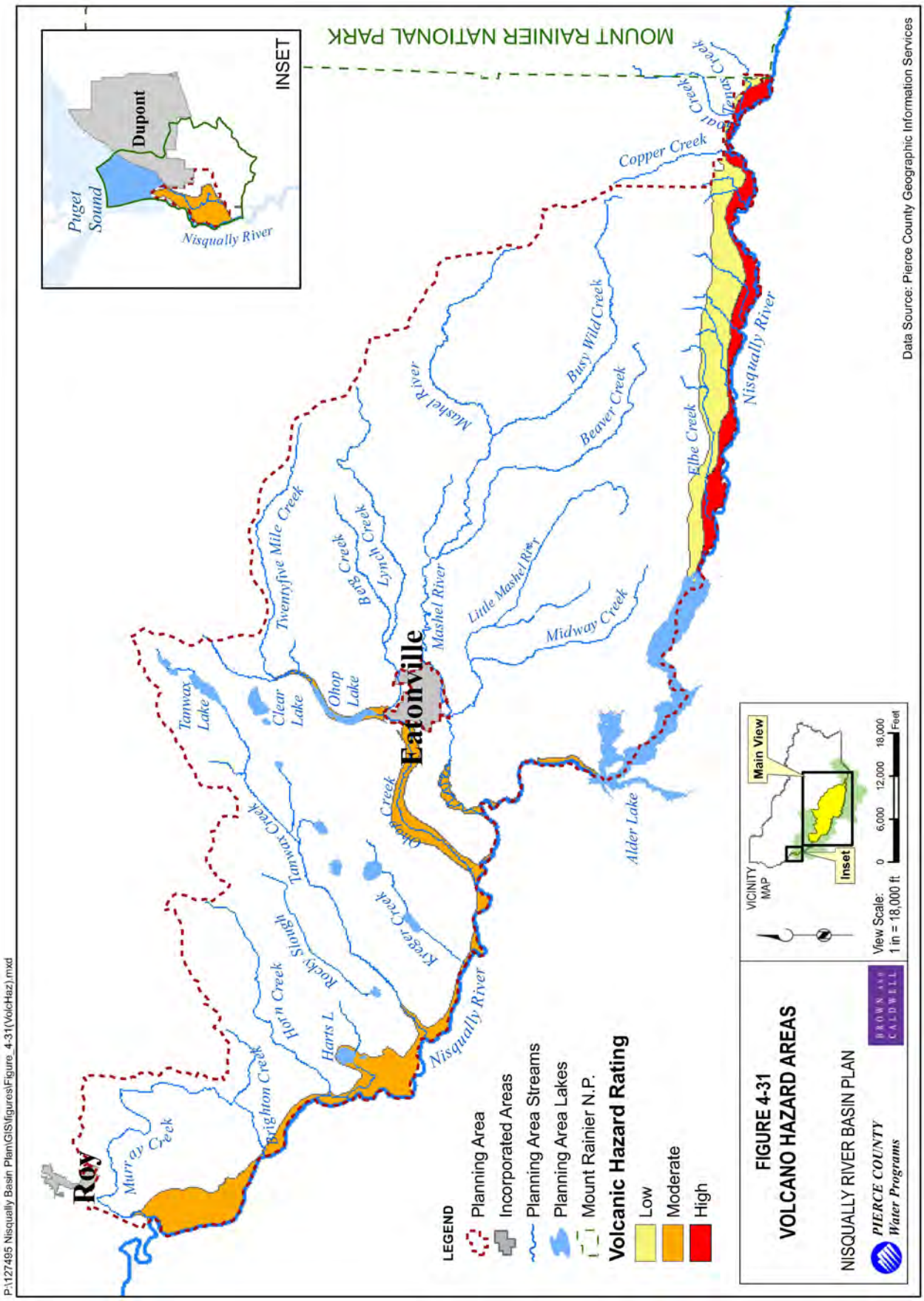
Mount Rainier above the Nisqually River

The primary volcanic hazard that would be likely to affect the Nisqually River Basin is a lahar. Lahars are fast moving mudflows caused by volcanic events. Lahars are flowing mixtures of water and sediment that contain such a high concentration of rock debris that they look and behave like flowing wet concrete.

They are capable of destroying buildings, bridges, and other man-made structures by battering, dislodgement, and burial.

Because lahars typically flow along river valleys, the area along the Nisqually River is considered to be a lahar hazard area (Pierce County Natural Hazard Mitigation Plan, 2004). See Figure 4-31 for Volcanic Hazard Areas.


P:\127495 Nisqually Basin Plan\GIS\figures\Figure_4-30(LandSlideHaz).mxd
Roy
Eatonville
MOUNT RAINIER NATIONAL PARK
INSET
Dupont
Puget Sound
Nisqually River
Copper Creek
Alder Lake
Tanwax Lake
Clear Lake
Ohop Lake
Kreger Creek
Harts L
Rocky Slough
Horn Creek
Brighton Creek
Murray Creek
Tanwax Creek
Little Mashel River
Mashel River
Beaver Creek
Pete Creek
Midway Creek
Thirtyfive Mile Creek
Data Source: Pierce County Geographic Information Services
LEGEND
Mount Rainier N.P.
Planning Area
Incorporated Areas
Planning Area Streams
Planning Area Lakes
Slope
Less than 15%
15% - 30%
Greater than 30%
VICINITY MAP
Main View
Inset
View Scale: 1 in = 18,000 ft
0 6,000 12,000 18,000 Feet
FIGURE 4-30
LANDSLIDE HAZARDS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL


P:\127495 Nisqually Basin Plan\GIS\figures\Figure_4-31(VolcHaz).mxd
INSET
Puget Sound
Dupont
Nisqually River
MOUNT RAINIER NATIONAL PARK
Copper Creek
Busy Wild Creek
Beaver Creek
Elbe Creek
Nisqually River
Mashel River
Little Mashel River
Midway Creek
Twentyfive Mile Creek
Bear Creek
Lynch Creek
Eatonville
Ohop Lake
Clear Lake
Tanwax Lake
Ohop Creek
Tanwax Creek
Kreger Creek
Alder Lake
Rocky Slough
Horn Creek
Harts L.
Brighton Creek
Murray Creek
Roy
LEGEND
Planning Area
Incorporated Areas
Planning Area Streams
Planning Area Lakes
Mount Rainier N.P.
Volcanic Hazard Rating
Low
Moderate
High
VICINITY MAP
Main View
Inset
View Scale: 1 in = 18,000 ft
0 6,000 12,000 18,000 Feet
FIGURE 4-31
VOLCANO HAZARD AREAS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
Data Source: Pierce County Geographic Information Services

CHAPTER FIVE
IDENTIFICATION OF PROBLEMS

This chapter describes existing and potential surface water management problems within the Nisqually River Basin planning area. Problems identified in this chapter fall into three general categories: flooding /drainage, water quality, and fish habitat.

5.1 IDENTIFICATION OF POTENTIAL PROBLEMS

A preliminary list of potential problems was compiled from numerous sources, including existing reports, county databases, meetings, interviews, questionnaires, and field observations. Sources used to develop the list of potential problems included the following:

- **Interviews with Stakeholders –** As part of the basin planning effort, stakeholders identified in Chapter 3 were contacted. Stakeholders were frequently interviewed by telephone; however meetings were conducted in several cases to facilitate more detailed discussion and locating of problems. Stakeholders such as Pierce County Surface Water Management, Pierce County Transportation Services, Pierce County Planning and Land Services, the Nisqually Tribe, and the Tanwax Basin citizens group identified many existing and potential problems in the Basin.
- **Public Meetings –** County staff and the project team conducted a public meeting on June 1, 2005. Basin residents were invited to discuss problems they have observed in the Basin and point out problem locations on maps. Basin resident questionnaires were made available for those participants who preferred to submit problem descriptions based on the questionnaire. Additional public meetings were in the summer of 2006 after the basin characterization was completed.
- **Basin Resident Questionnaires –** The County mailed questionnaires to 1,705 residents, and 122 completed questionnaires were returned. Their responses identified a total of 289 specific problems. As shown in Figure 5-1, respondents identified 143 problems related to flooding and drainage; 65 were related to water quality; 52 were fish habitat related problems; and 29 questionnaires reported no problems.

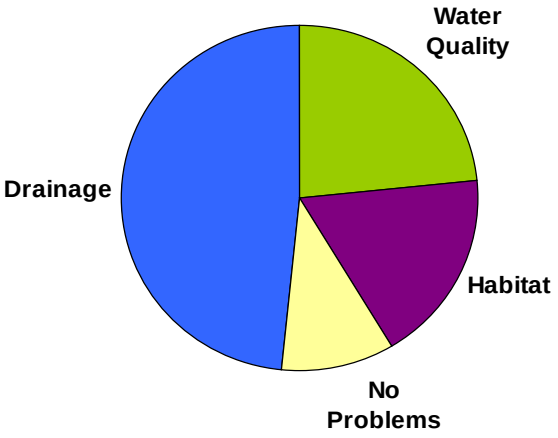


Figure 5-1
Problem Types from Questionnaire

- **Pierce County Service Request System Database (SRS) –** The County's Service Request System (SRS) database contains complaints and service requests for all County services from 1998 to present. This database was queried to identify entries that pertain to flood and drainage, water quality, or fish habitat.

Two queries were performed: the first query used SRS data published in November of 2004. The second query used updated SRS data published in January of 2006, after a prolonged wet period that caused widespread flooding. A total of 43 problems were identified from these queries: 23 were related to flooding and drainage and 20 were related to water quality.

- **Pierce County Surface Water Management Flood of 1996 and Flood of 1997 databases –** During the winters of 1996 and 1997, Pierce County experienced severe storms. During these events, Pierce County Surface Water Management set up a call center to handle the large volume of complaints. Information related to the large storm events was used to create the flood of 96 and flood of 97 databases. These complaints were used to identify flooding problems. Twenty-four flooding problems were identified from these databases.
- **Washington State Department of Ecology's 303(d) List –** Under the federal Clean Water Act (CWA) every state must establish and maintain water quality standards to protect, restore and preserve the quality of waters of the state. In Washington, that responsibility has been assigned to the Washington State Department of Ecology (Ecology). When a lake, river or stream fails to meet the water quality standards after applications of technology-based controls, Section 303(d) of the CWA requires that the state place the water body on a list of impaired water bodies and prepare a total maximum daily load (TMDL) analysis. Section 303(d) listed water bodies within the planning area were included as water quality problems.
- **Pierce Conservation District Culvert Survey** – A culvert survey completed by Pierce Conservation District evaluated stream crossings with regard to fish passage and identified fish barriers. A total of 17 fish barriers were identified within the Basin planning area based on this survey; each was included as fish habitat problems.
- **Nisqually Tribe Stream Conditions Data and EDT Analysis** – As discussed in Chapter 4, the Tribe has conducted numerous stream investigations throughout the planning area over the past 25 years, and has developed an extensive database on stream conditions and aquatic habitat problems. The Tribe developed an EDT model and used it to organize the field data and help the Tribe identify and rank aquatic habitat problems. The Nisqually Tribe has conducted numerous follow-up field investigations to confirm the EDT model projections and update the model as needed.

In addition to the sources described above, problems were identified from existing studies and reports, conversations with local residents, and field observations.

5.2 INVESTIGATION OF POTENTIAL PROBLEMS

Once a potential problem had been brought to the attention of the project team, the potential problem was located on a map. Field investigations were then conducted to ground-truth the potential problems. Finally, data and information concerning the problem was entered into a database so that the information could be sorted and tracked over time.

5.2.1 Problem Locations

As information was collected, problem locations were mapped to examine geographical distribution of the problems. This helped to evaluate the extent of problems and to discern spatial trends.

Several of the problem identification sources were provided in a geographic information system (GIS) format; therefore the problem locations were included with the data.

Problems identified during stakeholder interviews and public meetings were located by providing maps of the planning area that could be used for visual reference. Often problem locations were drawn directly onto the maps. In the cases where phone interviews were conducted, locations had to be described.

The problems reported in the questionnaire responses were entered into a database. This database was used to create a GIS data layer by locating a geographic point corresponding to each problem entry. The point locations were first based on the problem location notes that were included in the questionnaire responses. Of the 122 responses, 61 included a description of the problem location. If no problem location was provided, the point was located based on the respondent's address (51 responses included either an address or a name that could be cross-referenced with a tax parcel). The remaining 10 responses could not be located.

Two sources were used to locate fish habitat problems. The first source was the Pierce Conservation District Culvert Survey which was used to locate barriers to fish passage. The second source was the protection and restoration results from the Nisqually Tribe's EDT analysis. The EDT results correspond to stream reaches. However, for the purposes of illustration, each problem location was represented by single point. Therefore, fish habitat problems identified from the results of the EDT analysis were located by placing a point at the midpoint of the corresponding stream reach.

If a problem was found to be located outside of the planning area, it was removed from the database.

5.2.2 Field Investigation

After problem information had been collected and problem locations were mapped, the project team conducted field investigations. The objectives of these investigations were to:

- Conduct brief site assessments of problem areas to obtain a better understanding of the problem and the existing conditions.
- Refine problem locations.
- Photograph problem locations and major features of the Basin, such as stream crossings, lakes, and hydraulic structures.
- Observe the general characteristics of the planning area and each subbasin.

5.2.3 Database Development

Problems identified from each of the sources described above were combined into a single problem database. The database was created in the form of a *geo*-database, which retains the geographic information associated with the GIS layers used to map the problem locations. Each problem was stored in the geo-database corresponds to a single point location. The database includes fields for each of the criteria included in Surface Water Management's project ranking system for basin plans.

All of the identified problems were plotted together; entries representing the same problem or a closely related problem were grouped together. For example, if flooding was reported on two different properties, but both occurrences could be attributed to the same flooding problem, then these were grouped into one problem. Each problem was assigned a unique identification number beginning with a three letter prefix that identifies the subbasin.

Information collected on each of the problems, including observations from the field investigations, photographs, and sketches, was compiled and input into the database.

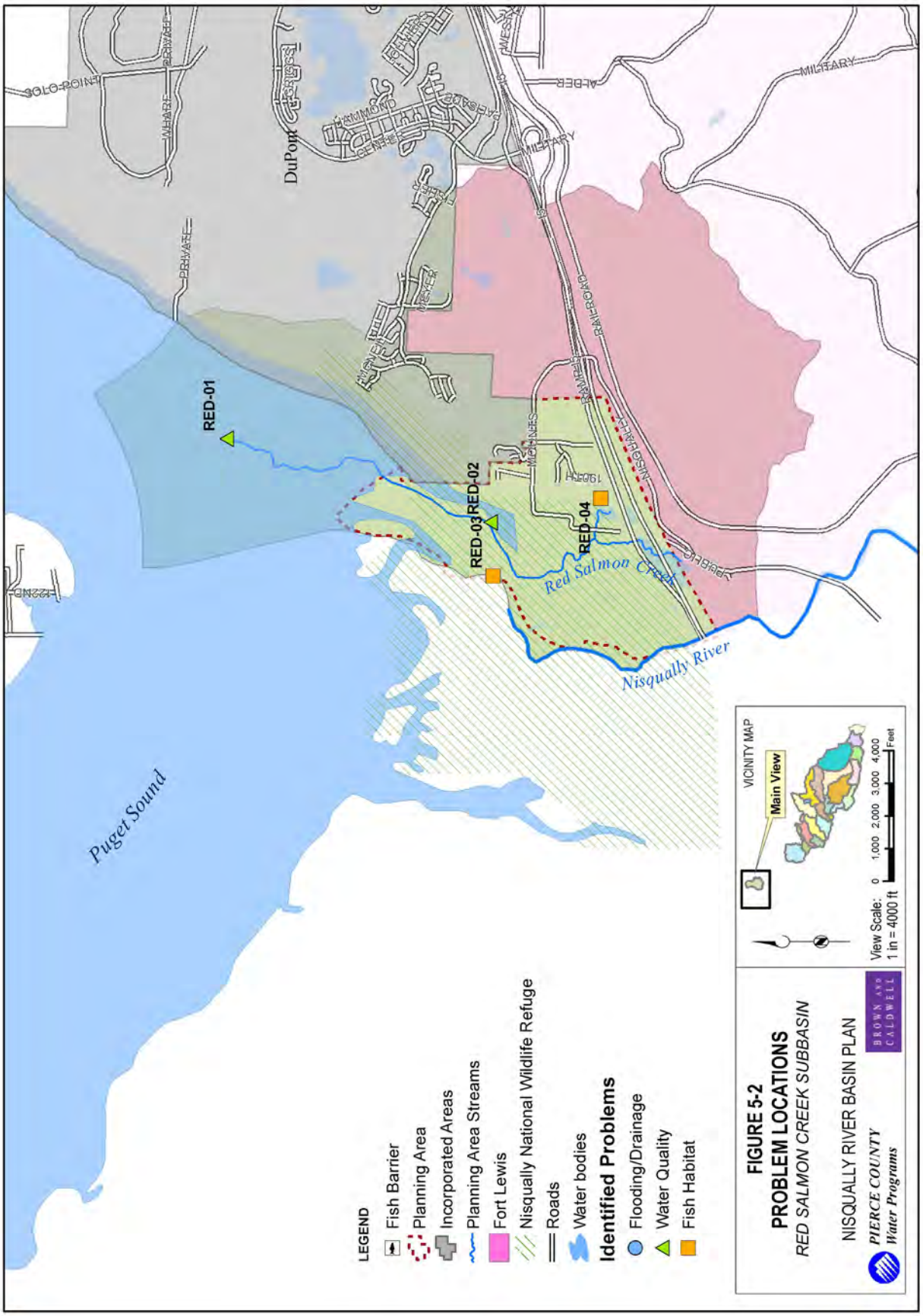
Attribute tables from the EDT analysis were imported into the problems database and linked to the problem locations using a *join* based on the EDT reach name. A join is a relationship linking two or more tables in a database using a unique identifier. In the case of the EDT analysis, the unique identifier was the reach name.

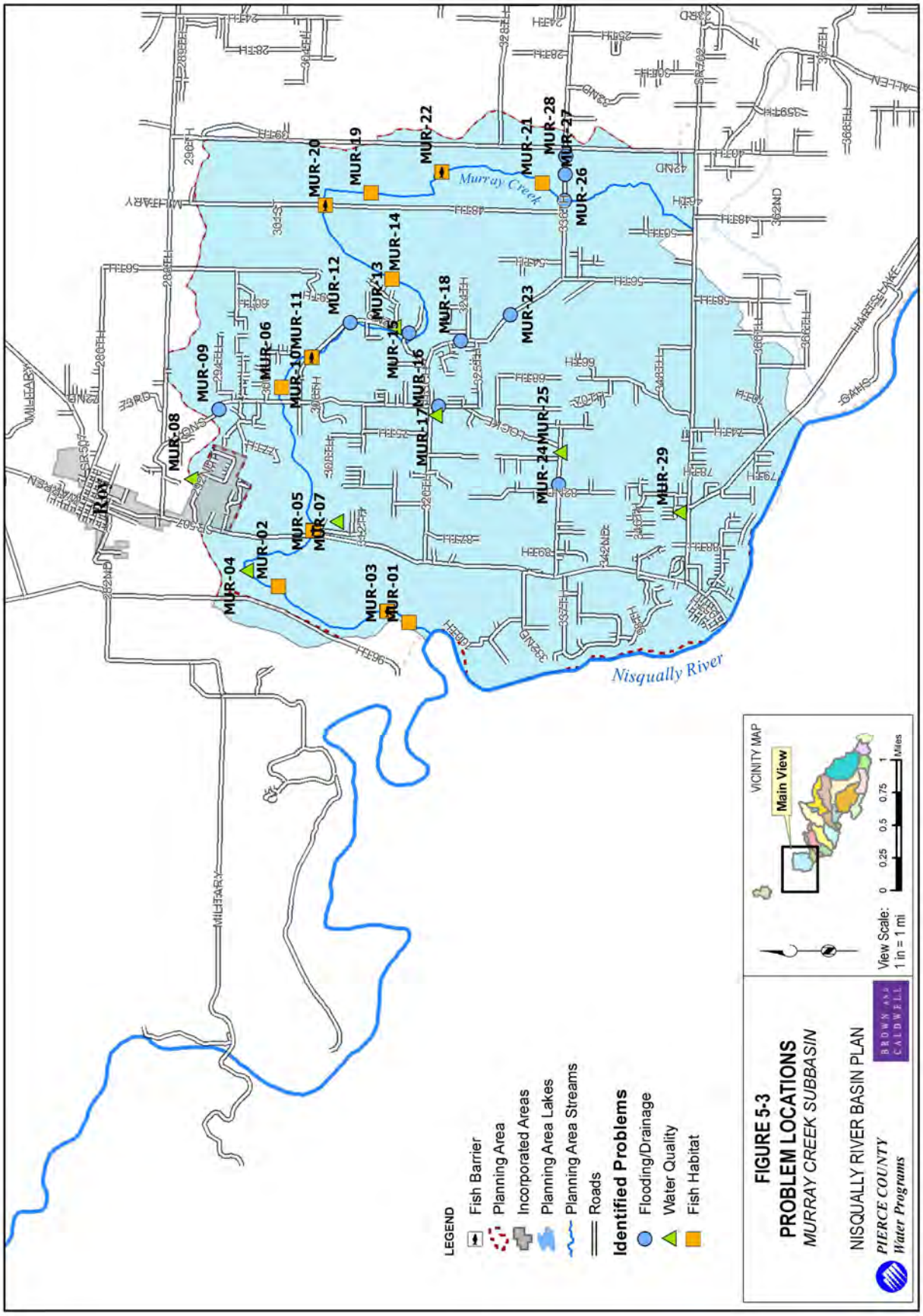
5.3 SPECIFIC PROBLEMS

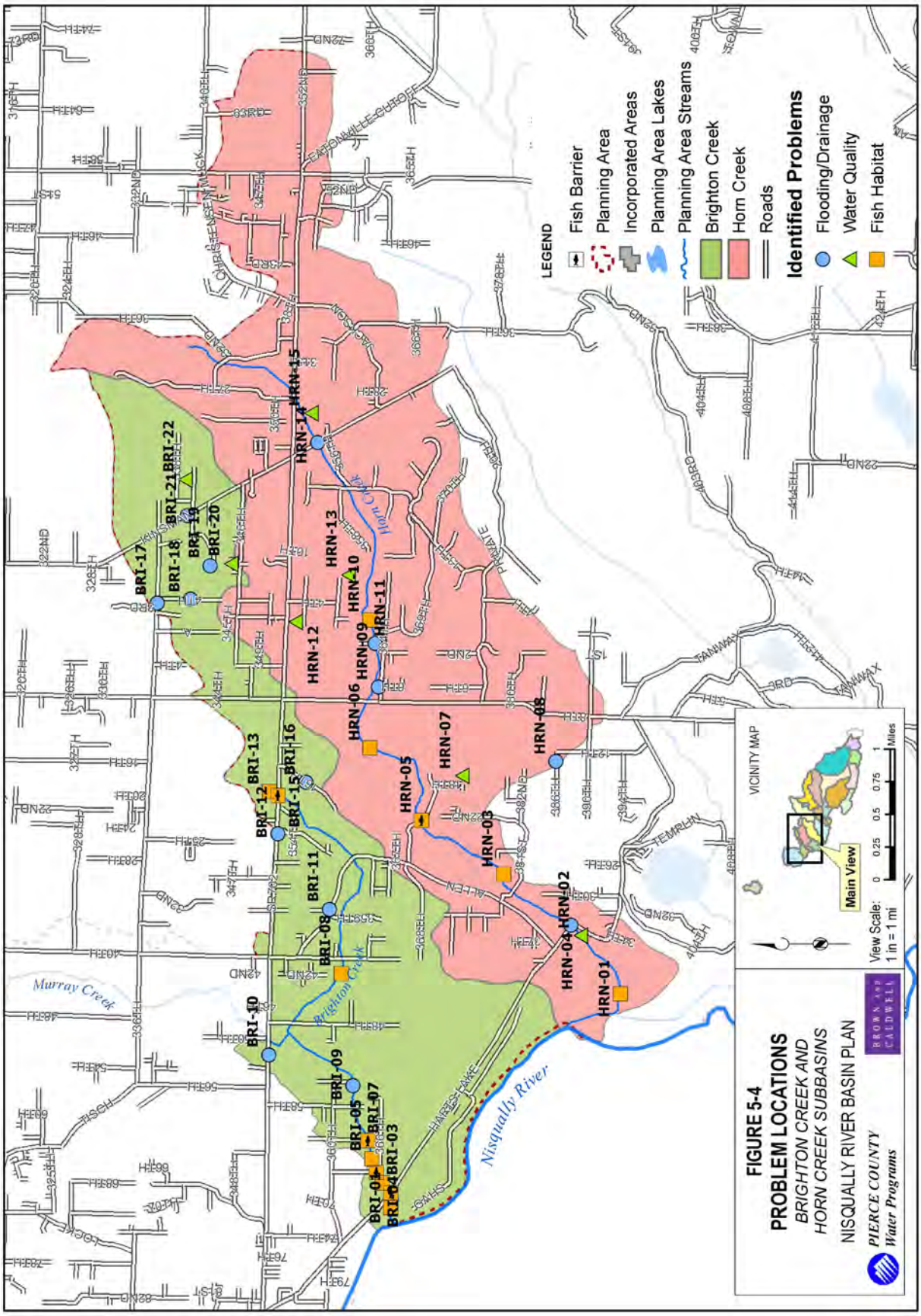
A total of 232 specific problems were identified during the problem investigation: **89 are related to flooding and drainage, 51 water quality, and 92 fish habitat**. The locations of all three types of problems are plotted together by subbasin on Figures 5-2 through 5-12. Each problem is labeled with a problem identification number, which consists of a three letter abbreviation for the subbasin following by a number that is unique within the subbasin.

Following the figures is a series of four tables:

- Table 5-1 lists each of the specific flooding and drainage problems. This table identifies the location of each problem and briefly describes problem.
- Table 5-2 lists each of the specific water quality problems. This table briefly describes each problem and identifies the location.
- Table 5-3 lists each of the barriers to fish passage.
- Table 5-4 lists the EDT reaches with an assigned problem ID.


LEGEND
Fish Barrier
Planning Area
Incorporated Areas
Planning Area Streams
Fort Lewis
Nisqually National Wildlife Refuge
Roads
Water bodies
Identified Problems
Flooding/Drainage
Water Quality
Fish Habitat
FIGURE 5-2
PROBLEM LOCATIONS
RED SALMON CREEK SUBBASIN
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL
VICINITY MAP
Main View
View Scale: 1 in = 4000 ft
0 1,000 2,000 3,000 4,000 Feet
Puget Sound
Nisqually River
Red Salmon Creek
RED-01
RED-02
RED-03
RED-04
DuPont
SOLO POINT
WHARF
PRIVATE
22ND
DRIVE
MILITARY
ALDER
RAILROAD
NISQUALLY
MOUNTAIN
19DTH


MUR-01
MUR-02
MUR-03
MUR-04
MUR-05
MUR-06
MUR-07
MUR-08
MUR-09
MUR-10
MUR-11
MUR-12
MUR-13
MUR-14
MUR-15
MUR-16
MUR-17
MUR-18
MUR-19
MUR-20
MUR-21
MUR-22
MUR-23
MUR-24
MUR-25
MUR-26
MUR-27
MUR-28
MUR-29
Murray Creek
Nisqually River
ROY
LEGEND
Fish Barrier
Planning Area
Incorporated Areas
Planning Area Lakes
Planning Area Streams
Roads
Identified Problems
Flooding/Drainage
Water Quality
Fish Habitat
VICINITY MAP
Main View
View Scale: 1 in = 1 mi
0 0.25 0.5 0.75 1 Miles
FIGURE 5-3
PROBLEM LOCATIONS
MURRAY CREEK SUBBASIN
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL


LEGEND
Fish Barrier
Planning Area
Incorporated Areas
Planning Area Lakes
Planning Area Streams
Brighton Creek
Horn Creek
Roads
Identified Problems
Flooding/Drainage
Water Quality
Fish Habitat
VICINITY MAP
Main View
View Scale: 1 in = 1 mi
0 0.25 0.5 0.75 1 Miles
FIGURE 5-4
PROBLEM LOCATIONS
BRIGHTON CREEK AND
HORN CREEK SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL
Murray Creek
Brighton Creek
Horn Creek
Nisqually River
BRI-01
BRI-02
BRI-03
BRI-04
BRI-05
BRI-06
BRI-07
BRI-08
BRI-09
BRI-10
BRI-11
BRI-12
BRI-13
BRI-15
BRI-16
BRI-17
BRI-18
BRI-19
BRI-20
BRI-21
BRI-22
HRN-01
HRN-02
HRN-03
HRN-04
HRN-05
HRN-06
HRN-07
HRN-08
HRN-09
HRN-10
HRN-11
HRN-12
HRN-13
HRN-14
HRN-15

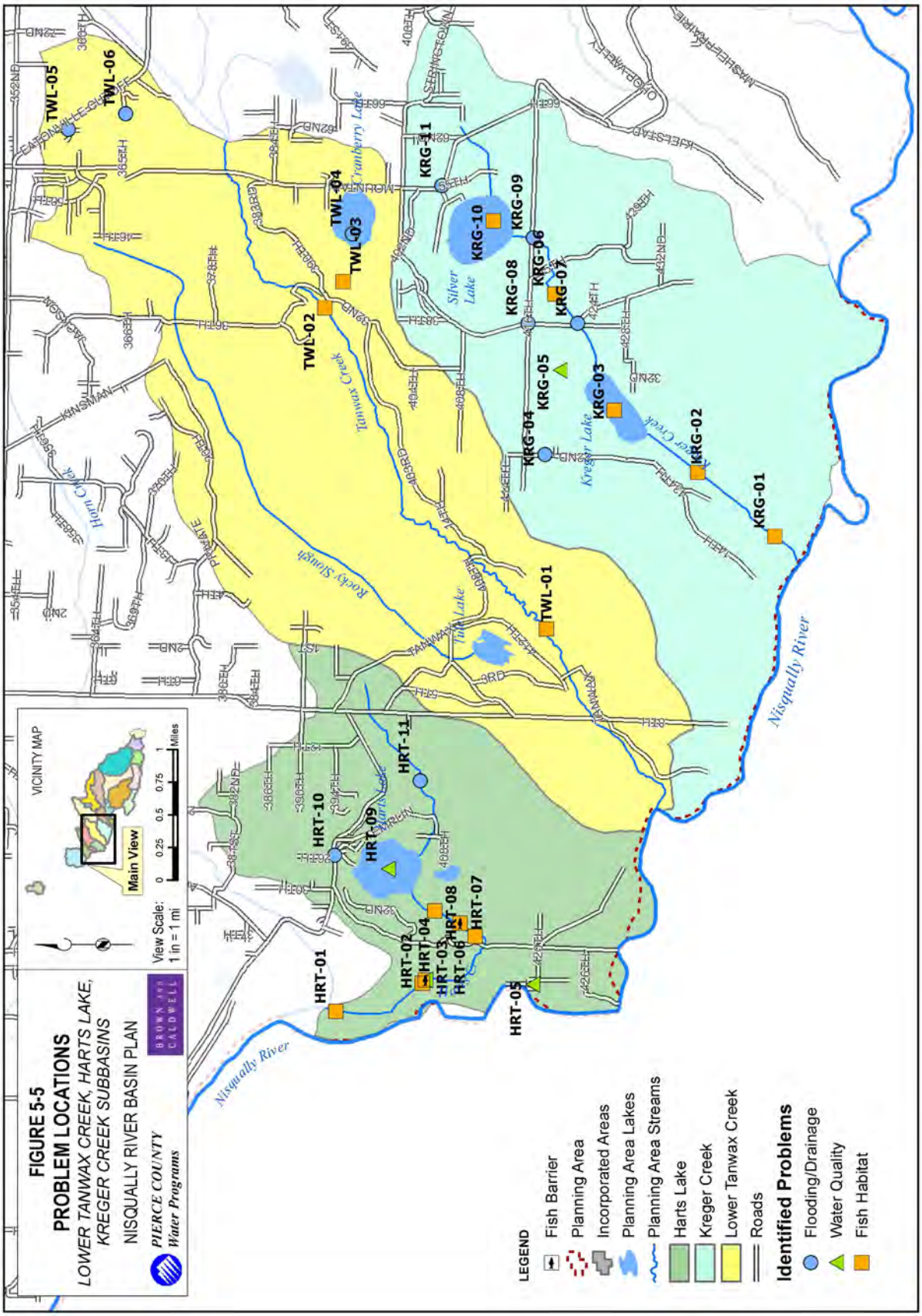


FIGURE 5-5
PROBLEM LOCATIONS
LOWER TANWAX CREEK, HARTS LAKE, KREGER CREEK SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
View Scale: 1 in = 1 mi
0 0.25 0.5 0.75 1 Miles
VICINITY MAP
Main View
LEGEND
Fish Barrier
Planning Area
Incorporated Areas
Planning Area Lakes
Planning Area Streams
Harts Lake
Kreger Creek
Lower Tanwax Creek
Roads
Identified Problems
Flooding/Drainage
Water Quality
Fish Habitat
TWL-01
TWL-02
TWL-03
TWL-04
TWL-05
TWL-06
KRG-01
KRG-02
KRG-03
KRG-04
KRG-05
KRG-06
KRG-07
KRG-08
KRG-09
KRG-10
KRG-11
HRT-01
HRT-02
HRT-03
HRT-04
HRT-05
HRT-06
HRT-07
HRT-08
HRT-09
HRT-10
HRT-11
Nisqually River
Tanwax Creek
Rocky Slough
Cranberry Lake
Silver Lake
Kreger Lake
Kreger Creek
Harts Lake
Horn Creek

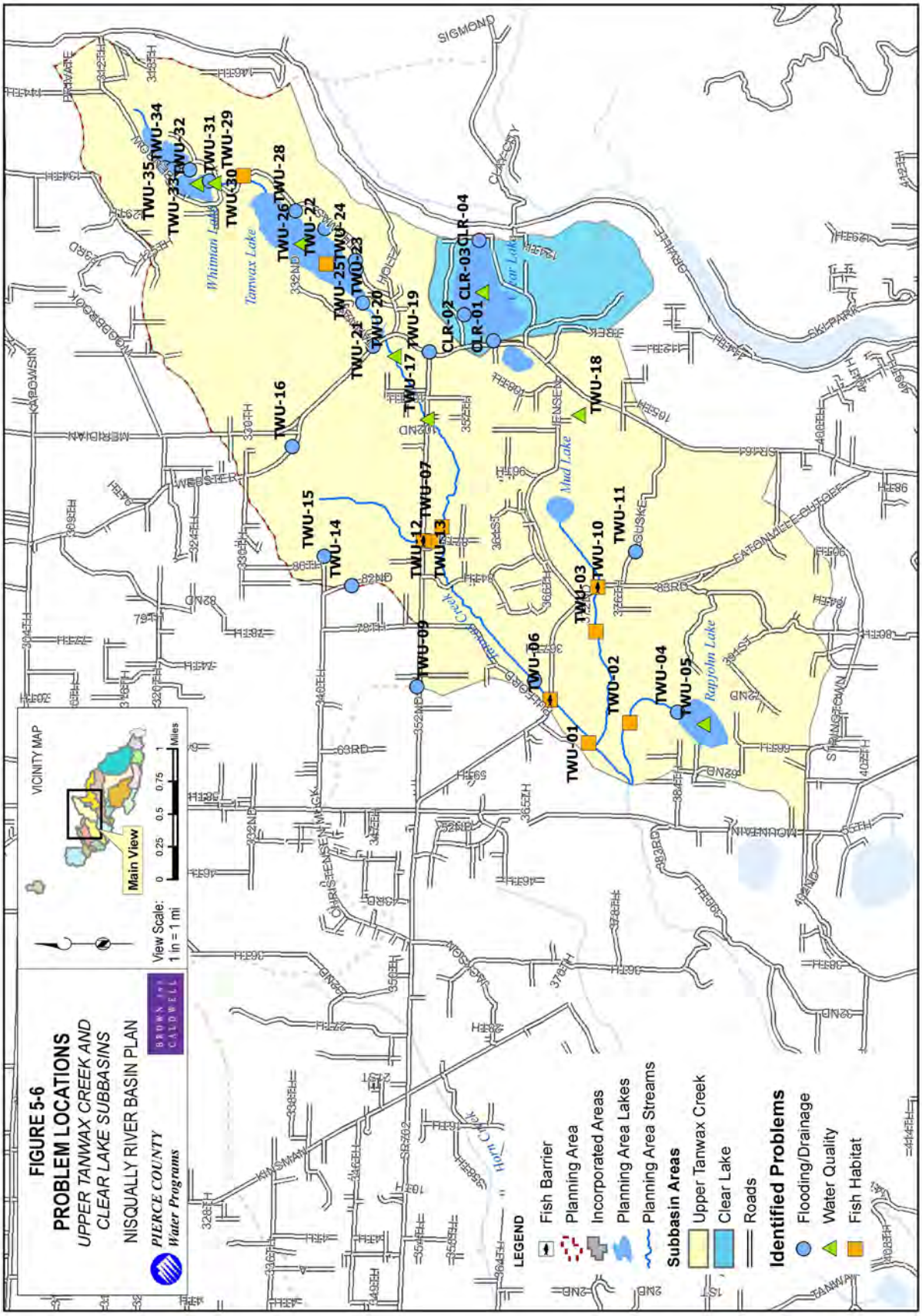


FIGURE 5-6
PROBLEM LOCATIONS
UPPER TANWAX CREEK AND CLEAR LAKE SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL
View Scale: 1 in = 1 mi
0 0.25 0.5 0.75 1 Miles
VICINITY MAP
Main View
LEGEND
Fish Barrier
Planning Area
Incorporated Areas
Planning Area Lakes
Planning Area Streams
Subbasin Areas
Upper Tanwax Creek
Clear Lake
Roads
Identified Problems
Flooding/Drainage
Water Quality
Fish Habitat
TWU-01
TWU-02
TWU-03
TWU-04
TWU-05
TWU-06
TWU-07
TWU-09
TWU-10
TWU-11
TWU-12
TWU-13
TWU-14
TWU-15
TWU-16
TWU-17
TWU-18
TWU-19
TWU-20
TWU-21
TWU-22
TWU-23
TWU-24
TWU-25
TWU-26
TWU-28
TWU-29
TWU-30
TWU-31
TWU-32
TWU-33
TWU-34
TWU-35
CLR-01
CLR-02
CLR-03
CLR-04
Tanwax Lake
Whitman Lake
Clear Lake
Mud Lake
Rapjohn Lake
Tanwax Creek
Hoh Creek
CLARK CITY
SIGMON
SKI PARK
EATONVILLE-GUSTOFF
MOUNTAIN
SPRINGTOWN
KIMSMAN
CHRISTENSEN
MERIDIAN
NISKOGEBOOK
WOODBROOK
DRAWER
ORAVILLE

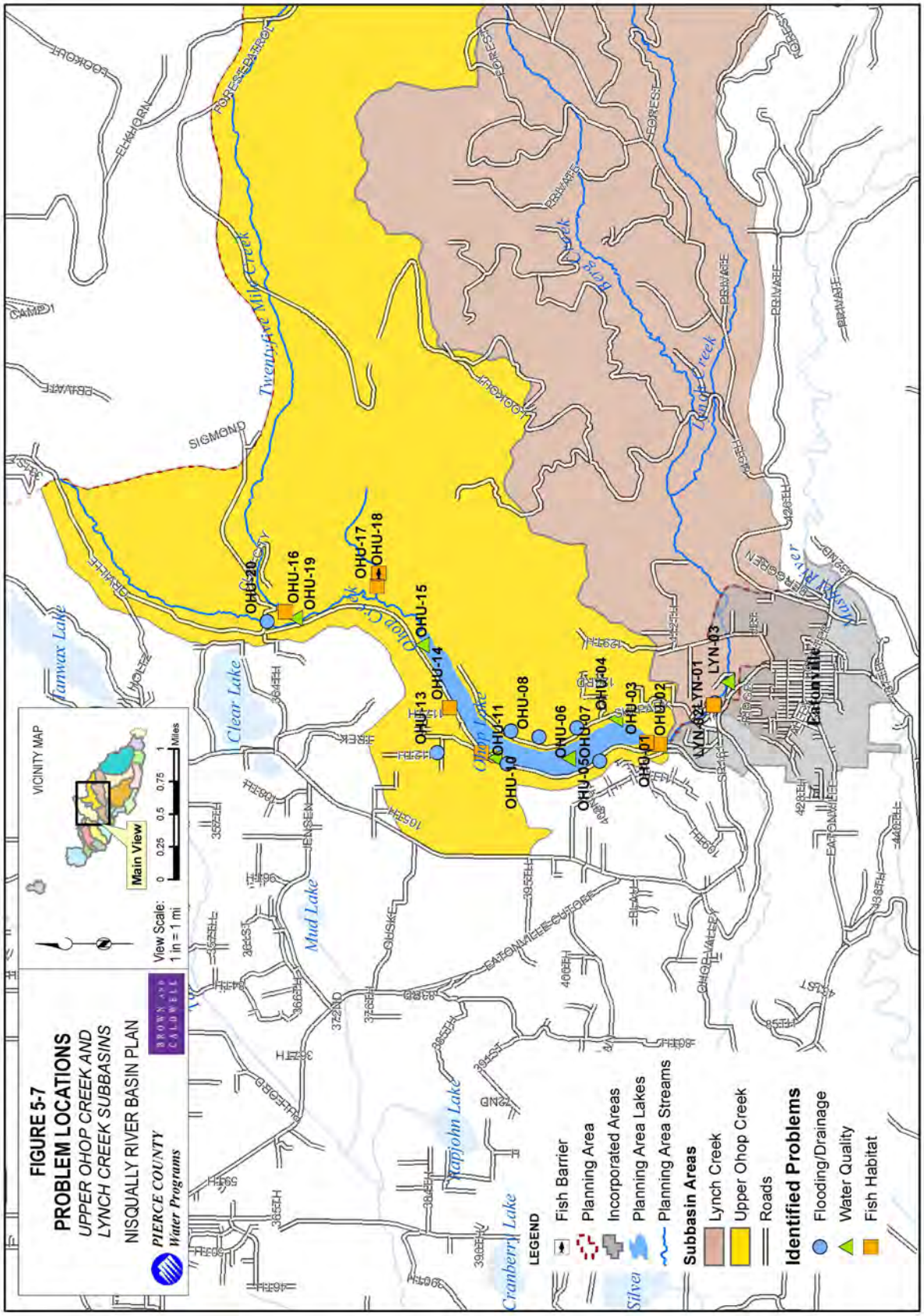


FIGURE 5-7
PROBLEM LOCATIONS
UPPER OHOP CREEK AND
LYNCH CREEK SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL
VICINITY MAP
Main View
View Scale:
1 in = 1 mi
0 0.25 0.5 0.75 1 Miles
LEGEND
Fish Barrier
Planning Area
Incorporated Areas
Planning Area Lakes
Planning Area Streams
Subbasin Areas
Lynch Creek
Upper Ohop Creek
Roads
Identified Problems
Flooding/Drainage
Water Quality
Fish Habitat
OHU-20
OHU-16
OHU-19
OHU-17
OHU-18
OHU-15
OHU-14
OHU-13
OHU-11
OHU-10
OHU-08
OHU-06
OHU-05
OHU-07
OHU-04
OHU-03
OHU-02
OHU-01
LYN-02
LYN-01
LYN-03
Twenty-Five Mile Creek
Ohop Creek
Lynch Creek
Clear Lake
Mud Lake
Kapjohn Lake
Cranberry Lake
Tanwax Lake
Silver
Nisqually River
Eatonville
SIGMOND
EATONVILLE-COUPEVILLE
FOREST
PRIVATE

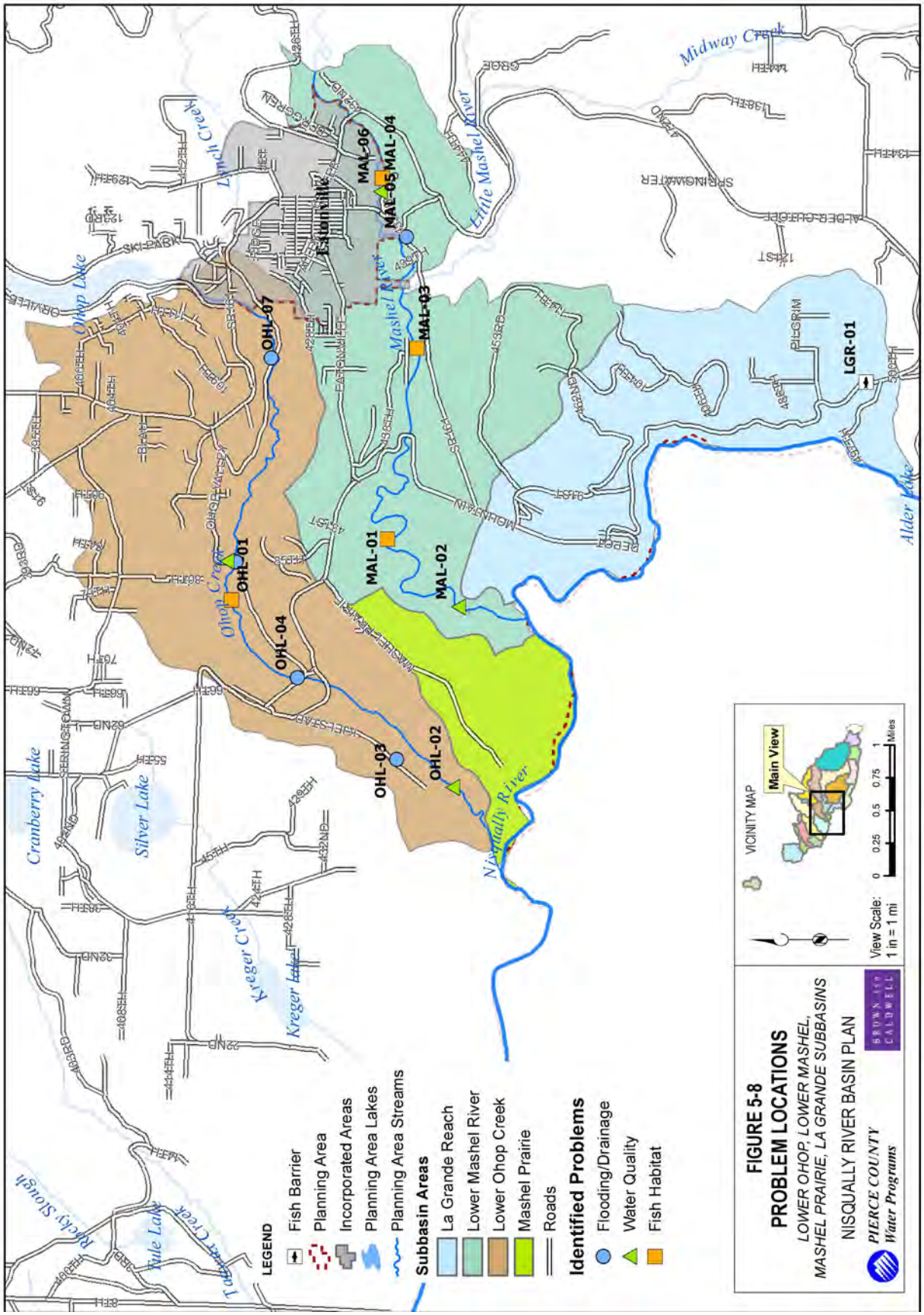
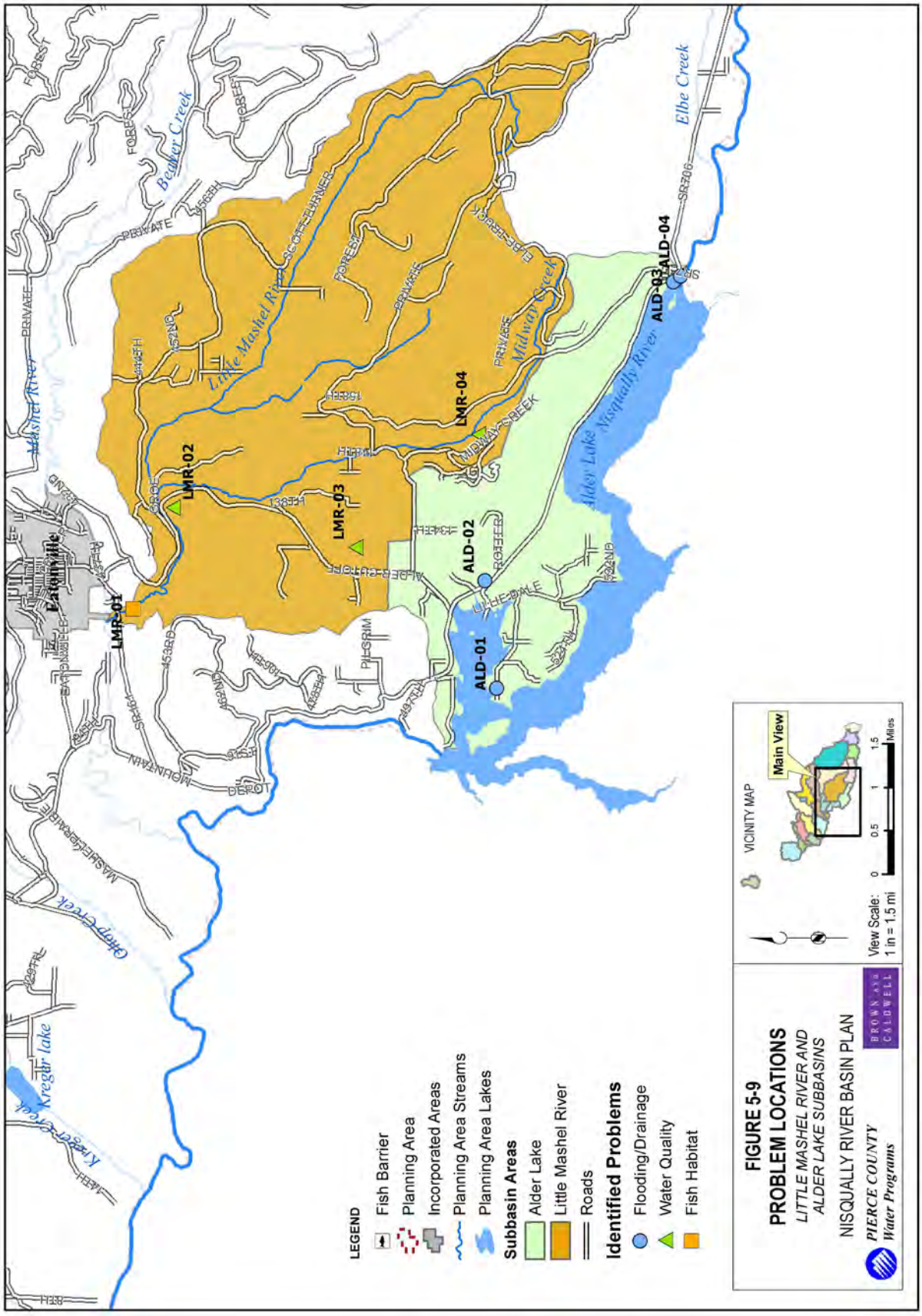
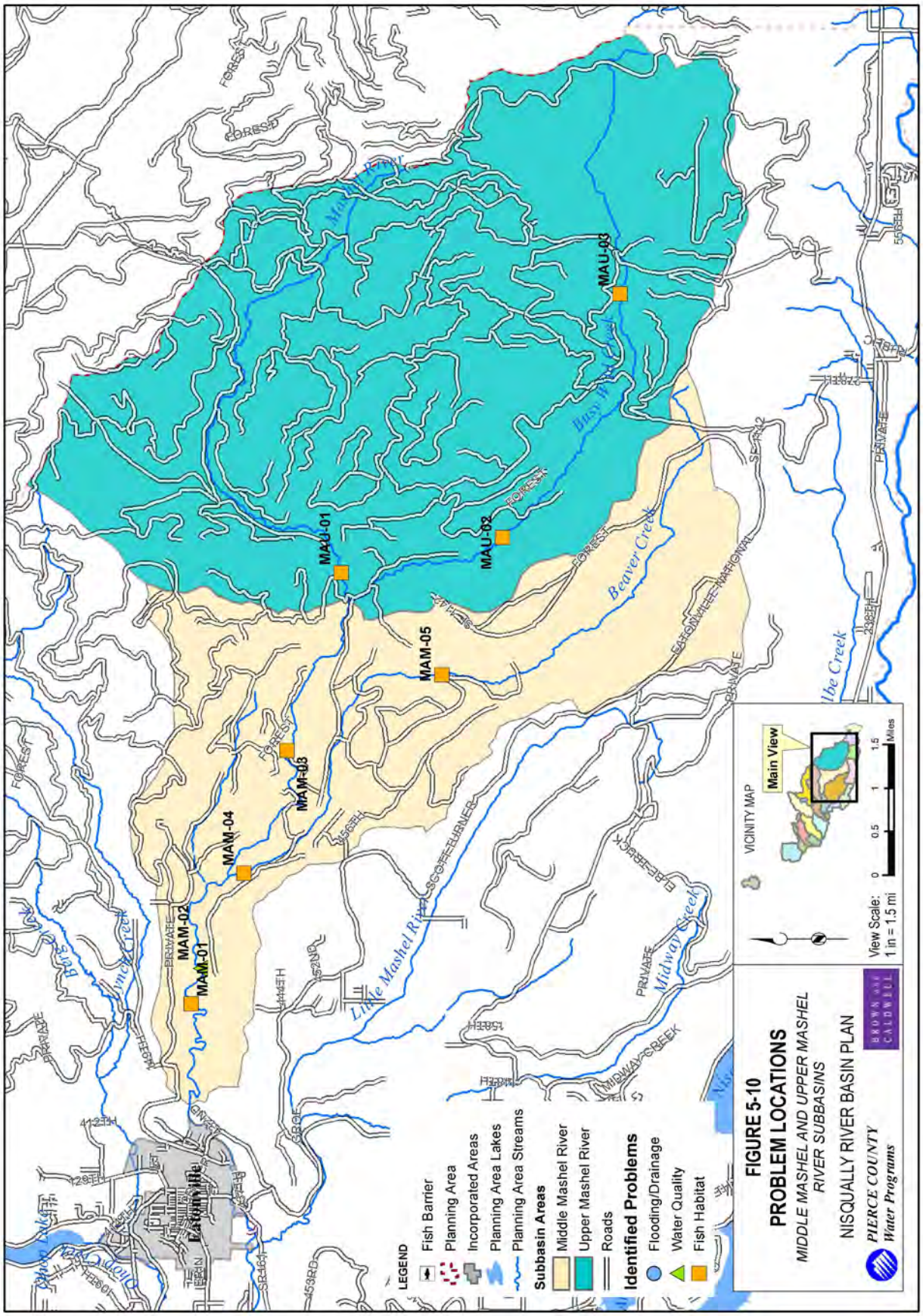
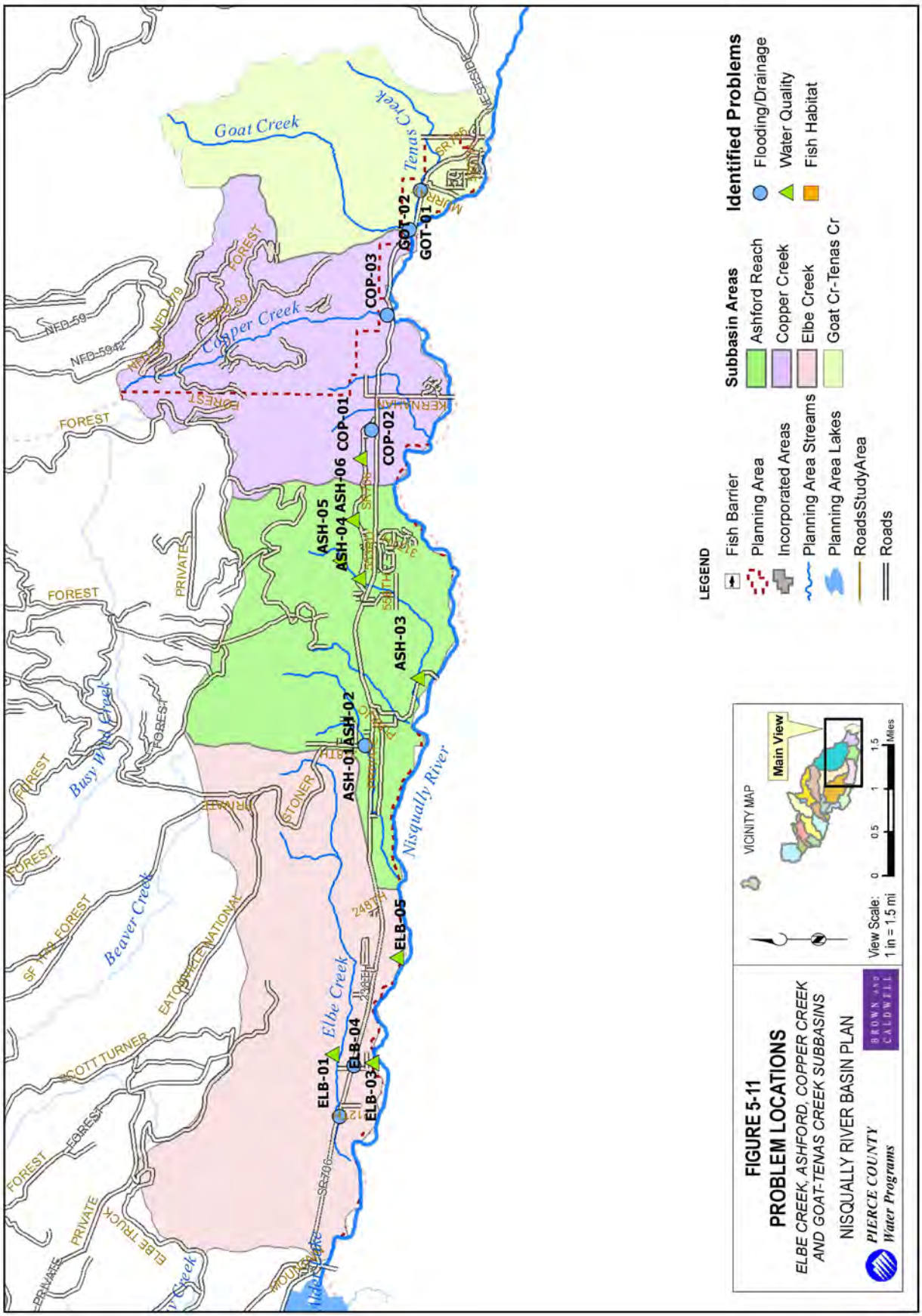


FIGURE 5-8
PROBLEM LOCATIONS
LOWER OHOP, LOWER MASHEL, MASHEL PRAIRIE, LA GRANDE SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
View Scale: 1 in = 1 mi
0 0.25 0.5 0.75 1 Miles
VICINITY MAP
Main View
LEGEND
Fish Barrier
Planning Area
Incorporated Areas
Planning Area Lakes
Planning Area Streams
Subbasin Areas
La Grande Reach
Lower Mashel River
Lower Ohop Creek
Mashel Prairie
Roads
Identified Problems
Flooding/Drainage
Water Quality
Fish Habitat
OHL-01
OHL-02
OHL-03
OHL-04
OHL-07
MAL-01
MAL-02
MAL-03
MAL-04
MAL-05
MAL-06
LGR-01
Ohop Lake
Ohop Creek
Lynch Creek
Eatonville
Mashel River
Little Mashel River
Midway Creek
Nisqually River
Alder Lake
Cranberry Lake
Silver Lake
Kreger Creek
Kreger Lake
Rule Lake
Rocky Slough
Tanwax Creek


LEGEND
Fish Barrier
Planning Area
Incorporated Areas
Planning Area Streams
Planning Area Lakes
Subbasin Areas
Alder Lake
Little Mashel River
Roads
Identified Problems
Flooding/Drainage
Water Quality
Fish Habitat
FIGURE 5-9
PROBLEM LOCATIONS
LITTLE MASHEL RIVER AND
ALDER LAKE SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL
VICINITY MAP
Main View
View Scale:
1 in = 1.5 mi
0
0.5
1
1.5
Miles
LMR-01
LMR-02
LMR-03
LMR-04
ALD-01
ALD-02
ALD-03
ALD-04
Eatonville
Little Mashel River
Alder Lake
Nisqually River
Elbe Creek
Midway Creek
Beaver Creek
Ohop Creek
Kregar Lake


MAU-01
MAU-02
MAU-03
MAM-01
MAM-02
MAM-03
MAM-04
MAM-05
Busy Wren Creek
Beaver Creek
Little Mashel River
Midway Creek
Eatonville
LEGEND
Fish Barrier
Planning Area
Incorporated Areas
Planning Area Lakes
Planning Area Streams
Subbasin Areas
Middle Mashel River
Upper Mashel River
Roads
Identified Problems
Flooding/Drainage
Water Quality
Fish Habitat
VICINITY MAP
Main View
View Scale:
1 in = 1.5 mi
Miles
FIGURE 5-10
PROBLEM LOCATIONS
MIDDLE MASHEL AND UPPER MASHEL
RIVER SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL


Goat Creek
Tenas Creek
Copper Creek
Busy Wash Creek
Beaver Creek
Elbe Creek
Nisqually River
GOT-01
GOT-02
COP-01
COP-02
COP-03
ASH-01
ASH-02
ASH-03
ASH-04
ASH-05
ASH-06
ELB-01
ELB-03
ELB-04
ELB-05
FOREST
PRIVATE
NFD-59
NFD-5942
NFD-79
SCOTT TURNER
ELBE TRUCK
STONER
KERNAHAN
SR-706
LEGEND
Fish Barrier
Planning Area
Incorporated Areas
Planning Area Streams
Planning Area Lakes
RoadsStudyArea
Roads
Subbasin Areas
Ashford Reach
Copper Creek
Elbe Creek
Goat Cr-Tenas Cr
Identified Problems
Flooding/Drainage
Water Quality
Fish Habitat
VICINITY MAP
Main View
View Scale:
1 in = 1.5 mi
0
0.5
1
1.5
Miles
FIGURE 5-11
PROBLEM LOCATIONS
ELBE CREEK, ASHFORD, COPPER CREEK
AND GOAT-TENAS CREEK SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL

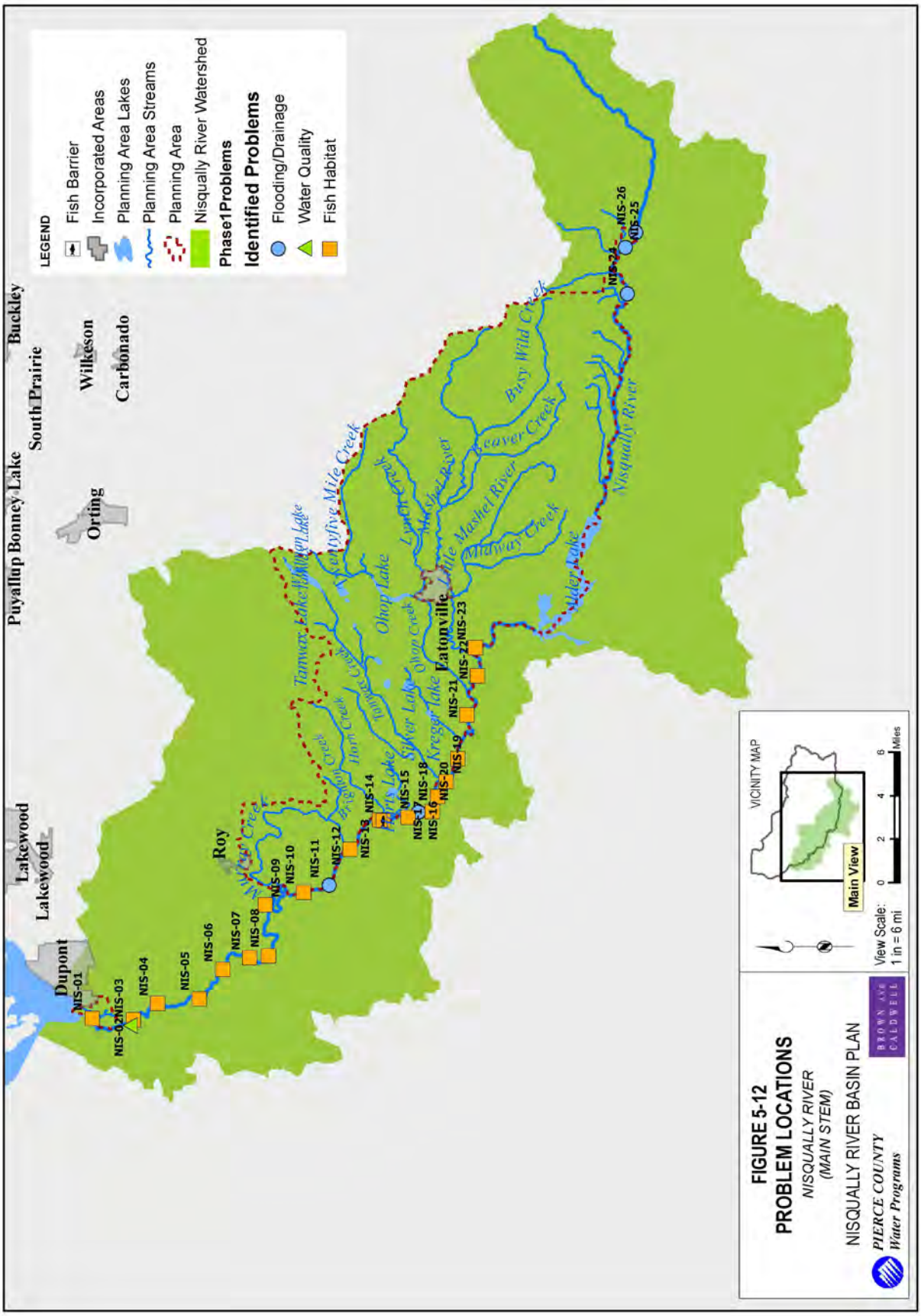

LEGEND
Fish Barrier
Incorporated Areas
Planning Area Lakes
Planning Area Streams
Planning Area
Nisqually River Watershed
Phase1Problems
Identified Problems
Flooding/Drainage
Water Quality
Fish Habitat
Puyallup Bonney Lake
Buckley
South Prairie
Wilkeson
Carbonado
Orting
Lakewood
Lakewood
Dupont
Roy
Eatonville
NIS-01
NIS-02
NIS-03
NIS-04
NIS-05
NIS-06
NIS-07
NIS-08
NIS-09
NIS-10
NIS-11
NIS-12
NIS-13
NIS-14
NIS-15
NIS-16
NIS-17
NIS-18
NIS-19
NIS-20
NIS-21
NIS-22
NIS-23
NIS-24
NIS-25
NIS-26
Tanwax Lake
Kapowsin Lake
Ohop Lake
Kreger Lake
Silver Lake
Alder Lake
Mashel River
Little Mashel River
Beaver Creek
Busy Wild Creek
Nisqually River
Mid Fork Creek
Ohop Creek
Lynn Creek
Tanwax Creek
Hom Creek
Bridge Creek
Mid Fork Creek
Twenty Five Mile Creek
Midway Creek
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
FIGURE 5-12
PROBLEM LOCATIONS
NISQUALLY RIVER
(MAIN STEM)
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AVE CALDWELL

TABLE 5-1
Flooding and Stormwater Drainage Problems Summary

Problem ID	Location	Description
ALD-01	10619 Cemetery Rd. E.	Roadway flooding; overflow of culverts, blocked drainage.
ALD-02	Tributary to Alder Lake near intersection of Lillie Dale Rd and Mountain Hwy (SR 7)	Overflowing ditches near the intersection.
ALD-03	Near Elbe between Alder Lake and Railroad tracks.	Blockage of drainage system on private property causes backups in County system
ALD-04	Town of Elbe near Lake Alder	There is some anecdotal evidence that the community of Elbe has had flooding problems. A small bank revetment/dike has been constructed along the north bank.
ASH-01	Drainage crossing 278th Ave E between SR 706 and 549th St E (55007 278th Ave E)	Blocked culvert; sedimentation. Erosion upstream.
ASH-02	55007 278th Ave E	From a residential survey, flooding over the roadway where stream crosses under 278th Avenue East.
BRI-06	Brighton Creek crossing of 62nd Ave S approx. 400 m south of 360th St S.	Culvert is submerged by standing water.
BRI-09	36121 55th Ave S	Blocked ditch.
BRI-10	Along Hwy 702 east of intersection with 56th Ave S. (35018 50th Ave S)	Seasonal ditch running diagonally across property does not drain properly and floods every year. Direction of flow unclear.
BRI-11	Allen Road and 359th Ave S (35915 Allen Rd S)	Drainage blocked by debris/sediment.
BRI-12	2410 SR 702 E	Flooding related to development
BRI-14	2410 SR 702 S	Flooding on private property.
BRI-16	35414 16th Ave S	Flooding over roadway/blocked ditch.
BRI-17	336th St E approx. 40 m west of 4th Ave E	Flooding over road. Standing water on both sides of 336th.
BRI-18	671 341 St. Ct. E.; 821 341st St. Ct. E.	Blockage of culverts, dams, debris, etc.; flooding of private property; overflow of culverts.
BRI-19	671 341 St. Ct. E.	Flooding of private property after new culvert installed at Kingsman; overflow of culverts.
BRI-21	Drainage crossing Kinsman Rd near 340th Ave S	Installation of new culvert causing downstream flooding.
CLR-01	Between SR 161 and Clear Lake (35921 West Clear Lake Rd E)	Flooding of private property; Runoff from Hwy 161 floods W. Clear Lake Road and private property.
CLR-02	Clear Lake at 11512, 11516 Clear Lake North Rd E	Flooding of private property; 11516 and 11512 Clear Lake Road N.
CLR-04	East side of Clear Lake at outlet.	Outlet to Clear Lake is near steep slope of Ohop Valley. Potential slope failure.
COP-02	SR 706 between Ashford and Kernahan Rd	Flooding over roadway where Copper Creek passes under SR-706 East.

TABLE 5-1
Flooding and Stormwater Drainage Problems Summary

Problem ID	Location	Description
COP-03	Copper Creek crossing of SR 706	Copper Creek crossing at SR 706 possible scour hazard.
ELB-01	SR 706 E approximately 0.5 miles west of Park Junction Rd	Flooding over SR-706 East approximately 0.5 miles West of Park Junction Road.
ELB-03	Park Junction Rd and SR 706 E	Flooding over roadway at junction of SR-706 East and Park Junction Road.
GOT-01	Goat Creek crossing of SR 706	Goat Creek crossing of SR 706 could have capacity problems due to sedimentation and debris.
GOT-02	Tenas Creek downstream of SR 706	Potential flooding of properties along Tenas Creek.
HRN-04	Horn Creek crossing of Hart's Lake Loop Road.	Reports of blockage of culverts, and debris where Horn Creek crosses under Hart's Lake Loop Road.
HRN-08	1411 338th St E	Flooding on private property. Flooding over roadway.
HRN-09	364th St E approximately 1000 feet east of 8th Ave S	Flooding over roadway.
HRN-11	Horn Creek crossing of 1st Ave S	Ponded water, historically beavers in area.
HRN-14	Horns Creek crossing of Kinsman Road.	Flooding of private property (beavers). Standing water along Kinsman Rd.
HRT-10	39600 Harts Lake Valley Rd	Flooding over road.
HRT-11	39600 Harts Lake Valley Rd	Flooding over 17th Ave South.
KRG-04	250 m south of 416th St E on 22nd Ave E	Blocked ditch and flooding over road.
KRG-07	Kreger Creek crossing of Dean Kreger Road	Blocked drainage. Potential flooding. Man-made channel.
KRG-08	10 m north of 416th St E on Dean Kreger Rd	Blocked drainage. Standing water on either side of Dean Kreger Rd.
KRG-09	Kreger Creek crossing of 416th St E approx 250 m south of Silver Lake	Drainage and flooding problems all along road and adjacent properties.
KRG-11	40515 Mountain Highway (Hwy 7 and Silver Lake Road)	Blocked drainage/culvert. Flooding over road. Flooding related to development.
LYN-02	12116 414th St Ct E	Blockage problem culverts, dams, debris, etc. Flooding of private property.
MAL-05	43919 SR-161	Flooding of private property along State Route 161; overflows of ditches.
MUR-09	Culvert under Lyon Drive South approximately 200 m northwest of 72nd Ave S.	Flooding over the roadway; culvert damage; blocked drainage.
MUR-10	Murray Creek crossing of Hinkleman Road approximately 600 meters east 72nd Avenue S.	Area reported to have flooding problems.
MUR-12	Hinkleman Road, approximately 3/4 mile east of 72nd Avenue S.	Flooding reported along Hinkleman Road.
MUR-15	6106 317th St Ct S. Approximately 200 meters south of Lake Serene along Hinkleman Road.	Flooding of private property reported in January of 1998.

TABLE 5-1
Flooding and Stormwater Drainage Problems Summary

Problem ID	Location	Description
MUR-17	Drainage crossing 72nd Ave S approx. 80 m south of 320th St S.	Overflows of ditches. Culvert mostly submerged; inlet may be blocked. Evidence of beaver activity.
MUR-18	Tisch Road near 324th St Ct S	Flooding along Tisch Road. Culvert under road submerged.
MUR-23	Approximately 400 m south of 32403 Tisch Rd.	Flooding occurring over Tisch Road. Culverts under road are partially submerged. Evidence of beaver activity.
MUR-24	Near intersection of 82nd Ave S and 336th St S; 8102 336th St S, 33717 82nd Ave S	Flooding over roadway causing flooding of private property along Hinkleman Road ¾ mile east of 72nd Avenue South. Blocked drainage.
MUR-26	Along 336th Street between 48th Ave S and 40th Ave S	Flooding and overflows of ditches occurring along 336th Street.
MUR-27	336th St S approximately 1000 feet west of 40th Ave S	Flooding over roadway.
MUR-28	336th St S approximately 400 feet west of 40th Ave S	Flooding over roadway.
OHL-03	44103 Kjelstad Rd E	Mud slides on road.
OHL-04	Ohop Creek (including drainage ditch) at Peterson Road	Flooding of roadway and bridge.
OHL-05	Ohop Creek (including drainage ditch) crossing of Ohop Valley Road	Flooding of roadway and bridge.
OHL-07	Approximately 1 miles west of Eatonville; downstream of SR16 crossing of Ohop Creek	Historical flooding of houses and bridge along Ohop Creek. Repetitive loss area.
OHU-02	Ohop Lake outlet	Blockage, debris at outlet (weir) from Ohop Lake; flooding problems.
OHU-05	Orville Road adjacent to Ohop Lake	Slope failures along road.
OHU-06	Ski Park Road adjacent to Ohop Lake (5414 N 42nd St)	Slope failures all along Ski Park Rd
OHU-08	54th and Warner	Residential questionnaire reported overflows of ditches (corner of 54th and Warner)
OHU-09	Ohop Lake Lot 70: 5414 N 42nd St	Flooding of private property at Lot 70 (5414 N 42nd St).
OHU-11	Ohop Lake at 28112 144th Ave E	Flooding of private property. Overflow of ditches.
OHU-13	37605 112th Ave E	Flooding over roadway.
OHU-20	Ohop Creek crossing of Clay City Road	Clay City road floods frequently; likely caused by beaver blockages of culvert.
TWL-04	Cranberry Lake	Blockages (beavers) at outlet to Cranberry Lake causing water levels to fluctuate.
TWL-05	35809 59th Ave Ct E	Flooding on private property.
TWL-06	6304 365 St E near Weyerhauser Elementary School	Flooding of private property. Culvert damage.
TWU-04	Rapjohn Lake (outlet)	Flooding of private property. Beaver dams and debris at outlet results in higher lake levels.

TABLE 5-1
Flooding and Stormwater Drainage Problems Summary

Problem ID	Location	Description
TWU-08	Tanwax Creek crossing of Eatonville Cutoff E	Flooding of private property.
TWU-09	Approx 100m east of 72 Ave E on 352 St E	Overflows of ditches; 72nd Ave., Roy. Culvert blocked by sediment. Culvert damage.
TWU-11	9016 Guske Rd E	Overflows of ditches; flooding of private property; blockages of culverts, dams, debris, etc.
TWU-14	34512 82nd Ave Ct E	Flooding of private roadway and blocked drainage system.
TWU-15	1400 E Crestview Dr	Flooding of private property.
TWU-16	Webster Rd E approximately 80 m west of Barney Larson Rd (near Camp Arnold)	Flooding of roadway. Culvert damage.
TWU-19	10921 352nd St E	Flooding of private property; overflow of culverts; high groundwater.
TWU-21	Tanwax Drive near Meridian Rd (33705 Tanwax Dr E)	Culvert filled with sediment causing roadway flooding at the intersection of Tanwax Drive and Meridian Road.
TWU-23	Tanwax Lake Outlet	Blockages of culverts, dams, debris, etc (beavers). Tanwax Lake (at outlet); Flooding of private property.
TWU-24	34402 Thomas Rd E	Flooding over roadway.
TWU-25	34328 Thomas Rd E (near Tanwax Lake)	Overflows of ditches/culverts. Channel/bank erosion. Blocked drainage. Flooding of private property.
TWU-27	Tanwax Lake at 33905 Tanwax Ct E	Flooding of private property.
TWU-28	Tanwax Lake at 33524 Benbow Dr E	Flooding of private property.
TWU-31	Inlet and outlet to Lake Whitman (upper Tanwax basin)	Inlet and Outlet to Whitman Lake severely overgrown which could potentially reduce conveyance.
TWU-33	Benbow Dr E at Lake Whitman	Flooding of private property; blockages problem culverts, dams, debris, etc at Whitman Lake.
TWU-34	32022 Benbow Dr E	Drainage system failure.
TWU-35	31614 Benbow Rd E	Flooding on private property.

TABLE 5-2
Water Quality Problems Summary

Problem ID	Location	Description
ASH-03	Near Nisqually River south of National Park.	Reports of off-road vehicles in streams.
ASH-04	Creek crossing Mt Tacoma Canyon Rd approx 1 mile east of intersection with SR 706	Channel/bank erosion; clearing/logging near stream; construction in or near stream.
ASH-05	31313 Mt. Tacoma Canyon Rd E	Septic/drainfield problems
ASH-06	Creek crossing Mt Tacoma Canyon Rd approx 500 m northeast of intersection with SR 706	Cloudy water reported in streams/ditches.
BRI-20	34414 8th Av Ct E	Septic/drainfield problems
BRI-22	1612 338th St E	Septic/drainfield problems
CLR-03	Clear Lake	High nutrient and pollutant levels. Listed on 303(d) in 1996 and 1998 for total phosphorous. Algae blooms. Septic system failures.
COP-01	33107 Mt. Tacoma Canyon Rd E	Septic/drainfield problems
ELB-02	North of SR 706 at Park Junction Road	Park Junction development proposed for this area could affect Elbe Creek.
ELB-04	55218 Park Junction Rd E	Septic/drainfield problems
ELB-05	East end of Alder Lake	Clearing/logging near water at east end of Alder Lake.
HRN-02	All along lower Horn Creek, especially adjacent to Allen Rd S	Many small farms; livestock; septic failure/seepage; suds in creek; septic tanks near creek.
HRN-07	37407 S 18th Ave	Septic/drainfield problems
HRN-12	113 354th St E	Septic/drainfield problems
HRN-13	712 358th St E	Septic/drainfield problems
HRN-15	2420 SR 702 E	Septic/drainfield problems
HRT-04	Hart's Creek west of Wilcox Dairy	Runoff from dairy could lead to water quality problems (fecal coliform, nutrient loading).
HRT-05	41910 40th Ave S	Septic/drainfield problems
HRT-09	Harts Lake	Cloudy water in streams/ditches; Hart's Lake. Manure in/near streams; high algae. Fish kill.
KRG-05	3204 416th St E	Septic/drainfield problems
LMR-02	Meadows near confluence of Little Mashel River and Midway Creek	Cattle in watershed
LMR-03	Tributary to Midway Creek, east of Alder-Cutoff Highway	Cattle in watershed
LMR-04	Headwaters of Midway Creek	Cattle in watershed
LYN-03	Lynch Creek adjacent to Eatonville	Cloudy water in streams/ditches; stormwater discharge/development along creek.
MAL-02	Lower Mashel River, approx 0.7 mile reach beginning at the confluence with the Nisqually River	303(d) violation for temperature
MAL-06	Lower reach of Mashel River (~1.5 miles near Eatonville)	Cloudy water in streams/ditches

TABLE 5-2
Water Quality Problems Summary

Problem ID	Location	Description
MAM-02	Middle Mashel River, approx 3 mile reach east of railroad tracks east of Eatonville	303(d) violation for temperature
MUR-04	Murray Creek in the vicinity of the gravel pit, west of SR 507	Reports of off-road vehicles in streams.
MUR-07	8513 311th St S	Septic/drainfield problems
MUR-08	29001 81st Ave S	Septic/drainfield problems
MUR-13	Hinkleman Road and 316th St S	Septic/drainfield problems
MUR-16	32010 72nd Ave S	Septic/drainfield problems
MUR-25	336th St S between 78th Ave S and Locke Drive	Clearing, logging, and construction in or near streams. Debris and blockages of the drainage.
MUR-29	8416 350th St Ct S	Septic/drainfield problems
NIS-03	Nisqually River (Township/Range/Section: 18N, 01E, 08)	Listed on state 303(d) for fecal coliform, temperature and chromium in 1998.
OHL-02	Lower Ohop Creek, primarily the lowest 0.75 miles	Low BIBI scores (County Site 29, Tribe Site 107) and elevated water temperatures. Lower portion listed under 303(d) (fecal coliform).
OHL-06	Lower Ohop Creek approximately from SR 161 to confluence with Nisqually River	Low BIBI scores (County Site 29, Tribe Site 107) and elevated water temperatures.
OHU-04	Ohop Lake (40502, 40314 Ski Pk Rd)	Cloudy water in streams/ditches; mass wasting; clearing/logging near stream/lake.
OHU-07	Ohop Lake	High phosphorus levels in Ohop Lake; algae. 303(d) violation for Total Phosphorus.
OHU-10	Tributary streams to Ohop Lake	Clearing/logging near stream/lake.
OHU-15	38015 Orville Rd E	Septic/drainfield problems
OHU-19	Along Twentyfive Mile Cr approximately 500 meters upstream from confluence with Ohop Creek	Cattle in stream
RED-01	Nisqually River outlet to Puget Sound	Nisqually Beach closed by DOH for biotoxins or pollution.
RED-02	Estuary parallel to the Nisqually Estuary a few hundred meters to the east	Red Salmon Creek on state 303(d) list in 1998 for exceeding fecal coliform standards.
TWU-05	Rapjohn Lake	High turbidity of runoff from adjacent property that is being cleared for timber.
TWU-17	Upper Tanwax Creek	Manure in/near streams. Cattle, pastures, houses and barns in the valley.
TWU-18	37021 103rd Av Ct E	Septic/drainfield problems
TWU-20	Upper Tanwax Creek	High turbidity, sediments. Cloudy water in streams/ditches.
TWU-26	Tanwax Lake	Septic failure/seepage; cloudy water in streams/ditches; channel/bank erosion; oil, litter, algae.
TWU-30	32612 Benbow Dr E	Septic/drainfield problems

TABLE 5-2
Water Quality Problems Summary

Problem ID	Location	Description
TWU-32	Benbow Dr E at Lake Whitman	Cloudy water in streams/ditches; channel/bank erosion at Whitman Lake.

TABLE 5-3
Fish Passage Barriers

Problem ID	EDT Reach	PCD Survey ID	Road Name	Stream Name	Barrier Type	Location
BRI-02	Brighton Cr-1_b	36	Harts Lake Road So.	Brighton Cr	Culvert	Approx 0.6 mi SE of intersection w/ 360th St So. on site reading: N 46°55'27" W-122°31'20"
BRI-04	Brighton Cr-1_c	93	Private	Brighton Cr	Culvert	3rd parcel from 62nd Ave. N 46° 55' 32.46" W122° 31' 07.05"
BRI-07	Brighton Cr 62nd Ave So Culvert	62	62nd Ave So	Brighton Cr	Culvert	0.2 mi So of intersection w/ 360th St So (off of Hart's Lake Loop Rd). N 46°55'35.93" W 122°30'48.74"
BRI-15	Brighton Cr Highway 702 Culvert	47	Hwy 702	Brighton Cr	Culvert	Passes under Hwy 702, 75m E of driveway for 2103/2108 - 354th St Ct So. on site: N 46°56'15.10" W -122°27'28.77"
HRN-05	Horn Cr-2 368th St Culvert	51	368th St So	Horn Cr	Culvert	0.4 mi E of Allen Rd, just W of driveway (2302-368th St So). on site: N 46°55'16.42" W -122°27'40.41"
HRT-03	Harts Creek-1_b	54	Hart's Lake Valley Rd	Harts Cr	Culvert	Approx 0.5 mi So of Wilcox Farms office. on site: N 46°52'56.55" W -122°28'52.21"
HRT-07	Harts Creek Private Driveway Culvert	54	Hart's Lake Valley Rd	Harts Cr	Culvert	Approx 0.5 mi So of Wilcox Farms office. on site: N 46°52'56.55" W -122°28'52.21"
LGR-01	Unnamed stream	0				
MUR-03	Murray Cr-2_a	61	BNSF RR	Murray Cr	Culvert	accessible through Miles Sand & Gravel property, culvert is approx 200 m so of private gate
MUR-05	Murray Cr-2_b_A	42	Chehalis RR	Murray Cr	Culvert	40m E of bridge on Hwy 507, just N of Miles Sand and Gravel entrance. on site: N 46°58'45.5" W -122°32'50"
MUR-11	Murray Cr_culvert_hinkleman	37		Murray Cr	Culvert	Approx 0.4 mi E of 72nd Ave So. on site reading: N 46°58'48.37" W-122°31'08.85"
MUR-20	Murray Cr-3_a	38	48th Ave So	Murray Cr	Culvert	0.2 mi No of 31117 - 48th Ave So. on site: N 46°58'44.17" W-122°29'39.97"

MUR-22	Murray Cr-3_b	74	Pipeline	Murray Cr	Culvert	Culvert located on pipeline between 40th Ave and 48 Ave in Roy. N 46° 57' 57.68" W 122° 29' 19.52"
OHU-18	Trib0094	84	RR	Stony Ladder	Culvert	Approximately 3/4 mi south of Sigmond Rd South and RR crossing. N 46° 54' 55.60", W 122° 15' 09.26"
TWU-06	Tanwax Cr-3 Eatonville Cutoff Rd Culvert	75	Eatonville Cutoff Rd	Tanwax Cr	Culvert	100m East of intersection of Pulford Rd E and Eatonville Cufoff Rd. N 46° 55' 19.94" W 122° 20' 19.60"
TWU-10	Mud	79	Eatonville Cutoff Road	Unnamed	Culvert	Approximately 0.1 mi East of intersection of Jensen Rd and Eatonville Cutoff Rd. N 46° 55' 01.37" W122° 19' 13.93"
TWU-13	Trout Creek	81	352nd St East	Unnamed from Trout Lake	Culvert	Approximately 30m East of 87th Ave. N 46° 56' 11.64" W122° 18' 49.70"

TABLE 5-4
EDT Reach Problems

Problem ID	EDT Reach
BRI-01	Brighton Cr-1_a
BRI-03	Brighton Cr-1_b
BRI-05	Brighton Cr-1_c
BRI-08	Brighton Cr-1_d
BRI-13	Brighton Cr-1_e
HRN-01	Horn Cr-1
HRN-03	Horn Cr-2_a
HRN-06	Horn Cr-2_b
HRN-10	Horn Cr-2_c
HRT-01	Harts Creek-1_a
HRT-02	Harts Creek-1_b
HRT-06	Harts Creek-1_c
HRT-08	Harts Creek-1_d
KRG-01	Kreger Cr-1
KRG-02	Kreger Cr-2
KRG-03	Kreger Lake
KRG-06	Kreger Cr-3
KRG-10	Silver Lake
LMR-01	Little Mashel R
LYN-01	Lynch Cr
MAL-01	Lower Mashel-A_A
MAL-03	Lower Mashel-A_B
MAL-04	Lower Mashel-B
MAM-01	Middle Mashel R-1
MAM-03	Middle Mashel R-2

TABLE 5-4
EDT Reach Problems

Problem ID	EDT Reach
MAM-04	Beaver Cr-1
MAM-05	Beaver Cr-2
MAU-01	Upper Mashel R
MAU-02	Busy Wild Cr-1
MAU-03	Busy Wild Cr-2
MUR-01	Murray Cr-1
MUR-02	Murray Cr-2_a
MUR-06	Murray Cr-2_b_A
MUR-14	Murray Cr-2_b_B
MUR-19	Murray Cr-3_a
MUR-21	Murray Cr-3_b
NIS-01	Nisqually1-Estuary
NIS-02	Nisqually2a-LowerReach
NIS-04	Nisqually2B.1-LowerReach
NIS-05	Nisqually2B.2-LowerReach
NIS-06	Nisqually2B.3-LowerReach
NIS-07	Nisqually2B.4-LowerReach
NIS-08	Nisqually3.1-Whitewater
NIS-09	Nisqually3.2-Whitewater
NIS-10	Nisqually3.3-Whitewater
NIS-12	Nisqually4.1-Mckenna
NIS-13	Nisqually4.2-Mckenna
NIS-15	Nisqually5.1-Wilcox
NIS-17	Nisqually5.2-Wilcox
NIS-18	Nisqually5.3-Wilcox
NIS-19	Nisqually6.1-MiddleReach
NIS-20	Nisqually6.2-MiddleReach
NIS-21	Nisqually6.3-MiddleReach
NIS-22	Nisqually7A-UpperReach
NIS-23	Nisqually7B-UpperReach
OHL-01	Ohop Cr-1
OHU-01	Ohop Cr-2
OHU-03	Ohop Lake
OHU-16	Twentyfive Mile Cr
OHU-17	Trib0094
RED-03	Nearshore
RED-04	Red Salmon Creek
TWL-01	Tanwax Cr-1
TWL-02	Tanwax Cr-2
TWL-03	Cranberry

TABLE 5-4
EDT Reach Problems

Problem ID	EDT Reach
TWU-01	Tanwax Cr-3_a
TWU-02	Rapjohn
TWU-03	Mud
TWU-07	Tanwax Cr-3_b
TWU-12	Trout Creek
TWU-22	Tanwax Lake
TWU-29	Tanwax Upper Tributaries

CHAPTER SIX
STORMWATER DRAINAGE AND FLOODING ANALYSIS

Chapter 6 provides an overview of flooding and drainage problems in the Nisqually River Basin. Section 6.1 presents an overall flood risk assessment for the Basin. Section 6.2 describes additional analyses of the flooding and drainage problems identified in Chapter 5. Section 6.3 summarizes existing and future flooding and drainage problems based on the risk assessment and additional analyses. Section 6.4 makes recommendations for each of the problems, including capital improvement projects (CIPs), maintenance activities, programmatic measures, and additional studies. Specific recommendations for the basin plan are described in Chapter 9.

6.1 FLOOD RISK ASSESSMENT

Surface Water Management recently completed a *Flood Risk Assessment* that covers all 10 of the County's basin planning areas (Tetra Tech/KCM, 2007). The assessment was prepared to:

- Assure that projects identified in each basin plan are eligible for federal and state funding by providing linkage to the plans required under those programs.
- Maximize the flood insurance premium reduction potential for Pierce County under the Federal Emergency Management Agency's (FEMA) Community Rating System (CRS) program by meeting prescriptive classification prerequisites.

The County Flood Risk Assessment report contains separate assessments for each basin planning area. The Flood Risk Assessment for the Nisqually River Basin was comprised of text from this Basin Plan, including portions of Chapter 4 and the following Sections 6.1.1 (Causes of Flooding) and 6.1.2 (Flood Hazard Impacts). The complete flood Risk Assessment for the Nisqually River Basin planning area is provided in "Appendix C."

6.1.1 Causes of Flooding

Major floods in the Nisqually River Basin occurred in 1933, 1965, 1974, 1975, 1977, 1996, and 1997. According to FEMA's 1987 Flood Insurance Study, major floods typically occur between October and March as a result of rainstorms, sometimes augmented by melting snow. According to the Pierce County Natural Hazard Mitigation Plan (2005) the potential for severe flooding is greatest during warm, wet periods when a mid to low level snow pack is combined with long duration rainfall, saturated soils and an elevated water table.

The Natural Hazard Mitigation Plan suggests that there is an increasing potential for urban flooding in Pierce County due to continued population growth and land development. Human alteration of the landscape–including clearing, grading, paving, building construction, and landscaping–has an impact on the hydrologic process. Increasing impervious area decreases infiltration, while clearing of natural vegetation decreases interception storage and allows

runoff to flow into streams faster. These effects lead to higher peak flows in streams and greater runoff volumes.

Channel aggradation may be contributing to flooding along the upper Nisqually River. The upper Nisqually River can transport large amounts of sediment and debris during high flow events. High sediment loads have caused substantial channel aggradation near the Mount Rainier National Park boundary. Retreat of the headwater glaciers, which exposes more unconsolidated sediment to erosion, and could be contributing to this increased sediment loading trend. Channel aggradation can significantly affect flood elevations and inundation areas.

Types of observed flooding within the Nisqually River Basin are:

- Mainstem Flooding
- Tributary Flooding
- Lake Flooding
- Roadway Flooding.

A summary of existing flooding problems for each of these categories is provided in Section 6.3.

6.1.2 Flood Hazard Impacts

Flooding within the Nisqually River Basin can have numerous impacts on the on the way of life within the Basin, and Pierce County in general. In this section we assess the vulnerability of the basins, improved property, critical facilities, and the impact of flooding on the basin's population and economy.

Public Safety and Health

The Nisqually River Basin presents a variety of impacts to life, safety, and health. There are no reported losses of life due to flooding within this Basin, but damage and disruption cased by flooding are a severe and recurrent problem.

Pierce County has experienced substantial growth in previous years and is expected to support more growth over the next 30 years. According to the U.S. Census, the population of Pierce County in 2000 was 586,203. According to the Puget Sound Regional Council's (PSRC) long-range population forecasts for the forecast analysis zones within Pierce County, the population in the County is expected to increase 16%, to 812,859, by the year 2010 (PSRC, 2002).

According to the *2001 Population and Employment Forecasts* report for the central Puget Sound region, Pierce County is expected to reach the populations of 812,859 in 2010, 892,314 in 2020, and 951,747 in 2030 (PSRC, October 2001).

Future population projections for Pierce County can help predict future populations within the Nisqually River Basin. The estimated 2000 population in the Nisqually River Basin planning area was 12,881, which is 1.8% of the county's total population 700,820 in 2000. Assuming that the planning area will continue to capture at least 2% of the County's growth, it is predicted that

the population residing in the Nisqually River Basin planning area will be approximately 16,300 in 2010 and 18,000 in 2020.

Based on these projections, the assumptions for the potential impacts of flooding are as follows:

- There may be increased pressure to develop floodplains within this Basin as land uses change to accommodate the increasing population.
- The current/existing regulatory environment within Pierce County is very focused on not allowing an increase in flood risk exposure due to new development. As long as this regulatory environment remains intact, the assumption is that development in responses to this new growth would be directed away from the known flood hazard areas within the Basin.
- There is currently little or no flood warning capability within the Basin. As the population increases within the Basin, the need to increase the County's flood warning and response capability may increase as well.

There is real-time flood warning capability within the Nisqually River Basin. There are an additional stream flow gauges within the Nisqually River Basin available for flood threat recognition. USGS real-time gauges are located at:

- Nisqually River Near National, WA
- Mineral Creek Near Mineral, WA
- Nisqually River At La Grande Dam, WA
- Nisqually River At La Grande, WA
- Mashel River Near La Grande, WA
- Ohop Creek Near Eatonville, WA
- Centralia Power Canal Near McKenna, WA
- Nisqually River At McKenna, WA

The approximate lead time for flood warning provided within the Basin is 24 to 48 hours based on flood threat recognition system capability within the Basin. Flood prediction is not an exact science.

Although gauge readings and historical data are excellent forecasting tools, rivers can continually change. There are also local factors that can contribute to flooding such as stream and creek discharge into a river, snowmelt, and damming caused by fallen trees and other debris. Therefore, during flood situations, floodplain residents should not rely solely on gauge readings and historical flood levels, but should keep an eye on the river and stay tuned to local media reports.

The Nisqually River mainstem appears to be in generally good condition from a water quality perspective. According to the Surface Water Quality Assessment Nisqually River Level I Watershed Assessment (WPN, 2002), the minimum dissolved oxygen concentrations at stations used to collect data for the assessment were well above the state standard, even during late summer. The stream temperature standard was occasionally exceeded at river mile 3.7, but the

maximum recorded temperature was only slightly higher than the standard. Fecal coliform levels were occasionally exceeded in winter at river miles 3.7 and 21.8, near the McKenna diversion. Levels at the lower station were slightly higher than the standard. In November 2000, the Washington State Department of Health restricted harvest status on 74 acres of commercial shellfish beds in the marine waters near the mouth of the Nisqually River (Nisqually reach) because fecal coliform bacteria concentrations exceeded standards for commercial shellfish harvest.

Critical Facilities

Using the parameters to define "Critical Facilities" discussed in Chapter 1 of this risk assessment, Pierce County Surface Water Management, coordinating with Pierce County Emergency Management, has identified the critical facilities listed in Table 6-1 that could be impacted by flooding within the Nisqually River Basin. The bases for this determination are physical location within a mapped or known floodplain, known history of flooding, and the lack of flood protection to the facility. These are facilities that are considered to be vulnerable and in need of action(s) to mitigate the impacts of flooding.

It should be noted that this list does not include critical "infrastructure." Since the *Pierce County Basin Planning Program* has such a strong capital facilities component, it is assumed that critical infrastructure with vulnerability to flooding within each basin will be adequately addressed through the basin planning problem assessment and action prioritization process.

A detailed assessment of these facilities is not provided in this Risk Assessment for security purposes. Pierce County Emergency Management has performed this assessment as part of the countywide hazard mitigation plan prepared pursuant to the *Disaster Mitigation Act*.

The focus of the basin planning program as it pertains to critical facilities is to provide flood protection to potentially vulnerable critical facilities through the structural approached identified as actions in the basin planning programs.

The non-structural approached will be directed by the Countywide Hazard Mitigation Plan. It is a high priority of both programs to provide protection to critical facilities, and both programs are committed to working together to achieve this objective.

TABLE 6-1
Nisqually River Basin Critical Facilities in the 100-Year Floodplain

Government Function	Medical	Hazardous Materials	Schools	Other	Total
0	2	0	5	2	**9**

Structures Impacted

Table 6-2 lists the approximate number of structures on parcels in the floodplain. These estimates were generated using Planimetric data available for this Basin. To identify the potential dollar/loss exposure for the Basin, assessed values for improvements to each of the

parcels shown to have structures within the 100-year floodplain were accumulated by subbasin. This value is representative of the exposure.

To truly gauge vulnerability, one would need to identify depth of flooding to apply FEMA's depth/damage functions to this exposure. This detail of information was not available at the time of this assessment. However, total exposure values can be a good gauge of potential flood impact for planning purposes and for identifying potential project benefits when prioritizing mitigation actions.

TABLE 6-2
Structures within the 100-Year floodplain Nisqually River Basin

Structure Type				Market Improvement Value
Commercial	Dwelling	Other	Total	
13	167	80	**260**	$26,449,200

Repetitive Loss Areas

Utilizing the FEMA definition of "Repetitive Loss" defined under the Community Rating System, there are two identified repetitive loss properties within two repetitive loss areas within the Nisqually River Basin. These two areas are described below.

Nisqually Mainstem -Wilcox Reach Repetitive Loss Area

Pierce County completed a Repetitive Loss Plan in July of 2001. This plan identifies one repetitive loss property in the Nisqually River Basin; the property is located in the Wilcox Flats area at the end of 41st Avenue South. The owner filed insurance claims in 1980, 1982, 1990, 1991, 1994, 1995, and 1996. According to the owner of the property, the floodwaters do not flow directly onto the property from the Nisqually River, but originate from an unnamed creek east of the property. The source of the unnamed creek is unknown, but it is ephemeral. The creek may be a historical channel of the Nisqually that currently drains a local drainage and may serve as an overflow channel during high river flows. The Repetitive Loss Plan recommended land acquisition as the preferred solution. It is estimated that there are approximately seven additional properties within this reach subject to similar repetitive flooding as the identified property. The total building count for this repetitive loss area is eight.

Ohop Creek Repetitive Loss Area

This area has been identified as a repetitive loss area subsequent to the completion of the Pierce County Repetitive Loss Plan in 2001, based on new claims data. The current repetitive loss report as of April 30, 2006, shows one identified property in this area. Ohop Creek is a tributary to the Nisqually River. The terrain of the Ohop Creek Basin consists of nearly level to rolling terrain. Ohop Creek originates north of Ohop Lake, flows into the lake, and continues southward from the lake. Ohop Creek has two tributaries that originate in the eastern portion of the basin, Twenty-Five Mile Creek and Lynch Creek. Twenty-Five Mile Creek conveys flows to Ohop Creek from the northern portion of the basin. Lynch Creek conveys flows to Ohop Creek

from the southern portion of the basin. The principal cause of flooding along this reach is surface water drainage into the creek channel, increasing stream flow above the capacity of the channel. This results in typical overbank flooding. It is estimated that there are approximately five additional properties within this reach subject to similar repetitive flooding as the identified property. The total building count for this repetitive loss area is six.

Insurance Analysis

Flood insurance statistics can help identify vulnerability by regionally isolating areas where claim activity is high and a high rate of flood insurance is in force. Table 6-3 summarizes vital insurance statistics that can be used to help identify vulnerability within the Nisqually River Basin.

TABLE 6-3
Flood Insurance Statistics for the Nisqually River Basin

Number of flood insurance policies in force within the basin (as of May 1, 2007)	52
Number of policies within a mapped floodplain (FIRM)	4
Number of policies outside of a mapped floodplain	48
Number of claims filed within the basin	1
Number of claims filed for losses outside the 100-year floodplain	1
Estimated number of insurable, primary structures in mapped floodplains	166
Estimated % of at-risk structures with flood insurance coverage	2.4%
% of current flood insurance coverage outside of a mapped floodplain	92%

Based on a review of this data, the following observations can be made:

- Based on the approximate number of primary, insurable structures in the floodplain and the insurance coverage in force within the floodplain, insurance coverage as a form of mitigation appears to be well below the national average. According to a study being conducted for the *National Flood Insurance Program* (NFIP) by the Rand Corporation, nationwide about 49% of single-family homes in special flood hazard areas (SFHAs) are covered by flood insurance.
- With 92% of the current policies in force located outside of a mapped floodplain, there appears to be some flooding issues within this Basin not addressed via the existing mapping. These could be drainage related flood issues that the Basin Planning Program seeks out that typically are not captured through standardized floodplain mapping techniques.
- All of the historical claims filed within this Basin have been outside of a mapped floodplain. This also suggests that there are flooding issues within this Basin not addressed through flood hazard mapping.
- The very small policy base within this Basin makes it difficult to establish trends or correlations to identify risk exposure within this Basin.

- The low policy counts within this Basin suggest that there has been wise land use within this Basin, and that new development has been directed away from known flood hazard areas. The continuance of this policy will help to keep the level of risk exposure in balance as this Basin continues to grow.

6.2 FLOODING AND DRAINAGE PROBLEM ANALYSIS METHODS

This section summarizes the analytical methods used to evaluate the flooding and drainage problems within the Nisqually River Basin. Flooding and drainage problems identified in Chapter 5 were grouped into the following general categories for analysis:

- Local flooding
- Lake flooding

6.2.1 Local Flooding Analysis Methods

Flooding problems identified in Chapter 5 that were outside of the Nisqually River mainstem tended to be localized flooding along tributaries, minor stormwater drainage failures, or roadway flooding.

Local flooding problems were evaluated by mapping the problem locations along with available information from the County's geographic information system (GIS) data library. These data included topographic contours (5-foot contour interval), road alignments, streams, and man-made drainage features (culverts, pipes, ditches, etc.).

A series of site visits were then conducted to observe drainage conditions, record measurements, and examine downstream areas. As additional information was gathered for each location, the problems were screened and categorized as follows:

- Problems that were found to be unrelated to flooding and drainage, water quality, or aquatic habitat were eliminated from further evaluation and referred to other jurisdictions where applicable.
- Flooding problems located on private property or private roads were eliminated from further evaluation unless those problems caused flooding elsewhere.
- Flooding problems at non-County facilities were eliminated from further evaluation and referred to other jurisdictions where applicable.
- Flooding caused by beavers was addressed by programmatic recommendation, and referred to roadway maintenance where applicable.
- Flooding problems that were determined to be maintenance issues were addressed by a programmatic recommendation, and referred to the appropriate maintenance department.

- Erosion or slope failure problems not associated with surface water drainage were eliminated from further evaluation.
- Where possible, problems were grouped together for analysis and recommendations.
- If additional data are required or a more advanced analysis is warranted, the problem was addressed by a recommendation for a more-detailed study.

After initial screening, hydrologic and hydraulic analyses were performed for the remaining local flooding problems as described in the following sections.

Hydrologic Analyses

GIS mapping and observations from field reconnaissance were used to identify and delineate drainage basins at each problem location. The drainage areas were divided into smaller subbasins to accommodate discharge calculations at each relevant conveyance structure (e.g., culvert). Each subbasin was overlayed with hydrologic soils data, hydrographic data (i.e. water bodies), tax parcel data, and forest cover estimates (based on orthographic photography) to determine the predominant soil types and land cover. The tax parcel "USE_CD" attribute was used to estimate existing land use for each parcel of land. The existing land use allowed for impervious area estimation.

The predominant soil types and land cover data, along with the calculated drainage areas, were used as input to the Western Washington Hydrologic Model (WWHM3) developed by the Department of Ecology (Ecology, 2006). WWHM3 is a simplified hydrologic model developed specifically for the Western Washington region and is based on continuous simulation hydrology with long-term recorded precipitation data.

Using the flow-frequency module in WWHM3, peak flows were calculated for recurrence intervals of 2, 5, 10, 25, 50, and 100 years. The 25-year flow rate was used to analyze most conveyance structures; however, the 100-year discharge was used to analyze culverts and bridges over natural stream channels. These design criteria are based on design standards for stormwater management specified in the Pierce County Stormwater Management and Site Development Manual[4] (Pierce County, 2005). In addition, the 100-year discharge was used to analyze culverts and bridges in accordance with Washington Department of Fish and Wildlife's (WDFW) "Design of Road Culverts for Fish Passage" (WDFW, 2003).

Hydraulic Analyses

The flow rates calculated by hydrologic analyses were used to perform hydraulic analyses of individual conveyance components, which consisted of open channels and culverts.

[4] Design flow rates for stormwater conveyance systems are provided in Section 6.8.2, "Design Event," from the Pierce County Stormwater Management and Site Development Manual (Pierce County, 2005).

Hydraulic calculations were first used to check that the existing drainage system is adequately sized to convey the design flow rate, and that other design criteria are met[5]. If the system was found to not meet required design criteria, then additional hydraulic calculations were performed to size proposed new conveyance components.

The WDFW "Design of Road Culverts for Fish Passage" design criteria were applied to all recommended new conveyance components to ensure that fish passage criteria are met[6].

Steady-state hydraulic calculations for open channels were performed using one of two methods:

1. Manning's Equation was used for open channels where uniform flow depth and velocity were assumed.
2. All other situations used the HEC-RAS model developed by the U.S. Army Corps of Engineers (USACE, 2005). HEC-RAS uses a standard step-backwater method to calculate water surface elevations, and includes options for modeling bridges and culverts.

Channel geometries were based on the County's storm drainage GIS data in combination with field observations. Channel slopes were estimated based on the County's 5-foot contour data and field observations. Manning's roughness coefficients were selected based on field observations and generally followed the assumed values listed in Table 6-4.

TABLE 6-4
Manning's Roughness Coefficients used for Open Channel Hydraulics

Channel Conditions	Manning's Roughness
Man-made earthen channels with some vegetation	0.045
Natural channels with some vegetation	0.055
Natural channels with dense vegetation	0.085

Hydraulic analyses at culverts were performed using one of two methods:

1. HY-8 model developed by the Federal Highway Administration (FHWA, 2007). HY-8 is a hydraulic calculation tool that analyzes inlet and outlet controlled culvert hydraulics. The program computes headwater depth, tail water depth, and flow velocities based on the technical methods presented in the FHWA publication "Hydraulic Design Series 5, Hydraulic Design of Highway Culverts" (FHWA, 2005).

[5] Design criteria for culverts are provided in Section 6.8.9, "Culvert Criteria," from the Pierce County Stormwater Management and Site Development Manual (Pierce County, 2005). Design criteria for open channels are provided in Section 6.8.11, "Open Conveyances," from the Pierce County Stormwater Management and Site Development Manual (Pierce County, 2005).

[6] The WDFW "Design of Road Culverts for Fish Passage" document provides guidance for designing stream crossings that meet fish passage criteria (WDFW, 2003). In general, the "Stream Simulation" and "No Slope" design methods were implemented. Bankfull widths were approximated based on field observations and photos of the existing channel crossings.

2. FEQUTL model developed by Delbert Franz (Franz, 2006). FEQUTL is a utility program used with the FEQ unsteady flow modeling system. FEQUTL performs calculations similar to HY-8 and also allows for countersunk culverts (which are prescribed for fish passage per WDFW's regulations) to be analyzed.

Culvert dimensions for existing culverts were based on the County's storm drainage GIS data in combination with field measurements. Manning's roughness coefficients were selected based on the culvert material as presented in Table 6-5.

TABLE 6-5
Manning's Roughness Coefficients used for Culverts

Culvert Material	Manning's Roughness
Concrete pipe or concrete box	0.012
Corrugated Metal Pipe (CMP) or Pipe Arch	0.024
Ductile Iron Pipe	0.012

6.2.2 Lake Flooding Analysis Methods

The planning area encompasses more than 15 lakes. As discussed in Chapter 4, flooding problems have been reported near several of these lakes.

The analysis of lake flooding problems in the planning area involved a survey of lakeshore property owners, review of historical data, and field investigations to evaluate lake water elevation control structures. These are described below.

Survey of Lakeshore Property Owners

As noted in Chapter 4 above, there is little information available regarding lake-related flooding in the Nisqually planning area.

To help address this data gap, Surface Water Management conducted a survey to obtain additional information about lake flooding problems in the planning area.

Surface Water Management developed a questionnaire that asked for input on flooding and other lake-related issues. The questionnaire was sent to nearly 800 lakeshore property owners surrounding the 15 lakes in the planning area (see Figure 6-1). "Appendix F," Technical Information Memorandum #5 – Lake Survey Result, contains a copy of the questionnaire.

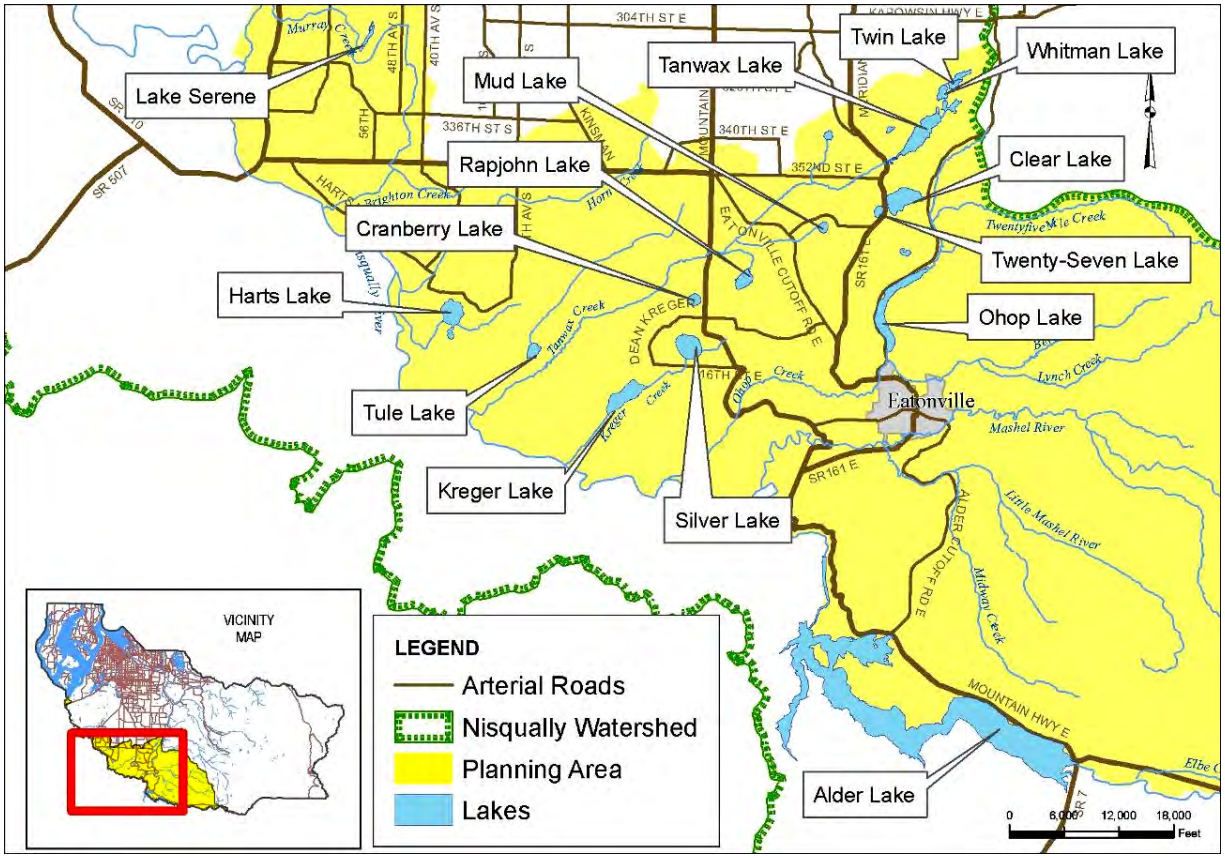


Figure 6-1. Lakes Included in Surface Water Management' Survey

Review of Historical Data

A review of published sources was completed to better characterize the lakes. Several historical reports completed by state and Tribal agencies have included data for lakes within the Nisqually River Basin. Available quantitative and qualitative data were collected from the following reports:

- Department of Ecology. *Water Supply Bulletin 14*, 1973
- Department of Ecology. *Water Supply 43c*, 1976
- Department of Ecology. *Water Supply Bulletin 57*, 1985
- Department of Ecology. Lakes Monitored by Ecology's Lake Water Quality Monitoring Program From 1989 through 1997 www.ecy.wa.gov/programs/eap/lakes/wq/lake_assessments.html
- Nisqually Indian Tribe. *Ohop Lake Phase I Study*, 1997

Table 6-6 summarizes the reports that contain information on the lakes within the Nisqually River Basin. If the report contains data on a specific lake, it is marked with an "X."

TABLE 6-6
Index of Lake Information Available by Report

Lakes	Water Supply Bulletin 14	Water Supply Bulletin 43c	Water Supply Bulletin 57	Monitoring 1990s
Alder	X	X		
Benbow	X		X	
Clear	X	X	X	X
Cranberry	X	X	X	
Harts	X	X	X	X
Horseshoe	X			
Kreger	X	X		
Little	X	X		
Mud	X	X		
Ohop	X	X	X	
Rapjohn	X	X		X
Silver	X	X	X	
Stidham	X	X	X	
Tanwax	X	X	X	
Trout	X			
Tule	X	X		
Whitman	X	X	X	X

Field Investigations

Field investigations were conducted to identify the likely causes and potential control measures to address reported lake flooding problems. The following lakes were evaluated:

- Clear Lake
- Ohop Lake
- Rapjohn Lake
- Silver Lake
- Tanwax Lake
- Whitman Lake

The above lakes were selected for evaluation based on the lake flooding problems identified as part of the basin characterization. Cranberry Lake has also been identified as part of the basin characterization; however, the lake was not visited due to lack of public access. Observations were made at the outlets for each lake visited to determine how lake levels were controlled. Section 6.3.4 describes the key findings of the field investigations.

6.3 EXISTING FLOODING AND DRAINAGE PROBLEMS ANALYSIS RESULTS

The following sections summarize the existing flooding and drainage problems for the Nisqually River Basin. Section 6.3.1 summarizes the results of the evaluation of mainstem hydrology. Section 6.3.2 summarizes mainstem flooding problems. Section 6.3.3 summarizes the result of analyses of local flooding and Section 6.3.4 summarizes the information collected on lake flooding.

6.3.1 Mainstem Hydrology

Flows in the lower reaches of the Nisqually River are regulated by the Nisqually hydroelectric project. There are no flood control requirements for the project. When possible and consistent with federal mandate, Tacoma Power voluntarily uses the available storage space to help reduce the downstream crest of the flood. However, Tacoma Power will do so only when these operations remain consistent with prudent operation of the project and the requirements of its federal license. Regardless of Tacoma Power's efforts, the small storage capacity of Alder Lake in relation to the potential upstream runoff is entirely inadequate to prevent downstream flooding (personal communication with Todd Lloyd, Tacoma Power, October 2006)

The existing floodplain mapping for the Nisqually River Basin was completed by FEMA in 1987. Since that time, several very large flood events have occurred. The largest peak discharge on record occurred in 1996, when there was an estimated flood flow of 50,000[4] cubic feet per second (cfs) at the McKenna gauge. The 1996 peak discharge is substantially larger than the 500-year discharge calculated for the 1987 FEMA study. Another large flood occurred in December 2006, causing substantial damage to levees near Mount Rainier National Park. Thus, the high flows that have occurred since 1987 may have shifted the discharge frequency curve for the Nisqually River.

A preliminary analysis was performed to estimate the relative change in the discharge-frequency curve that would result from adding the most recent 20 years of flow data. A log-Pearson Type III regression analysis was performed on peak annual discharge records from 1948 to 1987[5] using simply a station skew. This yielded similar results to discharge frequency data in the 1987 FEMA report. The log-Pearson Type III regression analysis was the repeated using records from 1948 to 2006. Peak discharge estimates increased between approximately 10 and 20% for the 10-year to 100-year events when the additional 20 years of data were included (see Figure 6-2). This, updating the flood frequency analysis to include the 1987-2007 flow data would probably result in higher estimated flows for the 50-, 100-, and 500-year events.

Climate change could also cause a shift in the flood frequency curve. Winter air temperatures in western Washington are predicted to increase. Increased winter temperatures would cause snow levels to rise to higher elevations, leading to less snowpack and more precipitation falling as rain rather than as snow. Spring runoff will shift, becoming earlier and lower, while winter

runoff will increase. This shift is likely to lead to increased flooding, especially in lower elevations (Mote, et al., 1999)

Therefore, a new updated hydrologic study is warranted for the Nisqually River Basin. The study should be completed for use in any future flood hazard mapping or flood mitigation studies. Specific recommendations are included in Section 6.4 "Appendix D" contains detailed description study recommendations.

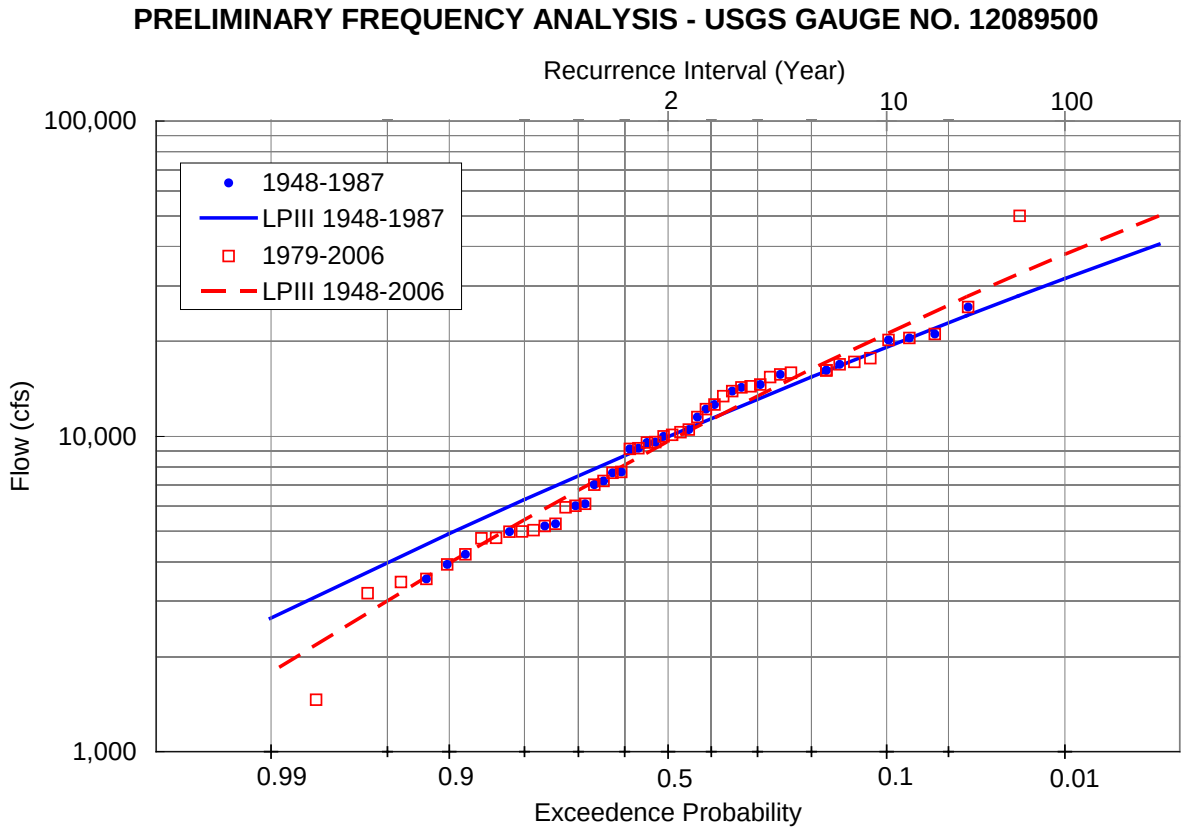


Figure 6-2. Preliminary Flood Frequency using Post-FEMA Flow Data

6.3.2 Mainstem Flooding Analysis Results

The Pierce County Natural Hazard Mitigation Plan (2005) describes flooding along the Nisqually River as "extremely variable in terms of frequency, severity and extent." Flooding along the Nisqually River has caused the most damage near the community of McKenna (FEMA 1987), an area that was severely damaged in February 1996. Flood damages have also been sustained in the Wilcox Flats area, which has been identified as a repetitive loss area after flood insurance claims in 1980, 1982, 1990, 1991, 1994, 1995, and 1996. A third area of concern is the upper Nisqually Delta (FEMA, 1987). However, the delta area is now used primarily for wildlife habitat and livestock grazing. Because there are few structures in the delta area, the potential for future flood damage is limited.

The following sections describe the flooding problems for the McKenna area, the Wilcox Flats area, and the Upper Nisqually River near Mount Rainier National Park.

McKenna Area Flooding Analysis Results

A preliminary evaluation was conducted to assess potential measures to reduce flood hazards near McKenna. "Appendix E" describes the evaluation methods and results. The key findings are summarized below.

The project team identified eight potential measures for reducing the flood hazards in the McKenna area:

1. No Action
2. Improved Flood Warning and Emergency Response
3. Elevating Existing Structures
4. Acquisition of Flood-Prone Properties
5. Levees
6. By-Pass Canal
7. Altered Reservoir Operations
8. Sand and Gravel Removal

Each measure was evaluated based on the following general criteria:

- Completeness: The extent to which the measure would provide all of the elements necessary to achieve the desired flood hazard reduction.
- Effectiveness: The extent to which the measure would alleviate the specified problems.
- Efficiency: The cost effectiveness of the measure.
- Acceptability: The acceptability of the measures to state and local entities and the public, and its compatibility with existing laws, regulations, and public policies.

The evaluation also considered some potentially important constraints specific to flood mitigation on the Nisqually River:

- Fish Habitat
- Coordination with Thurston County
- Permitting
- Federally Licensed Dams

The following summarizes the key findings of the preliminary evaluation:

- "No Action" is not a viable option because it would not achieve the desired level of flood hazard mitigation.
- An improved flood warning and emergency response system specifically for the Nisqually River and the McKenna area would provide considerable public safety benefits. This could be implemented in conjunction with other measures.

- Acquisition of flood-prone properties is the most effective method for reducing flood risk because people and improved property would be completely removed from the flood hazard zone.
- Elevating structures could reduce flood damage, although to a lesser extent than property acquisition. Elevation is only allowed in the flood fringe, so it could not be a stand-alone solution for McKenna; rather, it would need to be combined with another measure that can be applied within the floodway (e.g., property acquisition).
- A levee could provide effective flood protection, although there is always some risk of levee failure. A levee would likely require costly mitigation and engender opposition from entities such as Thurston County and the Nisqually Tribe. Construction of a levee around the existing State Route 507 bridge could also be costly.
- Changing the operations of the existing dam to increase flood control would likely be time-consuming, costly, and legally challenging.
- Sand and gravel removal could increase channel capacity, but probably not enough to eliminate flooding at McKenna. Removal would need to be repeated periodically. Sand and gravel removal could cause adverse environmental impacts and would probably be difficult to permit.

Wilcox Flats

The Wilcox Flats area has been identified as a repetitive loss area. FEMA has identified a repetitive loss property near the end of 41st Avenue South. The property owner filed insurance claims in 1980, 1982, 1990, 1991, 1994, 1995, and 1996.

According to the property owner, the floodwaters do not flow directly onto the property from the Nisqually River, but originate from an unnamed creek east of the property. The source of the unnamed creek is unknown, but it is ephemeral. The creek may be a historical channel of the Nisqually that currently drains a local drainage and may serve as an overflow channel during high river flows.

The Pierce County Repetitive Loss Plan (2001) recommended land acquisition as the preferred solution. The County has made attempts to purchase the property after previous flooding events; however, the landowner has repeatedly declined (personal communication with Randy Brake).

It is estimated that there are approximately seven additional properties within this area subject to similar repetitive flooding as the identified property.

Upper Nisqually River

The headwaters of the Nisqually River are located in Mount Rainier National Park (MRNP) where the river and tributary streams originate from the glaciers on the south slope of Mount Rainier. These upper reaches have high gradients and are capable of transporting large amounts of sediment and debris during high flow events. As the river flows away from the

mountain, the gradient decreases and mobilized sediments are deposited. This process can cause the river bed to rise (i.e., aggradation) and result in a braided river system with multiple flow channels that are subject to unpredictable changes. Retreating glaciers are increasing the sediment load by exposing more loose sediments to erosion. Deposited sediment and rising river bed can increase flood elevations and inundation areas.

The instability of the Nisqually River channels creates uncertainty with respect to what areas are at-risk to flooding and/or bank erosion. The risks to public safety and property have been substantiated by recent flooding events, particularly the event that occurred in November 2006.

Pierce County addresses the risks associated with channel migration by regulating the CMZ through the Critical Areas Ordinance (see Pierce County Code 18E.70). The CMZ is the area where the location of the main part of a river is likely to change, either by an abrupt change or more gradually by erosion or destabilization of the channel banks. CMZ studies show areas of severe, moderate and low migration risk. Pierce County regulates severe CMZ areas, which have the highest risk of being occupied by a river. These areas are deemed high hazard and high-risk for life, safety and damage to buildings and other property improvements.

A CMZ study was completed for a portion of the upper Nisqually River in 2007 (Pierce County, June 2007). The study characterizes the upper Nisqually River as "a braided river with a history of abrupt [channel] migration[7] and full scale avulsion[8] that occur over short periods of ten years or less."

Pierce County maintains approximately 4,000 feet of levee along the north bank of the Nisqually River near the Nisqually Entrance of MRNP. This levee system provides some flood protection to the Nisqually Park Subdivision (less than a 100-yr level of protection); however it is not considered adequate to provide protection from river migration. In fact, most levees do not provide adequate protection against channel migration, especially in high gradient and high velocity river reaches. Surface Water Management intends to continue maintenance along the entire length of the existing levee, including portions inside the MRNP boundary. When the levee is damaged, repairs are made as long as the river still occupies the same channel. All repairs to the levee are coordinated with MRNP to ensure consistent structural integrity along the length of the levee.

Figure 6-3. Damage after November 2006 Storm

[7] The study defines "channel migration" as the abrupt movement of a braided river across the valley floor.

[8] The study defines "avulsion" as the relocation of a river to a new route elsewhere on the floodplain.

Recent flooding events on the upper Nisqually River have caused considerable bank erosion and channel migration (see Figure 6-3). In November 2006 the headwaters of the Nisqually River received nearly 18 inches of rain in a 36 hour period (Mount Rainier National Park 2006). The resulting floodwaters on the Nisqually River caused extensive damage to roads and campgrounds within MRNP. The flood also damaged the Nisqually Park Levee. Surface Water Management completed repairs to the levee in the winter of 2007 (see Figure 6-4) at an approximate cost of $900,000.

The Kernahan Road Bridge, which crosses the Nisqually River approximately 3 miles downstream of the park entrance, has historically been susceptible to damage during major flooding events. The bridge was damaged in floods in February 1996 and again in November of 2006.

Several residents in the Community of Elbe have expressed concerns regarding sediment deposition and bank erosion at the upstream end of Alder Lake. Some bank revetments were observed near Elbe a few hundred feet downstream from the State Route 7 Bridge. Tacoma Public Utilities, the owners of Alder Dam, confirmed that it owns and maintains these revetments.

Figure 6-4. Reconstruction of Levee, Nisqually Park

6.3.3 Local Flooding Analysis Results

Local flooding problems include flooding along tributaries, minor stormwater drainage failures, and roadway flooding. Of the 72 local flooding problems identified in Chapter 5, 60 are related to roadway flooding, including 10 in the Murray Creek subbasin, 8 in the upper Tanwax Creek subbasin, 6 in the Brighton Creek subbasin, 5 in the Horn Creek subbasin, 6 in the upper Ohop subbasin, and 4 in the Kreger Creek subbasin. The remaining 12 local flooding problem areas include private property in the Murray Creek, Brighton Creek (4), and upper Tanwax Creek (2) subbasins; and a repetitive flood loss area on lower Ohop Creek.

As described in Section 6.2.2, additional information about each problem location was obtained from mapping and field investigations. An initial screening of the problems was then performed to determine how each problem would be addressed. Outcomes for those problems that were eliminated from further evaluation are noted in Table 6-10.

The following sections provide brief summaries of the analyses used to evaluate each of the remaining problems. Results from those problems that were analyzed by hydrologic and hydraulic methods are tabulated in “Appendix G.” Site maps are also included for problems that require a CIP to address flooding problems.

6.3.4 Local Flooding Analysis Results

Local flooding problems include flooding along tributaries, minor stormwater drainage failures, and roadway flooding. Of the 72 local flooding problems identified in Chapter 5, 60 are related to roadway flooding, including 10 in the Murray Creek subbasin, 8 in the upper Tanwax Creek subbasin, 6 in the Brighton Creek subbasin, 5 in the Horn Creek subbasin, 6 in the upper Ohop subbasin, and 4 in the Kreger Creek subbasin. The remaining 12 local flooding problem areas include private property in the Murray Creek, Brighton Creek (4), and upper Tanwax Creek (2) subbasins; and a repetitive flood loss area on lower Ohop Creek.

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The following sections provide brief summaries of the analyses used to evaluate each of the remaining problems. Results from those problems that were analyzed by hydrologic and hydraulic methods are tabulated in "Appendix G." Site maps are also included for problems that require a CIP to address flooding problems.

Unnamed Tributary crossing at 278th Avenue East, Problems ASH-01 and ASH-02

Local residents reported flooding over the roadway where an unnamed tributary crosses under 278th Avenue East. Residents also reported erosion and sediment problems for this crossing.

The crossing consists of a stream running generally from east to west along the floor of the Upper Nisqually River Valley. There are two parallel culverts under the road: one 48-inch-diameter CMP and one 24-inch CMP. The 48-inch culvert is partially filled with sediment, and both culverts are partially blocked at the inlet by rocks (see Figure 6-5). Bank erosion was noted at the upstream inlet to the culvert.

The drainage area to this culvert was delineated using USGS quadrangle maps (County topographic data is not available for this area). The stream originates in the mountains on the north side of the valley, then flows west along the valley floor joining with other streams flowing into the valley. The total area draining to these culverts is approximately 1,200 acres. Hydrologic calculations estimated the 25-year flow to be approximately 510 cfs and the 100-year flow rate to be approximately 810 cfs.

Figure 6-5. Blocked Culverts at 278th Ave E

Design criteria specified in the "Design of Road Culverts for Fish Passage" (WDFW, 2003) call for the culvert to convey a 100-year flow rate. However, the 100-year discharge calculated for the crossing at 278th Avenue East would require a considerably large structure; most likely a bridge with considerable span and rise. A lower design flow was considered for several reasons:

- A proposed project in this situation is retrofitting an existing structure.
- The location is on a rural roadway with what is assumed to be light traffic.
- The site conditions are not conducive to a large structure due to cover limitations.
- The channel leading to the culverts does not have adequate capacity to convey large flows such as the estimated 100-year flow rate.

A WDFW (2003) "Stream Simulation" design approach was used to size a 3-sided, 12-foot wide by 5-foot high concrete box culvert to be installed under 278th Avenue East. It is assumed the top of the box culvert will be flush with the existing roadway (i.e. no cover is assumed over the culvert). The culvert is proposed to have a slope of 2% and be countersunk 1.8-feet in accordance with fish passage design criteria. A hydraulic analysis of this proposed replacement culvert found the crossing could convey a flow rate of approximately 200 cfs, which would corresponds to a flow rate between the 2-year and 5-year recurrence interval.

Upper Brighton Creek, Problems BRI-17, BRI-18, BRI-19, BRI-21

A large depression in the vicinity of 4th Avenue East, 336th Street East, and Kinsman Road becomes inundated for long periods during the wet season. Residents reported that flooding in this area was exacerbated when a new culvert was installed at Kinsman Road (public road). In addition to flooding of private property, flooding was reported over the roadways at 4th Avenue East and 341st Street East (both private roads). Discussions with residents and field observations also found that saturated conditions in the area degraded land where livestock is kept.

An additional roadway flooding problem was reported at 336th Street East near the intersection of 4th Avenue East. Standing water was observed on both sides of the road even during relatively dry weather. Site visits on two different occasions found that 336th Street East had been raised recently, presumably due to problems with water on the roadway.

Drainage areas were delineated and 25-year and 100-year discharges were estimated for each of the culverts listed in Table 6-7.

TABLE 6-7 Design Flow Rates for selected Upper Brighton Creek Culverts			
Location	Drainage Area (acres)	Design Flow Rate	
		25-year	100-year
Kinsman Road culvert	1030	65	92
341st Street East culverts	1175	75	104
4th Avenue East culvert	1825	116	162
336th Street East culvert	28	1.7	2.3

Figure 6-6. Culvert at 4th Ave E

The main stream, which flows from Kinsman Road to 341st Street East to 4th Avenue East, appears to be a natural channel. As such, the design flow rate for those three culverts is the 100-year flow rate. The stream flowing under 336th Street East is a minor drainage that flows into the main stream downstream of the 4th Avenue East culvert (see Figure 6-6).

Hydraulic analysis of the drainage system found that the culvert at Kinsman Road is adequately sized to pass the 100-year flow rate without overtopping the road. A group of four parallel culverts under 341st Street East is not adequately sized to convey the 25-year or 100-year flow rate. The culvert at 8th Avenue East also does not have adequate capacity to convey the 25-year or 100-year flow rate without overtopping the road. The culvert at 336th Street East is sized to convey the 25-year and 100-year flow rates.

A countersunk 3-sided, 10-foot wide by 3-foot high concrete box culvert was sized for installation under 341st Street East while a countersunk 3-sided, 9-foot wide by 6-foot high concrete box culvert was sized for installation under 8th Avenue East. Both culverts were sized using the WDFW (2003) “No Slope” design approach and have capacity to convey the 100-year flow rate.

West Clear Lake Road Culvert, Problem CLR-01

A residential questionnaire reported water from State Route 161 drains down West Clear Lake Road East and causes flooding of private property.

Field observations confirmed that runoff flows over West Clear Lake Road and onto the driveway of a private residence toward the house (see Figure 6-7).

Examination of available topographic data (5-foot contours from the County's GIS data library) indicated that a small area (< 0.5 acres) of State Route 161 and West Clear Lake Road potentially drain toward the problem site. The peak 100-year flow rate for this drainage area was estimated to be approximately 1.5 cfs.

There is not a clearly defined ditch along the west side of State Route 161, nor is there a culvert under West Clear Lake Road. The County's drainage database shows a ditch along West Clear Lake Road, but the ditch appears to be overgrown and may have accumulated sediment. Current observations indicate storm flow may be exiting the ditch and traveling towards the problem site.

Figure 6-7. Stormwater Runoff at West Clear Lake

Maintenance of the existing drainage ditch along the west side of West Clear Lake Road is proposed to improve conveyance. In addition, 35 lineal feet of trench drain should be installed in front of the problem site to intercept surface flows. The trench drain will be connected to the existing County drainage ditch with 25 lineal feet of 6-inch diameter pipe.

Horn Creek at Hart's Lake Loop Road, Problem HRN-04

Roadway flooding was reported at the Horn Creek crossing of Harts Lake Loop Road (see Figure 6-8).

According to flow frequency data provided in the Pierce County Flood Information Study, the area draining to the Harts Lake Loop Road culvert is approximately 7 square miles, and the 100-year peak discharge is 174 cfs.

A hydraulic analysis found that the existing 48-inch concrete pipe culvert has sufficient capacity to pass the 100-year discharge without overtopping.

Figure 6-8. Upstream of Horn Creek Culvert

This crossing was also identified as a fish barrier due to high culvert velocities. Hydraulic calculations for proposed conditions were based on a proposed replacement culvert designed to improve fish passage.

The proposed culvert is a 19-foot wide by 6-foot, 4-inch high arch pipe culvert. The hydraulic analysis confirmed that the conveyance capacity of the proposed culvert is sufficient to pass the 100-year discharge.

Tributary Drainage at 364th Street East, Problem HRN-09

Roadway flooding was reported at 364th Street East near the intersection with 8th Avenue South. The flooding problem was confirmed by field observations (see Figure 6-9).

A 150-acre area drains to a drainage ditch along the south side of 364th Street East leading to a 12-inch concrete culvert flowing from south to north under 364th Street East. The 25-year and 100-year flow rates from this drainage were estimated to be 7 cfs and 11 cfs respectively.

Figure 6-9. Flooding at 364th Street East

The 100-year flow rate was assumed to be 6 cfs two approaching ditches, which must pass through a 12-inch concrete culvert under 8th Avenue South and a 12-inch concrete culvert under the private driveway.

Hydraulic analyses found that none of the three culverts had capacity to adequately convey the 25-year flow rate. Furthermore, the culverts at this location were identified as insufficient for fish passage. A WDFW (2003) "Stream Simulation" design approach found that an 11-foot wide by 3-foot high, 3-sided concrete box culvert under 364th Street East would be sufficient to convey the 100-year flow rate and provide for fish passage.

The culvert is assumed to have no slope and countersunk approximately 2-feet per WDFW design guidelines. The culverts under 8th Avenue South and the nearby driveway should be replaced with 3-foot wide by 2-foot high concrete box culverts to pass the 100-year flow rate.

Placement of the three culverts is proposed so that the top of the box culvert will be flush with the existing roadway (i.e. no cover is assumed over the culvert).

Tributary to Harts Lake at Harts Lake Loop Road, Problem HRT-10

Roadway flooding was reported on Harts Lake Loop Road at an unnamed tributary just north of Hart's Lake (Figure 6-10).

The drainage area to this crossing was calculated to be approximately 430 acres; the peak 25- and 100-year flow rates were estimated to be 26 and 38 cfs. Fish passage design criteria (WDFW, 2003) were used for proposed improvements.

Hydraulic analysis shows that the existing 24-inch concrete culvert does not have adequate conveyance capacity to pass the 100-year discharge.

Figure 6-10. Flooding north of Hart's Lake

During a site visit, it was noted that vegetation at the inlet and outlet of the culvert was overgrown and could be contributing to the flooding problem.

Additional hydraulic calculations adhering to requirements in the "Stream Simulation" method for designing road culverts for fish passage (WDFW, 2003) found that an 11-foot wide by 6-foot high, 3-sided concrete box culvert would provide adequate conveyance capacity to pass the 100-year discharge while providing for fish passage. The culvert will have no slope and be countersunk per WDFW criteria.

Dean Kreger Road Flooding and Erosion

An additional roadway flooding location was selected for analysis based on comments received at a public meeting. Surface Water Management staff conducted field investigations to evaluate roadway flooding and erosion at two culverts located under Dean Kreger Road north of 408th Street East. The investigations found two existing 12-inch culverts under Dean Kreger Road, and severe erosion of the downstream channels, which flow down a steep slope toward a wetland area to the southeast.

Hydraulic analyses found that the two culverts under Dean Kreger Road were under-sized. A 24-inch CMP culvert at the southern crossing and an 18-inch CMP culvert at the northern crossing would convey the 100-year discharges.

Murray Creek Flooding, Problems MUR-10, MUR-12, and MUR-15

Flooding of private property and roadway flooding was reported at several locations along Hinkleman Road (see Figure 6-11).

Field investigations confirmed that high flows in Murray Creek flood private property, driveways and other private roads. No flooding of Hinkleman Road was observed, but water levels appeared to be close to the road in some areas.

Although the basin is hilly, the overall slope along Murray Creek is relatively flat. The average slope along Murray Creek was estimated to be less than 0.5%. Drainage patterns are complex, with numerous low lying areas and poorly draining soils.

Figure 6-11. Flooding along Hinkleman Road

Although Murray Creek was mapped by FEMA for the Pierce County FIS published in 1987, the methods used were approximate. No flow frequency data are provided in the study. Furthermore, Murray Creek is a non-gauged stream, and no long-term flow records are available. Flood flow frequency along Murray Creek should be estimated using a detailed hydrologic model. Development of such a model was not included within the scope of this Basin Plan. Recommendations for further study are described in more detail in Chapter 9.

Tisch Road South near 324th Street South, Problem MUR-18

Roadway flooding was reported along Tisch Road South near 324th Street South (see Figure 6-12).

A drainage ditch flows from south to north along Tisch Road South and then crosses under Tisch Road through a 12-inch CMP culvert.

Roadway flooding was observed on the upstream side of the culvert and in the upstream ditch along the road.

Figure 6-12. Flooding at Tisch Road South

The area draining to this ditch and culvert was estimated to be about 185 acres. The drainage is mostly flat with mixed pasture, forest, and rural residential land use. The 100-year flow rate was estimated to be 29 cfs.

The existing 12-inch CMP is not sufficient to convey the 100-year flow rate and should be replaced with a 3-sided, 10-foot wide by 3-foot high concrete box culvert. The box culvert conveys the 100-year flow rate and allows for fish passage based on criteria in WDFW's "Stream Simulation" methodology. The culvert will have no slope and will be countersunk. The top of the box culvert will be placed at the roadway grade.

Upper Murray Creek Drainage, Problems MUR-26, MUR-27, and MUR-28

Residents reported roadway flooding on 336th Street South between 48th Avenue South and 40th Avenue South.

Field investigations found three low spots along this stretch of road (see Figure 6-13).

There is a 36-inch concrete pipe culvert under 336th Street South, approximately 500 feet east of 48th Avenue South. The direction of flow is not clear from field

Figure 6-13. Water upstream of 336th Street South

observations.

Pipe data from the County's GIS library indicated that the culvert flows south, but a review of available contour data indicates the area likely drains north along a man-made ditch. The drainage area upstream of the culvert under 336th Street South was estimated to be 640 acres of mixed forest and pasture land. The estimated 25-year flow rate is 67 cfs. Hydraulic calculations show that the existing culvert has adequate capacity.

Lower Ohop Valley Flooding, Problems OHL-4, OHL-5, and OHL-7

Flooding occurs along lower Ohop Creek when overbank flooding inundates large areas along the valley floor (see Figure 6-14).

Figure 6-14. Flooding near Repetitive Loss Area

The lower Ohop Creek Valley is an area of historic agricultural use that is being converted to rural residential use.

Several residential structures are located along Ohop Creek in the vicinity of the Ohop Valley Extension Road, downstream of the State Route 161 bridge near Eatonville. This area has been identified as a repetitive loss area. A property near the Ohop Valley Extension Road bridge has been listed by FEMA as a repetitive loss property. Five other properties in this area have been identified as having similar potential for repetitive flood losses.

Historical agricultural use in the lower Ohop Creek Valley has had a negative impact on fish habitat. Channel confinement modifications such as ditching and channelization have occurred, and riparian vegetation has been cleared. There is potential for habitat restoration efforts to be linked with flood mitigation efforts.

Seeps and Drainage along Ski Park Road, Problem OHU-08

Ohop Lake is located in the upper Ohop Creek Valley northwest of Eatonville.

The valley walls surrounding Ohop Lake are steep. Both Oroville Road, on the west side of the Lake, and Ski Park Road, on the east side of the lake, have been closed by mudslides and slope failures. Ski Park Road, in particular, has had several slope failures over the past few years.

In general, slope failures along roads is a problem referred to Transportation Service. However, reports of roadway drainage problems and blocked ditches warranted addition investigation.

Figure 6-15. Water flows under Ski Park Road

During a site visit along Ski Park Road several flowing streams were observed crossing under Ski Park Road despite the fact that there had not been recent rainfall (see Figure 6-15).

Numerous seeps were also observed along the slope side of the road. Sediment was observed on the road, and had collected in the ditch along the slope side of the road. Piles of drain pipe were stacked along the road, and it appeared as though some new drains were being installed along side of the road.

Additional information is need to determine if the slope failures are related to stormwater runoff, or if flooding along the roadway exacerbates the unstable conditions. Reported roadway flooding problems are likely due to sediment collecting in the ditches and around inlets.

Drainage Crossing at 365th Street East, Problem TWL-06

Flooding over the roadway was reported at 365th Street East near Weyerhaeuser Elementary School.

A tributary drainage flowing from north to south drains approximately 315 acres of mixed forest, pasture and rural residential land use (see Figure 6-16).

Figure 6-16. Drainage Ditch near 365th Street East

The drainage appears to be a natural stream channel, which would normally be designed to pass the 100-year flow rate. The 100-year flow rate was calculated to be 37 cfs.

The existing 18-inch concrete culvert does not have adequate capacity to convey the 100-year flow rate nor does it provide fish passage.

Hydraulic analysis in accordance with the WDFW "Stream Simulation" methodology found a 3-sided concrete box culvert, 7-foot wide by 4-foot high would have adequate capacity to convey the 100-year flow rate and provide the necessary geometry for fish passage. The top of the box culvert is assumed to be set at the elevation of the existing roadway with no cover.

Drainage Ditches along 352nd Street East, Problem TWU-09

A residential questionnaire noted flooding in an area along 352nd Street East, near 72nd Avenue East.

The site was visited on May 16 and August 21, 2007. It was noted that the culvert along the north side of 352nd, which passes flow under 72nd, was blocked at the outlet.

Figure 6-17. Sediment Blocking Culvert at 72nd Ave

Hydraulic analyses were performed to determine if the culverts and ditches along 352nd Street East had adequate capacity. Seven channels, in the two sub-drainage tributary to the culverts, were analyzed and found to have

adequate capacity.

Field investigation on August 21 confirmed that the ditches were properly maintained. The hydraulic analyses showed that the culverts on both the north and south sides of 352nd that convey water under 72nd Avenue are adequately sized to convey the 25-year flood event; however, the downstream ditch was overgrown with vegetation. Three additional culverts crossing under 352nd Street also have enough capacity to convey the 25-year flood event. However, the 12-inch and 18-inch concrete culverts in the flat area to the east of 72nd Avenue have sediment and debris blockages.

Drainage crossing at Webster Road, Problem TWU-16

Roadway flooding was reported at Webster Road near the intersection with State Route 161.

Field observations noted that the culvert under Webster Road, approximately 1200 feet northwest of State Route 161, is damaged at the inlet (see Figure 6-18). The 18-inch CMP culvert is bent at the inlet in a way that is an obvious hindrance to conveyance.

Figure 6-18. Damaged Culvert at Webster Road

The cover over the culvert does not meet the minimum 2-foot requirement. The culvert also had rusted along the bottom, which may indicate standing water for a long period of time. Local residents suggested that there are beavers in the area and that they may have contributed to backups.

The culvert drains an estimated 100 acres of mainly pasture and agricultural land to the north. The 25-year and 100-year flow rates were estimated to be 11 cfs and 15 cfs respectively. Hydraulic calculations indicated that an 18-inch culvert, in good condition, would convey the 25-year flow, but the inlet would be submerged.

In addition, the conditions do not provide adequate freeboard with the limited cover. A 3-sided concrete box culvert, 5-foot wide by 3-foot high would adequately convey the 100-year flow rate without a submerged inlet. Limitations in cover are addressed by the top of the box culvert assumed to set at the existing roadway grade. The box culvert design meets WDFW requirements for fish passage using the “Stream Simulation” methodology.

Drainage Ditch at Tanwax Drive, Problem TWU-21

A residential questionnaire reported overflowing of ditches area near the intersection of Tanwax Drive and State Route 161.

During a site visit on May 16, 2007, it was noted that the downstream end of the culvert under Tanwax Drive is filled with halfway with sediment at the outlet (see Figures 6-19 and 6-20).

Hydraulic calculations indicate that the 18-inch concrete culvert under Tanwax Drive is adequately sized to convey the 25-year flood event. Additional hydraulic calculations indicate the ditches approaching the Tanwax Drive culvert are adequately sized. However, the ditch along the north side of Tanwax Drive is shallow and may be accumulating sediment (see Figure 6-21).

Figure 6-19. Sediment at outlet of Tanwax Drive Culvert

Culverts and Ditches in the vicinity of Tanwax Drive and State Route 161 should be cleaned out to remove accumulated sediments. If sedimentation in these conveyance structures continues to be a problem, then a sediment trap may be necessary upstream.

Figure 6-20. Inlet to Tanwax Drive Culvert

Figure 6-21. Ditch at Tanwax Drive and State Route 161

Tributary Drainage crossing Thomas Road East, Problems TWU-24 and TWU-25

Roadway flooding problems leading to flooding of private property were reported near 34328 Thomas Road East.

A property owner reported frequent flooding of the roadway and overflow of ditches, which causes runoff to wash out the road and flow into the dwelling. Residents also reported that the drainage ditches have not been adequately maintained.

Field observations noted that construction and improper sediment control could be causing sediment buildup in ditches and conveyance structures.

Figure 6-22. Drainage at Thomas Road East

A tributary drainage to Tanwax Lake drains north and crosses under Thomas Road East through a 12-inch concrete culvert in the vicinity of the reported problems (see Figure 6-22). Flow from the outlet of the culvert is directed into a storm drain that leads to Tanwax Lake. The drainage area was estimated at 70 acres, and the 100-year discharge was estimated to be 14 cfs. The 12-inch culvert does not have adequate capacity to convey the 100-year flow rate.

Hydraulic analysis in accordance with the WDFW “Stream Simulation” methodology found a 3-sided concrete box culvert, 6-foot wide by 5-foot high would have adequate capacity to convey the 100-year flow rate and provide the necessary geometry for fish passage. The top of the box culvert is assumed to be set at the elevation of the existing roadway with no cover.

Benbow Drive Culvert at Outlet to Twin Lakes, Problems TWU-34 and TWU-35

Benbow Drive East is located between Twin Lakes and Whitman Lake, and crosses the low area where overflow from the Twin Lakes drains into Whitman Lake.

Field observations noted debris at the culvert inlet and signs of roadway overtopping. The existing crossing consists of two 24-inch concrete culverts with a debris cage surrounding both inlets.

Figure 6-23. Debris at Inlet to Culvert

During a site visit on May 16, 2007, it was noted that the debris cage had collected a considerable amount of debris, and that is could be restricting flow into the culverts (see Figure 6-23). Also, the downstream ends of the culverts were completely submerged.

A hydrologic analysis was completed to verify sufficient capacity of the roadway culverts. The area draining to the culverts was estimated to be about 235 acres of mixed forest and agricultural land use. The 100-year flow rate was estimated to be 69 cfs. Hydraulic calculations found that the existing parallel 24-inch culverts are not adequately sized to convey the 100-year flow rate without overtopping the road.

Additional hydraulic analyses show a 3-sided concrete box culvert, 9-foot wide by 5-foot high would convey the 100-year flood event flow with no overtopping. Road raising is avoided by placing the top of the box culvert, which is designed for H-20 loading, at the roadway grade with no cover. The box culvert also provides fish passage per the WDFW (2003) “No Slope” requirements.

6.3.5 Lake Flooding Analysis Results

Information on lake flooding was collected from three sources: a survey of lakeshore owners, a compilation of available data from reports, and field investigations.

Lakeshore Owners Survey Results

Survey respondents reported flooding problems at Alder, Clear, Harts, Serene, Ohop, Silver, Tanwax, Twin, and Whitman Lakes. No survey responses were received for Cranberry, Kreger, Mud, Trout, and Tule Lakes. Survey respondents were asked to rate the importance of lake issues. Flooding issues in and around lakes received the lowest average ranking of importance.

Thus, the survey results suggest that the reported lake-related flooding problems are relatively minor. "Appendix F" contains detailed descriptions of the survey results for each lake.

Lake Data Compilation

Tables 6-8 and 6-9 summarize the quantitative and physical characteristics for lakes in the planning area. "Appendix H" contains more detailed information.

TABLE 6-8
Summary of Lake Data from Published Reports

Lake Name	Elevation (ft)	Mean Depth (ft)	Max Depth (ft)	Shoreline Length (miles)	Volume (acre-ft)	Surface Area (acres)	Drainage Area (sq. miles)
Alder	1207	75	290	28	230,000	3100	286
Clear Lake (Pierce)	778	38	85	2.1	6100	160	0.41
Cranberry Lake	644	12	18	0.9	430	37	0.55
Harts Lake	347	26	50	1.6	3100	120	3.6
Horseshoe	750	NA	18	NA	NA	11.8	NA
Kreger	531	7	12	1.2	280	42	4.9
Little	349	7	12	0.55	80	12	0.9
Mud	623	9	14	0.66	180	21	1.37
Ohop Lake	524	17	25	4.6	3800	230	17.3
Rapjohn Lake	632	10	18	1.1	550	56	1.3
Silver	604	12	25	1.7	1800	150	1.8
Stidham	655	12	22	0.5	120	10	0.12
Tanwax Lake	600	20	30	2.8	3300	170	4.1
Trout	700	NA	NA	NA	NA	5.5	NA
Tule	456	5	10	1.2	160	30	4.34
Twin, North (Benbow)	600	14	20	1.2	656	48	0.76
Twin, South (Benbow)	610	11	16	1.2	459	43	0.83
Whitman Lake (Benbow)	601	12	20	1	350	30	1

TABLE 6-9
Summary of Qualitative Data from Published Reports

Lake Name	Inlets	Outlets
Alder	Nisqually River and Little Nisqually River	Nisqually River
Clear Lake (Pierce)	None	None
Cranberry Lake	Unnamed Creek	Unnamed Creek
Harts Lake	None	Harts Creek.
Horseshoe	None	Unnamed Creek leading to Ohop Lake

TABLE 6-9
Summary of Qualitative Data from Published Reports

Lake Name	Inlets	Outlets
Kreger	Kreger Creek	Kreger Creek
Little	Unnamed Creek	Unnamed Creek
Mud	None	Unnamed Creek
Ohop Lake	Twenty-five Mile Creek	Ohop Creek
Rapjohn Lake	None	Unnamed Creek leading to Tanwax Creek
Silver	None	Kreger Creek
Stidham	None	Unnamed Creek
Tanwax Lake	Tanwax Creek	Tanwax Creek
Trout	None	Trout Creek
Tule	Rocky Slough	None
Twin, North (Benbow)	None	Whitman Lake
Twin, South (Benbow)	None	Whitman Lake
Whitman Lake (Benbow)	None	Tanwax Creek

Additional field investigations were conducted to identify the likely causes of flooding and identify potential mitigation measures. The key findings are summarized as follows:

Clear Lake

The outlet to Clear Lake is a small cobble-lined channel flowing through a private lot. At the outlet from the lake the channel is between 12 and 18 inches wide at the bottom with a vertical wall on one side and approximately 2:1 (horizontal: vertical) side slope on the other side (see Figure 6-24).

Figure 6-24. Clear Lake Outlet

The depth of the channel is about 2 to 3 feet. The channel varies in size as it progresses downstream, but the narrowest point appears to be at the lake outlet.

Approximately 200 feet downstream of the outlet the stream flows through an 18-inch concrete pipe culvert under a private road: Clear Lake North. The stream continues along a relatively shallow slope for approximately another 200 feet before flowing down the steep slope into Ohop Valley.

At the time of the site visit there was very little flow through the outlet or the downstream channel. The outlet was filled with leaves and debris; however, it did not appear to be preventing outflow from the lake. Because of the shallow slope of the channel and the relatively small flow rate exiting the lake, there does not appear to be much potential for erosion of the downstream slope.

Water levels on Clear Lake would increase if debris is allowed to block the outflow channel. Based on field observations, this is the most likely cause of reported flooding.

Ohop Lake

Lake levels on Ohop Lake are controlled by a weir located approximately 800 feet downstream from the main body of the lake.

The weir is a log spanning 40 feet across the bottom of the channel and built into banks (see Figure 6-25). Large piles of wood and debris were stacked on either side of the weir. This debris appears to have been removed from the outlet.

Figure 6-25. Ohop Lake Outlet

Accumulation of this debris at the outlet weir is the most likely cause for the flooding problems at Ohop Lake. It is not clear whether this debris is a result of beaver activity or if it is transported into the outlet from upstream.

The 100-year discharge for Ohop Creek at the outlet is 690 cfs (FEMA, 1987). Hydraulic calculations indicate that the upstream head required to pass this discharge over a 40-foot weir is approximately 3 feet.

Water levels in the lake could be reduced by lowering the weir crest elevation. However, the elevation at which the weir could be lowered is limited by the downstream grade, which would

need to be analyzed hydraulically. Widening the weir could also reduce water levels. Increasing the weir length from 40 to 50 feet could lower the head required to pass the 100-year discharge by nearly 0.5 foot.

Rapjohn Lake

Information about the Rapjohn Lake outlet was received from David Hymel of the Tanwax Citizens Group, who visited the site with local landowners.

According to his observations and the landowners' experience, beavers are creating blockages at the outlet (see Figure 6-26). This has led to increased water levels and general flooding along the lakes shoreline.

In addition, observations made by the Nisqually Indian Tribe suggest that the outlet channel has heavy growth of reed canary grass, which has reduced conveyance in the channel.

According to the landowners, the beaver activity and vegetative growth at the outlet have become too difficult to maintain.

Figure 6-26. Beaver dam at Rapjohn Lake

Silver Lake

Silver Lake drains to a man-made ditch (Kreger Creek) at the south end of the lake. There is no outlet structure. The ditch flows south and crosses under 416th Street East approximately 750 feet downstream of Silver Lake. The ditch is shallow, approximately 10 feet across the bottom with approximately 3:1 (H: V) side slopes (see Figure 6-27). The crossing is two 56-inch reinforced concrete pipe (RCP) culverts.

Figure 6-27. Outlet Channel at Silver Lake

Anecdotal evidence from nearby landowners suggests that high water in the drainage ditch along the south side of 416th Street East causes backwater flooding through the dual 56-inch RCP culverts under 416th Street East. The flooding inundates large areas between Silver Lake and 416th Street East.

Approximately 200 feet downstream of 416th Street East crossing is another crossing for a private driveway (see Figure 6-28).

This crossing is a 48-inch CMP with rock-armored headwalls. The channel at this crossing is deeper than upstream with a bottom width of approximately 5 feet, 2:1 (H: V) side slopes, and a depth of approximately 8 feet. The culvert had a distinctive rust mark about halfway up.

Figure 6-28. Culvert Downstream of 416th Street East

The rust mark on the culvert could indicate that there has been standing water in the channel for a long period of time. However, at the time of the site visit the water in the culvert was flowing just a few inches deep even though the site visit was conducted during a wet period. A possible explanation is that the channel may have at one time been blocked with vegetation or debris, and has since been cleaned.

Subsequent discussions with local residents found that flooding has continued to occur, which indicates that even if the channel had been recently cleared of blockages, flooding problems are still occurring. The most likely cause of those flooding problems is that the culvert downstream of 416th Street East does not have sufficient capacity to convey flood flows.

The 100-year flow rate for the area draining to the culvert downstream of 416th Street East was estimated to be 195 cfs. Hydraulic analysis has shown a 3-sided concrete box culvert, 10-foot wide by 6-foot high would adequately convey the 100-year flow rate. The box culvert design meets WDFW requirements for fish passage using the “No Slope” methodology.

Tanwax Lake

The outlet to Tanwax Lake is located in a marshy area nearly 1,500 feet downstream of the main body of the lake, which is just a few hundred feet upstream from the State Route 161 culverts (two 10-foot by 6-foot concrete box culverts).

The outlet structure is an old concrete weir with notches broken out of it to lower the crest elevation (see Figure 6-29). The total length of the weir is around 40 feet. There is one notch in it with a depth of about 6 inches and a width of about 10 feet. A second notch is also about 10 feet wide, but about 6 to 7 feet of that notch is 6 inches deep and about 3 to 4 feet is about 12 inches deep. During the site visit, water was flowing over the lowest portion of the weir.

Figure 6-29. Weir Outlet at Tanwax Lake

The invert elevations of the culverts under State Route 161 appear to be 1 to 2 feet lower that the weir elevation. Therefore, the weir likely controls lake elevations under high flows.

There is a large amount of wood and debris piled near the weir. According to local landowners, the wood and debris were from blockages in the outlet caused by beaver activity, and that the outlet must be cleaned out periodically or lake levels will rise.

The likely cause of reported flooding on Tanwax Lake is blockage of the weir at the outlet by beaver activity.

Whitman Lake

Whitman Lake is one of a group of lakes upstream of Tanwax Lake referred to collectively as the Benbow Lakes. The Twin Lakes (North and South) flow into Whitman Lake, which flows into Byron Lake, which then flows into Tanwax Lake. These lakes are close together and there is very little difference in elevation from one to the next.

Figure 6-30. Beaver Dam downstream of Whitman Lake

Discussions with local landowners during the site visit found that there is a large amount of beaver activity around all of the lakes, but particularly downstream of Byron Lake.

Beaver dams were observed near Benbow Drive East, downstream of Byron Lake (see Figure 6-30). These dams are not only raising water elevations in Byron Lake, but also in Whitman and Twin Lakes. The most likely cause of reported flooding at Whitman Lake is backwater due to beaver dams downstream of Byron Lake.

6.4 POTENTIAL FUTURE FLOODING & DRAINAGE PROBLEMS

The following sections describe potential future flooding problems for the mainstem Nisqually River and for tributaries and stormwater conveyance.

6.4.1 Tributary and Stormwater Conveyance Flooding

Future development in the Nisqually planning area is expected to be relatively low density. Consequently, effective impervious areas (EIAs) are not expected to increase very much. Only 5 of the 23 subbasins in the planning area are projected to experience EIA increases of more than 1%. Therefore, most portions of the basin are unlikely to experience significant increases in stormwater runoff due to new development.

Although most of the basin will remain rural, current zoning and community plans allow for more intense development in several small areas. These areas include:

- Vicinity of the city of Roy (Murray Creek subbasin)
- Vicinity of the town of Eatonville (Lynch Creek, lower Ohop Creek, and lower Mashel River subbasins)
- Upper Nisqually Communities of Elbe, Ashford, and the park entrance (Elbe Creek, Ashford, Copper Creek, Goat/Tenas Creek subbasins)

Localized flooding and stream channel erosion could occur in these areas. However, new development would be subject to County site development and critical areas regulations. These regulations are intended to minimize the risk of flooding and stream channel erosion.

Other potential causes of future stormwater and tributary flooding problems include:

- Beavers dams blocking culverts and channels
- Invasive weeds reducing ditch and stream channel capacities
- Debris accumulations in roadside ditches, culverts, and lake outlet channels

Several programmatic measures are recommended to address these problems. These measures are described in Section 6.5 below.

6.5 POTENTIAL SOLUTIONS

This section describes how flooding and drainage problems identified in the Nisqually River Basin will be addressed. Table 6-10 summarizes the recommendations. Proposed programmatic measure and CIP projects are described in Chapter 9 and Figures 9-1 through *9-8* show CIP project locations.

6.5.1 Problems Resolved or Not Addressed in the Basin Plan

Forty-three of the potential flooding problems identified during basin characterization are not addressed in this Basin Plan, for the reasons listed below:

- Eight problems were found to be outside of Pierce County's jurisdiction.
- Eight problems were found to be on private land and did not appear to be related to County infrastructure or operations.
- Sixteen of the problems were referred to other County departments. Thirteen of these were referred to the County Roads Department.
- Ten of the flooding problems appear to have been resolved.

6.5.2 Maintenance and Enforcement Issues

Thirteen problems were identified as maintenance issues. These problems will be referred to Pierce County Department of Transportation Services. Most of these problems were sediment or debris blockages in drainage conveyance structures, or overgrown vegetation along drainage ditches.

6.5.3 Capital Improvement Program Projects

There were 11 projects developed to solve 13 drainage problems in the Nisqually River Basin. These projects are of a mix of conveyance improvements and culvert replacements. Each of the projects is discussed in greater detail in Chapter 9. The project locations are shown in Figures 9-1 through 9-8.

6.5.4 Programmatic Measures

Many of the drainage problems in the Nisqually are not amenable to structural solutions. For example, beaver dams and debris blockages appear to be the primary cause for the lake flooding problems in the basin.

Programmatic measures are recommended to address these problems. The recommended programmatic measures relevant to drainage and flooding problems are listed below:

- PRG00-01: Establish a “Low Impact Development Program”
- PRG00-02: Update “Stormwater Management Manual”
- PRG00-03: Increase Enforcement Inspections for Compliance with Stormwater Requirements and NPDES Permit
- PRG00-04: Develop and Implement a “Land Management Program” for Flood Hazard Reduction and Water Quality and Habitat Impact Mitigation
- PRG00-06: Develop and Implement an “Education, Outreach and Technical Assistance Program”
- PRG00-08: Develop and Implement a “Best Management Practices (BMP) Manual” for Pierce County Surface Water Management Maintenance Activities
- PRG00-09: Develop and Implement an “Invasive Species Management Program”
- PRG00-10: Require Flood Disclosure Statements on Property Titles
- PRG00-11: Establish Beaver Management Policy

Chapter 9 contains detailed descriptions of these measures.

6.5.5 Problems Requiring More Detailed Data or Analysis

Three additional studies are recommended to fill information gaps in the Nisqually River Basin:

1. ST11-MUR-ST05: Murray Creek Hydrologic Study and Flood Hazard Mapping
2. ST19-NIS-ST03: Analysis of Flooding at State Route 7 in Community of Elbe

Section 9.3.4 contains descriptions and cost estimates for each of the recommended studies.

TABLE 6-10
Flooding and Stormwater Drainage Problem Recommendations

Problem ID	Location	Description	Recommendation
ALD-01	10619 Cemetery Rd. E.	Roadway flooding; overflow of culverts, blocked drainage.	Reported to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
ALD-02	Tributary to Alder Lake near intersection of Lillie Dale Rd and Mountain Hwy (State Route 7)	Overflowing ditches near the intersection. Field observations note that culverts may be buried in sediment and overgrown.	Report to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
ALD-03	Near Elbe between Alder Lake and Railroad tracks.	Blockage of drainage system on private property causes backups in County system.	Problem is addressed by the following study: Analysis of Flooding at State Route 7 in Community of Elbe (ST19-NIS-ST03)
ALD-04	Town of Elbe near Lake Alder	Bank erosion at upstream end of Alder Lake near Elbe. A small bank revetment/dike has been constructed along the north bank.	Revetments owned and maintained by Tacoma Public Utilities. Erosion and sedimentation in Alder Lake (reservoir) are outside County jurisdiction. Comments on these problems forwarded to Tacoma Public Utilities.
ASH-01	Tributary crossing 278th Ave E between State Route 706 and 549th St E (55007 278th Ave E)	Blocked culvert, sedimentation, erosion upstream of culvert.	Problem is addressed by the following project: 278th Avenue East Culvert Replacement (CIP19-ASH-C01).
ASH-02	Tributary crossing 278th Ave E between State Route 706 and 549th St E (55007 278th Ave E)	From a residential survey, flooding over the roadway where stream crosses under 278th Avenue East.	Problem is addressed by the following project: 278th Avenue East Culvert Replacement (CIP19-ASH-C01).
BRI-06	Brighton Creek crossing of 62nd Ave S approx. 400 meters south of 360th St S.	Culvert is submerged by standing water on either side of the road. Likely caused by beaver activity.	Beaver Management Policy (PRG00-11).
BRI-09	36121 55th Ave S	Resident reported blocked ditch.	Report to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
BRI-10	Along Hwy 702 east of intersection with 56th Ave S. (35018 50th Ave S)	Seasonal ditch running diagonally across property does not drain properly and floods every year. Ditch should drain south under State Route 702.	Refer problem to Washington State Department of Transportation for maintenance.

TABLE 6-10
Flooding and Stormwater Drainage Problem Recommendations

Problem ID	Location	Description	Recommendation
BRI-11	Allen Road and 359th Ave S (35915 Allen Rd S)	Resident reported drainage blocked by debris/sediment.	Field observations noted recent excavation along roadside ditch and did not note any other blockage problems. Assumed the problem has been resolved.
BRI-12	2410 State Route 702 E	Resident reported flooding related to development.	Refer problem to Washington State Department of Transportation for maintenance of drainage ditches and culverts.
BRI-14	2410 State Route 702 S	Resident reported flooding on private property.	Refer problem to Washington State Department of Transportation for maintenance of drainage ditches and culverts.
BRI-16	35414 16th Ave S	Resident reported flooding over roadway/blocked ditch.	Flooding occurs over private road with no County ditches or culverts identified.
BRI-17	336th St E approx. 40 meters west of 4th Ave E	Resident flooding over road. Standing water on both sides of 336th; could be caused by beaver activity.	Field observations noted that the roadway had recently been raised, presumably due to flooding. Problem assumed to have been resolved. Also, Beaver Management Policy (PRG00-11).
BRI-18	671 341 St. Ct. E. and 821 341st St. Ct. E.	Resident reported blockage/ overflow of culverts and flooding of private property.	Upper Brighton Creek Culvert Replacements (CIP11-BRI-C01).
BRI-19	671 341 St. Ct. E.	Resident reported flooding of private property after new culvert installed at Kingsman; overflow of culverts.	Upper Brighton Creek Culvert Replacements (CIP11-BRI-C01).
BRI-21	Drainage crossing Kinsman Rd near 340th Ave S	Resident reported that installation of new culvert causing downstream flooding.	Upper Brighton Creek Culvert Replacements (CIP11-BRI-C01).
CLR-01	Between State Route 161 and Clear Lake (35921 West Clear Lake Rd E)	Resident reported flooding of private property; runoff from Hwy 161 floods West Clear Lake Road and private property.	West Clear Lake Road Culvert (CIP11-CLR-C01).
CLR-02	Clear Lake at 11512 and 11516 Clear Lake North Rd E	Residents reported flooding of private property at 11516 and 11512 Clear Lake Road North.	Report to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
CLR-04	East side of Clear Lake at outlet.	Outlet to Clear Lake is near steep slope of Ohop Valley. Potential slope failure.	Site investigation found that outlet to Clear Lake is several hundred feet away from the slope, and that outflow from Clear Lake is minimal.
COP-02	State Route 706 east of Kernahan Rd	Flooding over roadway where Copper Creek passes under SR-706 East.	State Bridge: refer problem to Washington State Department of Transportation.
COP-03	Copper Creek crossing of State Route 706	Copper Creek crossing at State Route 706 possible scour hazard.	State Bridge: refer problem to Washington State Department of Transportation.

TABLE 6-10
Flooding and Stormwater Drainage Problem Recommendations

Problem ID	Location	Description	Recommendation
ELB-01	State Route 706 E approximately 0.5 miles west of Park Junction Rd	Flooding over SR-706 East approximately 0.5 miles West of Park Junction Road.	Refer problem to Washington State Department of Transportation for maintenance of roadway drainage.
ELB-03	Park Junction Rd and State Route 706 E	Flooding over roadway at junction of SR-706 East and Park Junction Road.	Report to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
GOT-01	Goat Creek crossing of State Route 706	Goat Creek crossing of State Route 706 could have capacity problems due to sedimentation and debris.	State Bridge: refer problem to Washington State Department of Transportation.
GOT-02	Tenas Creek downstream of State Route 706	Potential flooding of properties along Tenas Creek.	Site investigation found few structures near the creek.
HRN-04	Horn Creek crossing of Hart's Lake Loop Road.	Reports of blockage of culverts, and debris where Horn Creek crosses under Hart's Lake Loop Road.	364th Street East Culvert Replacement (CIP11-HRN-FP02).
HRN-08	1411 338th St E	Flooding on private property. Flooding over roadway.	Flooding occurring over a private road.
HRN-09	364th St E approximately 1000 feet east of 8th Ave S	Flooding over roadway.	364th Street East Culvert Replacement (CIP11-HRN-C01).
HRN-11	Horn Creek crossing of 1st Ave S	Ponded water, historically beavers in area.	Beaver Management Policy (PRG00-11).
HRN-14	Horns Creek crossing of Kinsman Road.	Flooding of private property (beavers). Standing water along Kinsman Rd.	Beaver Management Policy (PRG00-11).
HRT-10	39600 Harts Lake Valley Rd	Flooding over road.	Hart's Lake Loop Road Culvert Replacement (CIP11-HRT-C01).
HRT-11	39600 Harts Lake Valley Rd	Flooding over 17th Ave South.	17th Ave South is a private road and not in County jurisdiction.
KRG-04	250 meters south of 416th St E on 22nd Ave E	Blocked ditch and flooding over road.	Site visit on May 16th, 2007, found a 1-foot-diameter log stuck in the culvert. Clean out vegetation in surrounding ditches and remove any debris from within the culvert. Install debris rack at inlet to prevent future blocking of culvert.
KRG-07	Kreger Creek crossing of Dean Kreger Road	Blocked drainage. Potential flooding. Man-made channel.	Report to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
KRG-08	10 meters north of 416th St E on Dean Kreger Rd	Blocked drainage. Standing water on either side of Dean Kreger Rd.	Beaver Management Policy (PRG00-11).

TABLE 6-10
Flooding and Stormwater Drainage Problem Recommendations

Problem ID	Location	Description	Recommendation
KRG-09	Kreger Creek crossing of 416th St E approx 250 meters south of Silver Lake	Drainage and flooding problems all along road and adjacent properties.	Silver Lake Culvert Replacement (CIP11-KRG-C01).
KRG-11	40515 Mountain Highway (Hwy 7 and Silver Lake Road)	Blocked drainage/culvert. Flooding over road. Flooding related to development.	Report to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
LYN-02	12116 414th St Ct E	Blockage problem culverts, dams, debris, etc. Flooding of private property.	Report to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
MAL-05	43919 SR-161	Flooding of private property along State Route 161; overflows of ditches.	Refer problem to Washington State Department of Transportation.
MUR-09	Culvert under Lyon Drive South approximately 200 meters northwest of 72nd Ave S.	Flooding over the roadway; culvert damage; blocked drainage.	Report to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
MUR-10	Murray Creek crossing of Hinkleman Road approximately 600 meters east 72nd Avenue S.	Area reported to have flooding problems.	Beaver Management Policy (PRG00-11).
MUR-12	Hinkleman Road, approximately 3/4 mile east of 72nd Avenue S.	Flooding reported along Hinkleman Road.	Murray Creek Hydrologic Study and Flood Hazard Mapping (ST11-MUR-ST05).
MUR-15	6106 317th St Ct S. Approximately 200 meters south of Lake Serene along Hinkleman Road.	Flooding of private property reported in January of 1998.	Murray Creek Hydrologic Study and Flood Hazard Mapping (ST11-MUR-ST05).
MUR-17	Drainage crossing 72nd Ave S approx. 80 meters south of 320th St S.	Overflows of ditches. Culvert mostly submerged; inlet may be blocked. Evidence of beaver activity.	Beaver Management Policy (PRG00-11).
MUR-18	Tisch Road near 324th St Ct S	Flooding along Tisch Road. Culvert under road submerged.	Tisch Road South Culvert Replacement (CIP11-MUR-C01).
MUR-23	Approximately 400 meters south of 32403 Tisch Rd.	Flooding occurring over Tisch Road. Culverts under road are partially submerged. Evidence of beaver activity.	Beaver Management Policy (PRG00-11).
MUR-24	Near intersection of 82nd Ave S and 336th St S; 8102 336th St S, 33717 82nd Ave S	Flooding over roadway causing flooding of private property along Hinkleman Road ¾ mile east of 72nd Avenue South. Blocked drainage.	Murray Creek Hydrologic Study and Flood Hazard Mapping (ST11-MUR-ST05).

TABLE 6-10
Flooding and Stormwater Drainage Problem Recommendations

Problem ID	Location	Description	Recommendation
MUR-26	Along 336th Street between 48th Ave S and 40th Ave S	Flooding and overflows of ditches occurring along 336th Street.	Hydrologic and hydraulic calculations suggest the culvert under 336th Street is adequately sized.
MUR-27	336th St S approximately 1000 feet west of 40th Ave S	Flooding over roadway.	Hydrologic and hydraulic calculations suggest the culvert under 336th Street is adequately sized.
MUR-28	336th St S approximately 400 feet west of 40th Ave S	Flooding over roadway.	Hydrologic and hydraulic calculations suggest the culvert under 336th Street is adequately sized.
OHL-03	44103 Kjelstad Rd E	Mud slides on road.	Unstable slopes; not related to surface water.
OHL-04	Ohop Creek (including drainage ditch) at Peterson Road	Flooding of roadway and bridge.	Ohop Creek Property Acquisition Phase 1 (CIP14-OHL-AC01), Ohop Creek Property Acquisition Phase 2 (CIP14-OHL-AC02), Ohop Creek Property Acquisition Phase 3 (CIP14-OHL-AC03).
OHL-05	Ohop Creek (including drainage ditch) crossing of Ohop Valley Road	Flooding of roadway and bridge.	Ohop Creek Property Acquisition Phase 1 (CIP14-OHL-AC01), Ohop Creek Property Acquisition Phase 2 (CIP14-OHL-AC02), Ohop Creek Property Acquisition Phase 3 (CIP14-OHL-AC03).
OHL-07	Approximately 1 miles west of Eatonville; downstream of SR16 crossing of Ohop Creek	Historical flooding of houses and bridge along Ohop Creek. Repetitive loss area.	Ohop Creek Repetitive Loss Property Acquisition (CIP14-OHL-AC04).
OHU-02	Ohop Lake outlet	Blockage, debris at outlet (weir) from Ohop Lake; flooding problems.	Beaver Management Policy (PRG00-11). Refer to appropriate maintenance department for clearing debris at outlet.
OHU-05	Orville Road adjacent to Ohop Lake	Slope failures along road.	Report to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
OHU-06	Ski Park Road adjacent to Ohop Lake (5414 N 42nd St)	Slope failures all along Ski Park Rd.	Report to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
OHU-08	54th and Warner	Residential questionnaire reported overflows of ditches (corner of 54th and Warner)	Report to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).

TABLE 6-10
Flooding and Stormwater Drainage Problem Recommendations

Problem ID	Location	Description	Recommendation
OHU-09	Ohop Lake Lot 70: 5414 N 42nd St	Flooding of private property at Lot 70 (5414 N 42nd St).	Beaver Management Policy (PRG00-11). Refer to appropriate maintenance department for clearing debris at outlet.
OHU-11	Ohop Lake at 28112 144th Ave E	Flooding of private property. Overflow of ditches.	Beaver Management Policy (PRG00-11). Refer to appropriate maintenance department for clearing debris at outlet.
OHU-13	37605 112th Ave E	Flooding over roadway.	Flooding occurring over a private road.
OHU-20	Ohop Creek crossing of Clay City Road	Clay City road floods frequently; likely caused by beaver blockages of culvert.	Beaver Management Policy (PRG00-11).
TWL-04	Cranberry Lake	Blockages at outlet to Cranberry Lake causing water levels to fluctuate. Blockages at outlet likely caused by beaver activity.	Beaver Management Policy (PRG00-11).
TWL-05	35809 59th Ave Ct E	Flooding on private property.	Flooding occurring over a private road.
TWL-06	6304 365 St E near Weyerhauser Elementary School	Flooding of private property. Culvert damage.	Culvert Replacement at 365th Street East (CIP11-TWL-C01).
TWU-04	Rapjohn Lake (outlet)	Flooding of private property. Beaver dams and debris at outlet result in higher lake levels. Blockages at outlet likely caused by beaver activity and reed canary grass.	Beaver Management Policy (PRG00-11). Develop and Implement an Invasive Species Management Program (PRG00-09).
TWU-08	Tanwax Creek crossing of Eatonville Cutoff E	Flooding of private property.	Eatonville Cutoff Road Culvert Replacement Assessment (Tanwax Creek), (ST11-TWU-ST03).
TWU-09	Approx 100 meters east of 72 Ave E on 352 St E	Overflows of ditches; 72nd Ave., Roy. Culvert blocked by sediment. Culvert damage.	352nd Street East Culvert Repair and Cleaning (CIP11-TWU-C03).
TWU-11	9016 Guske Rd E	Overflows of ditches; flooding of private property; blockages of culverts, dams, debris, etc.	Flooding occurring over a private road.
TWU-14	34512 82nd Ave Ct E	Flooding of private roadway and blocked drainage system.	Flooding occurs over private road that is located between two wetlands. Project would likely require raising roadway elevation.
TWU-15	1400 E Crestview Dr	Flooding of private property.	Flooding occurring over a private road.
TWU-16	Webster Rd E approximately 80 meters west of Barney Larson Rd (near Camp Arnold)	Flooding of roadway. Culvert damage.	Webster Road Culvert Repair (CIP11-TWU-C02).

TABLE 6-10
Flooding and Stormwater Drainage Problem Recommendations

Problem ID	Location	Description	Recommendation
TWU-19	10921 352nd St E	Flooding of private property; overflow of culverts; high groundwater.	Report to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
TWU-21	Tanwax Drive near Meridian Rd (33705 Tanwax Dr E)	Culvert filled with sediment, causing roadway flooding at the intersection of Tanwax Drive and Meridian Road.	Report to Transportation Services for required maintenance. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
TWU-23	Tanwax Lake Outlet	Blockages of culverts, dams, debris, etc (beavers). Tanwax Lake (at outlet); flooding of private property. Blockages at outlet likely caused by beaver activity.	Beaver Management Policy (PRG00-11).
TWU-24	34402 Thomas Rd E	Flooding over roadway.	Thomas Road East Culvert Replacement (CIP11-TWU-C03).
TWU-25	34328 Thomas Rd E (near Tanwax Lake)	Overflows of ditches/culverts. Channel/bank erosion. Blocked drainage. Flooding of private property.	Thomas Road East Culvert Replacement (CIP11-TWU-C03).
TWU-27	Tanwax Lake at 33905 Tanwax Ct E	Flooding of private property. Blockages at outlet likely caused by beaver activity.	Beaver Management Policy (PRG00-11).
TWU-28	Tanwax Lake at 33524 Benbow Dr E	Flooding of private property. Blockages at outlet likely caused by beaver activity.	Beaver Management Policy (PRG00-11).
TWU-31	Inlet and outlet to Lake Whitman (upper Tanwax basin)	Inlet and outlet to Whitman Lake severely overgrown which could potentially reduce conveyance. Backwater flooding at lake likely caused by beaver activity.	Beaver Management Policy (PRG00-11).
TWU-33	Benbow Dr E at Lake Whitman	Flooding of private property; blockages problem culverts, dams, debris, etc. at Whitman Lake. Likely caused by beaver activity.	Beaver Management Policy (PRG00-11). Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PROG00-03).
TWU-34	32022 Benbow Dr E	Drainage system failure.	Benbow Drive Culvert Replacement (CIP11-TWU-C01).
TWU-35	31614 Benbow Rd E	Flooding on private property.	Benbow Drive Culvert Replacement (CIP11-TWU-C01).

CHAPTER SEVEN
WATER QUALITY ANALYSIS

7.1 INTRODUCTION

Chapter 7 provides an analysis of the water quality information and problems described in Chapter 4, "Current and Future Conditions", and Chapter 5, "Identification of Problems." Section 7.2 summarizes the identified water quality problems and their likely causes. Section 7.3 discusses the water quality concerns and management needs for the numerous lakes in the planning area. Section 7.4 recommends potential solutions to the water quality problems. The recommended solutions include a range of programmatic measures and capital improvement projects.

7.2 EXISTING WATER QUALITY PROBLEMS REVIEW

Table 7-1 lists the water quality problems identified during basin characterization. These problems were identified based on a variety of sources as discussed in Chapter 5.

TABLE 7-1
Water Quality Problems in the Nisqually River Basin Planning Area

			Parameter of Concern				
Problem ID	**Location**	**Description**	**Bacteria**	**Phosphorus**	**Suspended Solids**	**Temperature**	**Other**
ASH-03	Near Nisqually River south of National Park.	Reports of off-road vehicles in streams.			X		
ASH-04	Creek crossing Mt Tacoma Canyon Rd approx 1 mile east of intersection with SR 706	Channel/bank erosion; clearing/logging near stream; construction in or near stream.			X		
ASH-05	31313 Mt. Tacoma Canyon Rd E	Septic/drain field problems[1]	X				
ASH-06	Creek crossing Mt Tacoma Canyon Rd approx 500 m northeast of intersection with SR 706	Cloudy water reported in streams/ditches.			X		
BRI-20	Brighton Creek Sub-basin	Septic/drain field problems[1]	X				
BRI-22	Brighton Creek Sub-basin	Septic/drain field problems[1]	X				
CLR-03	Clear Lake	High nutrient and pollutant levels. Listed on 303(d) in 1996 and 1998 for total phosphorous. Algae blooms. Septic system failures[1].	X	X			
COP-01	Copper Creek Sub-basin	Septic/drain field problems[1]	X	X			

TABLE 7-1
Water Quality Problems in the Nisqually River Basin Planning Area

			Parameter of Concern				
Problem ID	**Location**	**Description**	**Bacteria**	**Phosphorus**	**Suspended Solids**	**Temperature**	**Other**
ELB-02	North of SR 706 at Park Junction Road	Park Junction development proposed for this area could affect Elbe Creek.			X		
ELB-04	Elbe Sub-basin	Septic/drainfield problems	X	X			
ELB-05	East end of Alder Lake	Clearing/logging near water at east end of Alder Lake.			X		
HRN-02	All along lower Horn Creek, especially adjacent to Allen Rd S	Many small farms; livestock; septic failure/seepage[1]; suds in creek; septic tanks near creek.	X	X	X		
HRN-07	Horn Creek Sub-basin	Septic/drain field problems[1]	X	X			
HRN-12	Horn Creek Sub-basin	Septic/drain field problems[1]	X	X			
HRN-13	Horn Creek Sub-basin	Septic/drain field problems[1]	X	X			
HRN-15	Horn Creek Sub-basin	Septic/drain field problems[1]	X	X			
HRT-04	Hart's Creek west of Wilcox Dairy	Runoff from dairy could lead to water quality problems (fecal coliform, nutrient loading).	X	X			
HRT-05	Harts Lake Sub-basin	Septic/drain field problems[1]	X	X			
HRT-09	Harts Lake	Cloudy water in streams/ditches; Hart's Lake. Manure in/near streams; high algae. Fish kill.	X	X	X		
KRG-05	Kreger Creek Sub-basin	Septic/drain field problems[1]	X	X			
LMR-02	Meadows near confluence of Little Mashel River and Midway Creek	Cattle in watershed	X	X	X		
LMR-03	Tributary to Midway Creek, east of Alder-Cutoff Highway	Cattle in watershed	X	X	X		
LMR-04	Headwaters of Midway Creek	Cattle in watershed	X	X	X		
LYN-03	Lynch Creek adjacent to Eatonville	Cloudy water in streams/ditches; stormwater discharge/development along creek.	X	X	X		
MAL-02	Lower Mashel River, approx 0.7 mile reach beginning at the confluence with the Nisqually River	303(d) violation for temperature				X	
MAL-06	Lower reach of Mashel River (~1.5 miles from Eatonville)	Cloudy water in streams/ditches			X		
MAM-02	Middle Mashel River, approx 3 mile reach east of railroad tracks east of Eatonville	303(d) violation for temperature				X	

TABLE 7-1
Water Quality Problems in the Nisqually River Basin Planning Area

			Parameter of Concern				
Problem ID	**Location**	**Description**	**Bacteria**	**Phosphorus**	**Suspended Solids**	**Temperature**	**Other**
MUR-04	Murray Creek in the vicinity of the gravel pit, west of SR 507	Reports of off-road vehicles in streams.			X		
MUR-07	Murray Creek Sub-basin	Septic/drain field problems[1]	X	X			
MUR-08	Murray Creek Sub-basin	Septic/drain field problems[1]	X	X			
MUR-13	Murray Creek Sub-basin	Septic/drain field problems[1]	X	X			
MUR-16	Murray Creek Sub-basin	Septic/drain field problems[1]	X	X			
MUR-25	336th St S between 78th Ave S and Locke Drive	Clearing, logging, and construction in or near streams. Debris and blockages of the drainage.			X		
MUR-29	Murray Creek Sub-basin	Septic/drain field problems[1]	X	X			
NIS-03	Nisqually River (Township/Range/Section: 18N, 01E, 08)	Listed on state 303(d) for fecal coliform, temperature and chromium in 1998.	X			X	X
OHL-02	Lower Ohop Creek, primarily the lowest 0.75 miles	Low BIBI scores (County Site 29, Tribe Site 107) and elevated water temperatures. Lower portion listed under 303(d) (fecal coliform).	X			X	X
OHL-06	Lower Ohop Creek approximately from SR 161 to confluence with Nisqually River	Low BIBI scores (County Site 29, Tribe Site 107) and elevated water temperatures.				X	X
OHU-04	Ohop Lake (40502, 40314 Ski Pk Rd)	Cloudy water in streams/ditches; mass wasting; clearing/logging near stream/lake.		X	X		
OHU-07	Ohop Lake	High phosphorus levels in Ohop Lake; algae. 303(d) violation for total phosphorus.		X			
OHU-10	Tributary streams to Ohop Lake	Clearing/logging near stream/lake.			X		
OHU-15	Upper Ohop Sub-basin	Septic/drain field problems[1]	X	X			
OHU-19	Along Twentyfive Mile Cr approximately 500 meters upstream from confluence with Ohop Creek	Cattle in stream	X	X	X		
RED-01	Nisqually River outlet to Puget Sound	Nisqually Beach closed by DOH for biotoxins or pollution.	X				
RED-02	Estuary parallel to the Nisqually Estuary a few hundred meters to the east	Red Salmon Creek on state 303(d) list in 1998 for exceeding fecal coliform standards.	X				
TWU-05	Rapjohn Lake	High turbidity of runoff from adjacent property that is being cleared for timber.			X		

TABLE 7-1
Water Quality Problems in the Nisqually River Basin Planning Area

			Parameter of Concern				
Problem ID	**Location**	**Description**	**Bacteria**	**Phosphorus**	**Suspended Solids**	**Temperature**	**Other**
TWU-17	Upper Tanwax Creek	Manure in/near streams. Cattle, pastures, houses and barns in the valley.	X	X			
TWU-18	Upper Tanwax Sub-basin	Septic/drain field problems[1]	X	X			
TWU-20	Upper Tanwax Creek	High turbidity, sediments. Cloudy water in streams/ditches.			X		
TWU-26	Tanwax Lake	Septic failure/seepage[1]; cloudy water in streams/ditches; channel/bank erosion; oil, litter, algae.	X	X			
TWU-30	Upper Tanwax Sub-basin	Septic/drain field problems[1]	X	X			
TWU-32	Benbow Dr E at Lake Whitman	Cloudy water in streams/ditches; channel/bank erosion at Whitman Lake.			X		

[1]According to the TPCHD, septic/drainfield failures are usually repaired soon after the problems have been identified. Thus, the specific system failures listed above have probably been corrected. However, the failures may be indicative of the potential for other systems in the area to fail due to age, soil, water table, or other local conditions.

As shown in Table 7-1, the most common water quality problems in the Nisqually River Basin planning area are elevated levels of fecal coliform bacteria, phosphorus, suspended solids, and water temperatures.

The water quality problems in the planning area are primarily associated with rural land use activities and non-point sources, such as failing septic systems, livestock waste, land clearing, construction, logging, and off-road vehicle use. Stormwater runoff is also a potential pollution source in several portions of the planning area. Sections 7.2.1 through 7.2.4 below discuss the fecal coliform, phosphorus, suspended solids, and water temperature problems and their likely sources or causes.

7.2.1 Fecal Coliform Problems

Fecal coliform bacteria come from feces of warm-blooded animals. Common sources of fecal coliform are failing septic systems, livestock, pets, and wildlife (e.g., birds, rodents). High fecal coliform levels may indicate a health risk to people who come into contact with contaminated water through recreational uses (swimming and boating) or ingest it.

Septic system effluent typically contains high concentrations of bacteria. Septic system drainfields tend to clog over time. Severe clogging can result in surface failures and allow

inadequately treated effluent to flow overland into lakes and streams, with little contaminant removal en route. In general, the risk of failure is generally greater for older systems.

Septic system failures are a common problem in the basin planning area because many of the rural houses were originally built as part-time residences. In recent years they have been converted to full-time residences. In particular, septic systems serving shoreline homes may provide inadequate treatment if the water table is high or if they are too close to the surface water body. Lack of maintenance can also lead to inadequate treatment. Problem identification sources such as the County's Service Response System and the basin resident questionnaire reported 23 incidents of septic system failures. Of these, five were reported in the Murray Creek subbasin, and five were reported in the Horn Creek subbasin. The remaining 13 were dispersed throughout the other subbasins in the planning area.

Because the basin is largely rural, there is a significant amount agricultural land use. Both commercial livestock operations and hobby farms are common. During the basin characterization, several agricultural sites were noted that could be significant sources of fecal pollution:

- Hobby farms in the Red Salmon Creek subbasin
- Hobby farms in the Horn Creek subbasin
- Hobby farms in the Tanwax Creek subbasin
- Wilcox Dairy Farm near Harts Lake
- Cattle grazing and dairy farms (since closed) in the lower Ohop Creek subbasin
- Cattle in streams in the upper Ohop Creek subbasin
- Cattle grazing in the Little Mashel River subbasin

Current and past 303(d) listings indicate elevated fecal coliform levels in the Nisqually River (lower reaches), Red Salmon Creek, and Ohop Creek. In addition, the Washington State Department of Health has closed the Nisqually Reach adjacent to the mouth of the Nisqually River and McAllister Creek to harvesting of shellfish due to high fecal coliform. A report produced by the Nisqually Tribe (Whiley and Walter, 1998) also suggests that the Mashel River contains significant levels of fecal coliform.

Ecology submitted the Nisqually Watershed bacteria and dissolved oxygen TMDL (Water Cleanup Plan) in June 2005. The TMDL encompasses the Red Salmon Creek and Ohop Creek subbasins, which were listed for fecal coliform bacteria only (i.e., not dissolved oxygen). In May 2007, Ecology published the Water Quality Implementation Plan that prescribes the specific actions to attain the load reductions required by the TMDL. Details from the Ecology's TMDL report and implementation plan are summarized below:

- ***Red Salmon Creek*** –The Nisqually Tribe sampled Red Salmon Creek at river mile 1.40 for a number of parameters, including fecal coliform bacteria, from July 1993 - April 1995. During that period, there was a significant positive correlation between the two-day antecedent rainfall and fecal coliform levels. Fecal coliform concentrations were chronically

elevated, and some of the highest median fecal coliform levels were seen during storm events (Whiley and Walter, 1996).

Red Salmon Creek and its tributaries above river mile 1.4 are considered fresh water bodies. The state water quality criteria for "extraordinary" fresh water bodies (geometric mean fecal coliform concentration must be less than 50 colonies/100 mL, with no more than 10% of samples above 100 colonie/100 mL). From river mile 1.4 to the mouth, the marine standards apply, which call for a geometric mean less than 14 colonies with no more than 10% of samples above 43 colonies per 100 mL). During Ecology's 2002-2003 sampling, Red Salmon Creek at RM 1.44 met the freshwater standards but exceeded the marine standards for fecal coliform. Wash Creek, a small tributary upstream of river mile 1.4 did not meet either the freshwater standard. Even if both Red Salmon RM 1.44 and Wash Creek met the extraordinary primary contact standards for freshwater, Red Salmon would not meet marine standards during the low tide period. The downstream sample sites at RM 1.4 and the unnamed tributary at RM 1.3 are both classified as marine water due to salinity, while the upstream sites are freshwater. Due to freshwater inputs of fecal coliform from upstream sources, the critical period is the low tide period annually.

The floodplain and estuary of Red Salmon Creek have been used for cattle grazing. Ecology's TMDL report identified livestock as the primary source of bacterial pollution affecting Red Salmon Creek. In 2007, the Nisqually Tribe removed all livestock operations from the Red Salmon Creek subbasin (personal communication with Jeanette Dorner, Nisqually Tribe, 2008).

Surface Water Management participated in the development of the Water Quality Implementation Plan for Red Salmon Creek and has committed to several programmatic actions (e.g., stormwater BMP implementation, coordination with the Pierce Conservation District) that will help protect water quality in the Red Salmon Creek subbasin (James 2007).

- ***Ohop Creek*** – A 1997 report by Whiley and Walter found that fecal coliform levels were higher at lower Ohop Creek sites (river miles 6.0, 3.3, 2.0, and the mouth) than farther upstream. During the study, the lower Ohop Creek stations received drainage from two dairy farms that have since closed (although portions of the lower Ohop Valley are still used for grazing). Significantly higher levels of fecal coliform were seen in the creek during the dry season, especially at the lower stations.

- ***Lynch Creek*** – Identified in the TMDL study as a source of bacteria to Ohop Creek below the lake. Stormwater is believed to be a primary contributor of bacteria to Lynch Creek. Stormwater from a large portion of the Town of Eatonville is conveyed to Lynch Creek via a large channel. Eatonville has recently purchased land adjacent to the lower reach of the stormwater channel (i.e., just above its confluence with Lynch Creek), which could serve as the site for some type of regional stormwater treatment facility. The Town participated in the development of the Water Quality Implementation Plan, and has committed to (1) design a bio-filtration system to treat discharges to Lynch Creek, and (2) investigate low-impact development techniques for stormwater management (James 2007).

- The Nisqually Tribe and the Pierce Conservation District have been working on a large habitat restoration project on lower Ohop Creek. The project will include a number of elements that should enhance water quality, including riparian plantings, removal of drainage tiles, and buffers and fencing to reduce livestock access to the creek (James 2007).

Surface Water Management has committed to a number of non-structural measures designed to improve water quality in Lynch Creek and Ohop Creek (James 2007). These include:

- Provide pet owner education materials to the Town of Eatonville
- Monitor Ohop and Lynch Creeks
- Investigate bacteria sources affecting Lynch Creek
- Continue implementation of stormwater BMPs
- Complete the Nisqually River Basin Plan

Surface Water Management met with the Town of Eatonville to visit the potential site for the regional stormwater treatment facility. The County considered partnering with the Town on the design, construction, and costs for the potential stormwater facility if it was determined that the unincorporated areas of the county contributed to stormwater problems at this location. However, the tributary area to the facility lies almost entirely within the Town. Therefore, no recommendations have been made for the County to contribute at this time.

7.2.2 Phosphorus

Phosphorus plays a major role in freshwater ecosystem dynamics. Nearly all freshwater lakes are limited by phosphorus. High levels of phosphorus can lead to algal blooms and accelerated eutrophication of a lake system. Lake eutrophication is a key concern in the planning area, which contains 16 lakes. Ecology has identified three of the lakes (Ohop, Clear, and Harts) as “polluted” and listed the remaining 13 as “waters of concern” for eutrophication due to phosphorus pollution. Phosphorus can come from a variety of sources, including septic systems, livestock, and urban runoff.

Septic systems can contribute phosphorus via overland flow caused by septic system failure. As discussed in Section 7.2.1, septic system drainfields tend to clog over time, resulting in surface failures that allow inadequately treated effluent to flow overland into lakes and streams.

Septic failures have been reported for a number of locations within the Nisqually River planning area (see Table 7-1). Septic failures that occur in shoreline areas have the greatest potential to discharge phosphorus and bacteria to receiving waters because there is little opportunity for pollutant removal en route.

Septic systems can also contribute phosphorus via groundwater flow. Phosphorus usually moves very slowly in soil and groundwater because it adsorbs on soil particles and forms chemical complexes with low solubilities. Over a long period of time, groundwater “plumes” from shoreline septic systems can carry phosphorus to nearby lakes or streams.

Section 7.2.1 above discusses several areas where water is prone to contamination from fecal coliform bacteria from livestock and other agricultural activities. These agricultural activities

may also contribute phosphorus to receiving waters. In addition, there are three areas where stormwater runoff may contribute to water quality problems, including elevated phosphorus levels:

- *Eatonville* –Much of the town's stormwater runoff drains to Lynch Creek, which has been noted as a potential water quality concern for Lynch and Ohop Creeks.
- *Upper Nisqually Valley* – Growth is expected around the communities of Elbe, National, Ashford, and near the park entrance, which could lead to increased urban stormwater runoff. In addition, a large development is planned for the Park Junction area east of Elbe.
- *Murray Creek Subbasin* – Development in the Murray Creek subbasin, particularly in the area between Roy and McKenna, could lead to increased urban stormwater runoff.

In addition to these specific areas, there is significant development around some of the lakes in the planning area such as Clear Lake, Ohop Lake, and Tanwax Lake. Other lakes with homes near the shoreline include, Alder Lake, Harts Lake, Kreger Lake, Lake Serene, Lake Twenty-Seven, Rapjohn Lake, Silver Lake, Twin Lakes, and Whitman Lake. Stormwater runoff from paved and landscaped shoreline areas could carry phosphorus and other pollutants to the adjacent lakes.

7.2.3 Suspended Sediment

High levels of suspended sediments in natural waters can be harmful to aquatic organisms and can transport pollution that adsorbs to particles. In addition, sediments can settle out in slow-moving reaches, decreasing drainage system conveyance capacity and decreasing aquatic habitat quality. Suspended sediments also increase water turbidity. Highly turbid water can be a sign of high levels of suspended sediments. Highly turbid or cloudy water was reported in at least eight locations in the planning area, including Harts Lake, Whitman Lake, Rapjohn Lake, Tanwax Creek, Lynch Creek, Ohop Lake, the Mashel River, and Hershey Creek (east of Ashford). In addition, EDT analysis indicated that high turbidity contributes to habitat impairment in the lower and middle reaches of the Nisqually River (lower reaches upstream of estuary, Whitewater, McKenna, near Wilcox).

High levels of suspended sediments are often caused by human disturbances upstream. The following potential sources of suspended sediments were identified:

- *Construction in or near Streams and Lakes* – This is potentially a problem for all areas experiencing development near streams and lakes. Basin residents specifically reported seeing an increase in turbidity in Tanwax Creek related to construction near Tanwax Lake.
- *Logging and Land Clearing* – A significant amount of logging and land clearing occurs in the basin. Some of it is related to the commercial logging industry in the eastern part of the basin, and some is related to continued residential development of rural areas. Specific problems with logging and land clearing near lakes and streams were identified in the Murray Creek subbasin (near Locke Drive), near Rapjohn Lake, near and around Ohop Lake, Hershey Creek near Ashford, and on the east end of Alder Lake.

- *Mass Wasting* – Mass wasting is large-scale, down slope movement of earth such as a land slide or the slumping of a river bank. Disturbances such as timber harvesting can lead to land instability and mass wasting events. A watershed characteristics and conditions inventory of the upper Mashel River watershed (Jones and Stokes, 1991) noted several occurrences of mass wasting, including three large debris flows. A debris flow in this case is a rapidly occurring mass wasting event that is transported primarily by water down a stream channel.
- *Off-Road Vehicle Disturbance* – Many rural portions of the planning area have problems with off-road vehicles driving outside of allowed areas, including through streams and wetland habitat. This type of disturbance can lead to erosion and increased suspended sediments. Off-road vehicle disturbance tends to be dispersed over large areas, but three specific areas were identified: 1) near the gravel pit in the Murray Creek subbasin, 2) south of Mt. Rainier National Park in the Ashford subbasin, and 3) developing areas of the Tanwax Creek subbasin.
- *Urban Development* – Increased stormwater runoff from areas of urban development can lead to increased levels of suspended sediments in receiving waters.

7.2.4 Water Temperature

Elevated water temperatures can be harmful to salmon. Water temperatures have exceeded the state standard in the Mashel River and lower Ohop Creek. Recent sampling in the Mashel River found that the temperature standard was exceeded 30% of the time at the mouth of the river and 18% of the time at river mile 60. The elevated temperatures may be related to sparse shade along the stream.

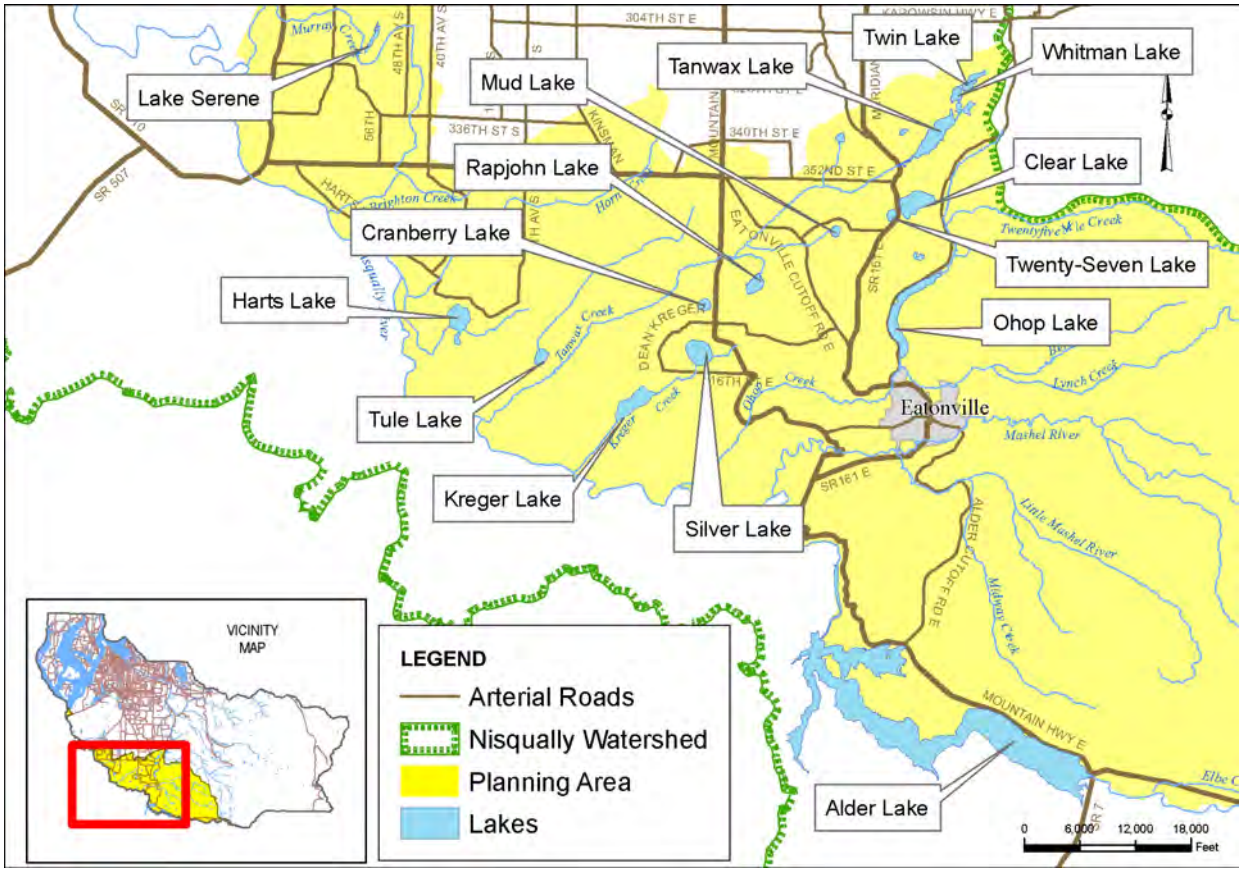
Water temperatures in lower Ohop Creek have frequently exceeded the state standard during the summer. The most frequent temperature exceedances were observed in the reach just downstream of Ohop Lake. The elevated temperatures in this reach are likely due to the discharge of warm water from the lake. Although water temperatures generally improved with distance downstream from the lake, water temperatures near the mouth have often exceeded the state temperature standard, probably due to the sparse riparian canopy along this reach.

7.3 LAKE WATER QUALITY PROBLEMS

The Nisqually River Basin planning area encompasses more than 16 lakes. Figure 7-1 shows the major lakes in the planning area.

Much of the residential development in the planning area is concentrated around lakes, notably Clear, Ohop, and Tanwax lakes. Lakeshore development increases the potential for lake pollution due to land clearing, construction, septic systems, fertilizer and pesticide use, trash, and runoff from impervious areas.

Lakes with public boat ramps may be more susceptible to invasive weed problems.



Lake eutrophication is a key concern in the planning area. Ecology has identified three of the lakes (Ohop, Harts, and Clear) as "polluted" and 13 as "waters of concern" for lake eutrophication due to phosphorus pollution.

Lake eutrophication can involve a range of problems including:

- Excessive and/or invasive aquatic plant growth
- Excessive algal growth (typically due to elevated phosphorus inputs to the lake) and toxic algae (cyanobacteria) blooms
- Poor water clarity due to algal growth and/or soil eroded from the lake watershed
- Low dissolved oxygen levels caused by excessive aquatic plant growth and/or discharges of oxygen-demanding materials into the lake

Potential nutrient sources include land use activities (such as removal of native vegetation along lakeshores and tributary streams), point source discharges (such as wastewater treatment plant and industrial discharges), and non-point discharges (such as agricultural runoff, stormwater, and septic systems). Flow controls (e.g. weirs) can affect lake parameters such as temperature and suspended sediment.

Although recreational usage and aesthetic values of lakes can be impaired by excessive aquatic plant and algae growth, healthy lakes typically require some level of algae and aquatic plants.

FIGURE 7-1. Lakes in the Nisqually River Basin Planning Area

Algae are primary producers and serve as the food base for many lake organisms, including fish and benthic invertebrates. Aquatic plant communities provide oxygen for aquatic life; habitat and food for waterfowl, fish, amphibians, invertebrates, and insects; protection of the shoreline from erosive waves; and stabilization of bottom sediments from re-suspension (Cooke et al. 2005).

However, excessive algal and aquatic plant growth and its effects on water quality are the most common problems addressed in the management of shallow, eutrophic lakes (Cooke et al. 2005). Excessive algal blooms hinder lake recreation, are unsightly, and deplete lake oxygen levels during decomposition. Certain strains of blue-green algae (also known as cyanobacteria) can be toxic to people and animals if ingested; thus, algae-dominated lakes require close surveillance to ensure public safety. Aquatic plants, especially invasive species, can grow out of control in nutrient-rich lakes. Excessive aquatic plant growth similarly hinders lake recreation, is unsightly, and can negatively alter lake food webs.

The factors typically affecting the abundance and distribution of plants within lakes are nutrients, light availability, sediment characteristics, wind, and wave energy (Nichols, 2001). Algae growth is often limited by nutrient (usually phosphorus) concentrations in the water column. The cycling of phosphorus in lakes is complex and dependent upon a variety of physical, chemical, and biological factors. Generally, the addition of phosphorus to a lake will increase the rate and amount of algae production (Bachmann, 2001). However, lake size and depth control how nutrients affect algal growth.

In deeper lakes, there is generally a continual loss of nutrients from the epilimnion to the hypolimnion as algae and particulate matter die and sink to the bottom of the lake. In contrast, the frequent mixing of shallow lakes typically results in a relatively rapid return of nutrients from most settled material into the water column.

Controlling nutrient inputs to lakes is a key component in maintaining or improving lake water quality. Septic systems and runoff from agricultural land are two potential sources for nutrient inputs to lakes and contributing streams. Stormwater runoff can also contribute nutrients to lakes from fertilizers and eroded soil.

In Pierce County, the Tacoma-Pierce County Health Department is responsible for septic system design, inspection, and repair. Pierce Conservation District addresses runoff from agricultural land through voluntary landowner participation in its conservation planning program. Surface Water Management addresses stormwater quality through its NPDES MS4 permit program and basin planning. The Washington State Department of Ecology (Ecology) also supports programs to address invasive aquatic weeds and toxic algae in lakes. The control measures implemented by these agencies are described in greater detail in “Appendix I.”

Once lake sediments are enriched with nutrients, addressing invasive or excessive aquatic vegetation generally requires controlling plant growth through physical, mechanical, chemical, or biological control methods. Examples of physical and mechanical control methods include hand pulling and harvesting with machines. Examples of chemical control methods include herbicides that target certain types of aquatic vegetation and alum to reduce concentrations of plant-available forms of Phosphorus. Examples of biological control methods include

herbivorous fish (such as sterilized grass carp), weevils that feed on target aquatic plants, and restoration of native aquatic plant communities.

Ecology recommends that lake management groups and local governments collaborate in the development of integrated aquatic vegetation management (IAVM) plans for lakes with aquatic plant management issues. An IAVM plan evaluates the available control methods and selects the most appropriate methods for the lake conditions and management goals. Ecology generally will not issue permits for application of certain aquatic herbicides and other control techniques unless the applicant has completed an IAVM.

7.3.1 Lake Survey

As discussed in Chapter 4, little information was available for many of the lakes in the Nisqually River Basin planning area. To address this data gap, Surface Water Management conducted a survey to obtain additional information about lake water quality problems in the planning area.

A questionnaire was sent to the property owners around the 16 lakes shown in Figure 7-1. The questionnaire asked for information relevant to lake water quality including:

- Lake access and use
- Fish populations
- Algae blooms
- Aquatic weeds
- Water quality
- Fertilizer and lake habitat
- Septic systems
- Lake management groups
- Willingness to pay for lake management actions
- Other problems and issues

The questionnaire also asked for information about lake flooding and water level control. “Appendix F” contains a detailed description of the survey and its findings. Table 7-2 summarizes the survey’s findings relevant to lake water quality.

TABLE 7-2
Lake Water Quality Survey Results

Lake	Fish Kills	Algae Blooms	Aquatic Weeds	Water Quality
Alder Lake	x	x	x	
Clear Lake	x	x	x	x
Cranberry Lake	No data[1]	No data[1]	No data[1]	No data[1]
Harts Lake	x	x	x	x
Kreger Lake	No data[1]	No data[1]	No data[1]	No data[1]
Lake Serene	x	x	x	x
Lake Twenty-Seven				
Mud Lake	No data[1]	No data[1]	No data[1]	No data[1]
Ohop Lake	x	x	x	x
Rapjohn Lake				
Silver Lake	x	x		x
Tanwax Lake	x	x	x	x
Trout Lake	No data[1]	No data[1]	No data[1]	No data[1]
Tule Lake	No data[1]	No data[1]	No data[1]	No data[1]
Twin Lakes		x	x	x
Whitman Lake	x	x	x	x

[1]No completed questionnaires were received for these lakes.

The questionnaires also asked respondents to describe their specific issues or concerns. Specific issues identified included:

- For Clear Lake, one respondent described concerns related to motor boat and jet ski usage and water quality; another respondent indicated there is an aquatic weed management program in place.
- For Harts Lake, there was one complaint regarding aquatic plants (milfoil) and one complaint regarding trash left in the lake by fishermen and hunters.
- Ohop Lake has a Lake Improvement Club that has been controlling aquatic weeds using an IAVM approved by Ecology. Ohop Lake also limits water ski and Jet Ski activity to the period from 11:00 AM to 3:30 PM, with a speed limit of 8 mph during other hours. Ohop Lake respondents expressed concerns about sediment buildup, failing septic systems, fireworks, motor boats, and excessive populations of cormorants reducing the fish in the lake.
- On Lake Serene, one respondent noted that thick weeds preclude fishing and swimming, and that past herbicide applications were not effective in controlling aquatic plant growth.
- For Whitman Lake, four respondents expressed concern that motor boats and jet skis are damaging the lake.

The survey results indicate that most of the lakes in the Nisqually River Basin planning area have public access points, and most are used for boating, swimming and fishing. In addition, Clear Lake, Harts Lake, and Silver Lake provide water for irrigation.

Survey respondents were asked to rate the importance of lake issues. As shown in Table 7-3, water quality issues received the highest average ranking of importance and flooding issues in and around lakes received the lowest average ranking of importance. (Note: Lake-related flooding is discussed in Chapter 6 of this Basin Plan.)

TABLE 7-3
Perceived Importance of Lake Issues

Rank of Issue	Issue	Average Ranking*
1	Water Quality	1.3
2	Fish Health	1.6
3	Algae Blooms	1.7
4	Water Weeds	1.9
5	Septic System Use	1.9
6	Fertilizer Use	2.2
7	Lake Level	2.3
8	Flooding	2.8

*1 is most important and 4 is least important

7.3.2 Lake Water Quality Management Gap Analysis

A gap analysis was conducted to evaluate the existing lake management activities in the planning area and identify additional activities that would be needed for a fully functional lake management program. The gap analysis determined that a fully functional lake management program should include the following components:

1. Monitoring and Source Identification
2. Volunteer Monitoring
3. Data Management and Dissemination
4. Education and Outreach
5. Community Technical Assistance
6. Inter-Agency Coordination and Information Sharing
7. Implementation of the Aquatic Invasive Plant Program
8. Funding for Lake Projects
   a. Lake Projects: Detailed lake studies

b. Lake Projects: In-lake control and management strategies

c. Lake Projects: Watershed strategies

d. Lake Projects: Provide funding for private projects

9. Enforcement

10. Legal Authority

The analysis found that Surface Water Management, the Tacoma-Pierce County Health Department, Pierce Conservation District, and the state departments of Ecology and Fish and Wildlife currently perform some, but not all, of the lake management activities listed above. Table 7-4 summarizes the gaps in current activities related to the lake management program components listed above. "Appendix I" contains a detailed description of the lake management gap analysis.

TABLE 7-4
Gaps in Pierce County Lakes Program

Lake Management Component	Function	Current work	Gap/Need
Monitoring and Source Identification	Identify water quality problems (including aquatic weeds and toxic algae) and their sources or causes, track changes in water quality over time. Determine which lakes need further study or improvement.	TPCHD has 0.5 FTE to monitor 7 beaches at 4 lakes for fecal bacteria, and to respond to algae concerns on all lakes.	Limited water quality data is available for many lakes. TPCHD only reports lake water quality concerns, does not propose how to address concerns. Need additional info to organize lake management activities and determine which lakes need proposed projects for additional study and water quality improvement activities. Need to use a boat to conduct lake water quality monitoring at multiple sites in lakes (not just public access points).
Volunteer Monitoring	Train volunteers in lake monitoring techniques, collect samples from volunteers, perform testing on samples, and distribute data to public via website.	PCD Stream Team provides equipment loan of 3 lake kits to landowners.	Volunteer monitoring provides an opportunity for residents to take an active part in monitoring lake health, and provides economic and useful background data on lake functions and health. Volunteers can collect data at more frequent intervals than County staff.
Data Management and Dissemination	Make monitoring data and other program information accessible to other organizations and to the public.	TPCHD grant will be used to provide algae data on the web. PCD shares data with TPCHD.	Monitoring data needs to be accessible to other organizations and to the public. If additional monitoring is conducted, data management and dissemination will be required as well.

TABLE 7-4
Gaps in Pierce County Lakes Program

Lake Management Component	Function	Current work	Gap/Need
Education and Outreach	Perform outreach and education regarding lake-friendly landscaping, on-site sewage treatment, lake health, etc.	TPCHD, PCD, WDFW, and Ecology perform limited outreach and education. PCD provides outreach and education on watershed health and nutrient management. PCD and TPCHD distribute lake management brochures.	Additional outreach and education activities are needed to inform the public about lake issues and motivate changes to improve lake health
Community Technical Assistance	Answer questions on lake health and functions. Help lakeshore owners obtain grants, form lake management districts, and determine appropriate fees or rates. Provide technical guidance on lake projects.	TPCHD and PCD provide limited technical assistance related to lakes. PCD provides aquatic weed management advice when requested.	Lakeshore property owners and recreational users often want to know more about lake health and address problems on lakes. Assistance for these stakeholders is needed.
Inter-Agency Coordination and Information Sharing	Share information on lake management activities with other local and state agencies (e.g., TPCHD, PCD, Ecology).	Limited inter-agency coordination occurs. PCD shares data with TPCHD and communicates with Ecology.	Inter-agency coordination is needed to improve the efficiency and effectiveness of lake management activities.
Aquatic Invasive Species Management	Implement activities recommended by PCWP Invasive Vegetation project such as education, lake monitoring and management activities.	PCWP is currently conducting an Invasive Vegetation project.	Invasive aquatic species reduce recreational and aesthetic qualities of lakes and put lakes at risk for shifts in ecological functions and decreased habitat quality.
Funding for lake projects	Provide funding to implement projects to improve lake health.	None.	As a result of the Aquatic Invasive Plant Program, monitoring information, public requests, and detailed lake studies, various capital lake projects are likely to be proposed. Funding to implement these projects will be needed.
Lake Projects: Detailed lake studies	Perform detailed analysis of lake characteristics, functions, problems, and proposed projects to address problems.	None.	Costs could range from $150,000 to $400,000 or more per lake studied. There are five 1st Tier Lakes in the Nisqually Basin that could require detailed studies. Funding will be needed.

TABLE 7-4
Gaps in Pierce County Lakes Program

Lake Management Component	Function	Current work	Gap/Need
Lake Projects: In-lake control and management strategies	As a result of the Invasive Vegetation project and detailed lake studies, in-lake control and management strategies are likely to be proposed including aquatic plant harvesting or chemical control.	Ecology provides small grants for aquatic weed and algae management.	Costs could range from $10,000 to $8 million or more per lake studied and managed. Funding will be needed.
Lake Projects: Watershed strategies	As a result of the Invasive Vegetation project and detailed lake studies, watershed strategies such as stormwater treatment, agricultural runoff management, and forestry runoff management to reduce inputs of nutrients, bacteria, and other pollutants to lakes that receive stormwater runoff.	PCWP and PCD implement watershed improvements for stormwater and water quality enhancement.	Costs could range from $10,000 to $20 million or more per lake studied and managed. Funding will be needed.
Lake Projects: Funding for private projects	As a result of education, outreach, and monitoring, lakeshore owners may request assistance in retrofitting septic systems, funding in-lake treatment or management, etc.	Ecology provides small grants for aquatic weed and algae management.	Costs could range from $10,000 to $1 million or more per requested project. Funding will be needed.
Enforcement	Enforcement options may be needed to address sources of water quality problems.	Limited to none. TPCHD has ability to obtain search warrant if they have evidence that a property is discharging untreated wastewater, but this option is rarely used.	The need for additional enforcement options will be evaluated as the lake management program is implemented. No FTE staff need is currently identified.
Legal Authority	As a public agency, Pierce County requires legal authority to implement programs such as the lake management program.	Pierce County is responsible for addressing surface water quality under the NPDES MS4 program and the TMDL program.	To implement a lake management program, a County-wide ordinance may be needed to establish the program and the lake management function in Surface Water Management. This will not require on-going FTE support; however temporary initial investment by County staff of 0.1 FTE may be needed.

NOTES:
PCWP = Pierce County Surface Water Management
TPCHD = Tacoma-Pierce County Health Department
PCD = Pierce Conservation District
WDFW = Washington Department of Fish and Wildlife

7.4 POTENTIAL FUTURE PROBLEMS

As described in Chapter 4, the predominant existing land uses in the basin planning area are rural residential, agricultural and forested/open land. Most of the basin is currently zoned for forest land (eastern portion of the basin) and rural residential development (western portion of the basin). PALS staff is not aware of any planned conversions from commercial forest to subdivisions other than the Park Junction resort, between Elbe and Ashford. Outside of Eatonville, there are no subdivisions planned or vested, but there may be a few vested short plats in the planning area. However, large tracts in the planning area, such as between Ohop and Harts Lakes, are being converted from commercial timber to rural residential 20-acre parcels.

Future development in the Nisqually River planning area is expected to be relatively low density; consequently, effective impervious areas (EIAs) are not expected to increase very much. Only five of the 23 subbasins in the planning area are projected to experience EIA increases of more than 1%. Two subbasins are projected to experience EIA increases of more than 5%, the Lower Mashel River and Red Salmon Creek subbasins (see Chapter 4).

Rural zoning allows for residences, pastures and hobby farms. Further development in the rural zoning areas would increase automobile usage in the basin. These areas may have logging roads that were not intended for increased traffic and may go through critical areas. In addition, people often clear the land to improve their views. Therefore, areas that were once forested will have less trees and native vegetation, more impervious areas, and may have pets, livestock, septic systems, and increased traffic–all possible pollutant sources. The County's site development and critical areas regulations are designed to reduce the potential for adverse water quality impacts from new development.

7.5 POTENTIAL SOLUTIONS

This section describes how water quality problems identified in the Nisqually River Basin will be addressed. Table 7-5 summarizes the actions recommended. Proposed programmatic measures and CIP projects are described in Chapter 9 and Figures 9-1 through 9-8 show CIP project locations.

7.5.1 Problems Resolved or Not Addressed in the Basin Plan

During Basin Plan development, one resident reported cloudy water in a creek crossing Mt. Tacoma Canyon Rd (Problem ID ASH-06). Subsequent field investigations did not identify cloudy water or a potential source of cloudy water.

7.5.2 Maintenance and Enforcement Issues

Four reported problems were related to impacts or potential impacts from land clearing from logging and/or development. Construction plan review and site inspections are not under the

purview of Surface Water Management. These problems will be referred to Pierce County Planning and Land Services (PALS) for enforcement of County ordinances. One of these problems also included debris and blockages of a drainage. This problem can be addressed with a maintenance activity.

7.5.3 Capital Improvement Program Projects

Eleven CIP projects were developed to address water quality as well as habitat problems. Six are land acquisition projects. Some of these are agricultural lands which are sources of bacterial pollutants. Farm waste can enter streams from run-off or directly from livestock with access to the stream. Livestock access can also damage the creek channels contributing sediment. Acquiring these lands will also prevent logging and construction which can also result in sediment discharges to streams. Revegetation projects associated with land acquisition will also help stabilize streambanks and increase shading, thereby reducing suspended solids and stream temperatures. One of these projects is acquiring and preserving a wetland. Wetlands help maintain water quality through biofiltration and groundwater recharge for streams. Wetlands also reduce erosion by attenuating flow.

Four of the projects are restoration projects and one project is a revegetation project. All eleven projects will allow vegetation in riparian areas to be maintained or restored. Vegetation will provide shade and lower water temperatures.

7.5.4 Programmatic Measures

Five programmatic measures (two county-wide and three basin-specific) are recommended to protect and improve water quality:

- **PRG00-06**, Develop and Implement an Education, Outreach, and Technical Assistance Program
- **PRG00-13,** Implement Elements of Shellfish Protection Program
- **PRG00-15,** Develop and Implement a Lake Water Quality Management Program
- **PRG11-03**, Enhance Nisqually River Council Capacity
- **PRG11-04**, Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems
- **PRG11-05**, Implement Elements of Nisqually Bacteria TMDL Water Quality Implementation Plan

In addition to the lake water quality problems identified in Chapter 5, problems associated with the other lakes in the planning area were identified during the water quality analysis described in this Chapter. The recommended action for these lake problems is to implement the Lake Management Plan (PRG00-15).

7.5.5 Problems Requiring More Detailed Data or Analysis

No separate recommendations were made for additional studies. However, additional studies for lakes are included as part of PRG00-15 (Develop and Implement a Lake Water Quality Management Program).

TABLE 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
ASH-03	Near Nisqually River south of National Park.	Reports of off-road vehicles in streams.	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).
ASH-04	Creek crossing Mt Tacoma Canyon Rd approx 1 mile east of intersection with SR 706	Channel/bank erosion; clearing/logging near stream; construction in or near stream.	Problem will be referred to PALS for enforcement of development regulations.
ASH-05	31313 Mt.Tacoma Canyon Rd E	Septic/drain field problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
ASH-06	Creek crossing Mt Tacoma Canyon Rd approx 500 m northeast of intersection with SR 706	Cloudy water reported in streams/ditches.	Location investigated and a problem was not observed.
BRI-20	34414 8th Av Ct E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
BRI-22	1612 338th St E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
CLR-03	Clear Lake	High nutrient and pollutant levels. Listed on 303(d) in 1996 and 1998 for total phosphorous. Algae blooms. Septic system failures.	Develop and Implement a Lake Water Quality Management Program (PRG00-15).
COP-01	33107 Mt.Tacoma Canyon Rd E	Septic/drain field problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
ELB-02	North of SR 706 at Park Junction Road	Park Junction development proposed for this area could affect Elbe Creek.	Problem will be referred to PALS for enforcement of development regulations.
ELB-04	55218 Park Junction Rd E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
ELB-05	East end of Alder Lake	Clearing/logging near water at east end of Alder Lake.	Problem will be referred to PALS for enforcement of development regulations or DNR for enforcement of logging regulations.

TABLE 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
HRN-02	All along lower Horn Creek, especially adjacent to Allen Rd S	Many small farms; livestock; septic failure/seepage; suds in creek; septic tanks near creek.	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).
HRN-07	37407 S 18th Ave	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
HRN-12	113 354th St E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
HRN-13	712 358th St E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
HRN-15	2420 SR 702 E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
HRT-04	Hart's Creek west of Wilcox Dairy	Runoff from dairy could lead to water quality problems (fecal coliform, nutrient loading).	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06), and Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05).
HRT-05	41910 40th Ave S	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
HRT-09	Harts Lake	Cloudy water in streams/ditches; Hart's Lake. Manure in/near streams; high algae. Fish kill.	Develop and Implement Lake Water Quality Management Program (PRG00-15), Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
KRG-05	3204 416th St E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
LMR-02	Meadows near confluence of Little Mashel River and Midway Creek	Cattle in watershed	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).
LMR-03	Tributary to Midway Creek, east of Alder-Cutoff Highway	Cattle in watershed	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).
LMR-04	Headwaters of Midway Creek	Cattle in watershed	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).
LYN-03	Lynch Creek adjacent to Eatonville	Cloudy water in streams/ditches; stormwater discharge/development along creek.	Implement Elements of Nisqually Bacteria TMDL Water Quality Implementation Plan (PRG11-05).

TABLE 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
MAL-02	Lower Mashel River, approx 0.7 mile reach beginning at the confluence with the Nisqually River	303(d) violation for temperature	Mashel River Property Acquisition (CIP20-MAL-AC01), Mashel Shoreline Buffer Acquisition (CIP20-MAL-AC02), Mashel Small Properties Acquisition (CIP20-MAL-AC03), and Mashel Eatonville Reach Riparian Revegetation (CIP20-MAL-VC01), Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05), and Develop and Implement Countywide Vegetation Management Program, (PRG00-16).
MAL-06	Lower reach of Mashel River (~1.5 miles from Eatonville)	Cloudy water in streams/ditches	Mashel River Property Acquisition (CIP20-MAL-AC01), Mashel Shoreline Buffer Acquisition (CIP20-MAL-AC02), Mashel Small Properties Acquisition (CIP20-MAL-AC03), Mashel Eatonville Reach Instream Restoration Phase II (CIP20-MAL-RST01),
MAM-02	Middle Mashel River, approx 3 mile reach east of railroad tracks east of Eatonville	303(d) violation for temperature	Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05), and Develop and Implement Countywide Vegetation Management Program, (PRG00-16).
MUR-04	Murray Creek in the vicinity of the gravel pit, west of SR 507	Reports of off-road vehicles in streams.	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06). Enhance Nisqually River Council Capacity (PRG11-03).
MUR-07	8513 311th St S	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
MUR-08	29001 81st Ave S	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
MUR-13	Hinkleman Road and 316th St S	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
MUR-16	32010 72nd Ave S	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
MUR-25	336th St S between 78th Ave S and Locke Drive	Clearing, logging, and construction in or near streams. Debris and blockages of the drainage.	Culvert maintenance will be performed and problem will be referred to PALS for enforcement of development regulations.

TABLE 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
MUR-29	8416 350th St Ct S	Septic/drain field problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
NIS-03	Nisqually River (Township/Range/Section: 18N, 01E, 08)	Listed on state 303(d) for fecal coliform, temperature and chromium in 1998.	Nisqually Mainstem Acquisition (CIP11-NIS-AC01), Enhance Nisqually River Council Capacity (PRG11-03). Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05), and Develop and Implement Countywide Vegetation Management Program, (PRG00-16).
OHL-02	Lower Ohop Creek, primarily the lowest 0.75 miles	Low BIBI scores (County Site 29, Tribe Site 107). Lower portion listed under 303(d) (fecal coliform).	Ohop Creek Property Acquisition Phases 1 (CIP14-OHL-AC01), 2 (-AC02), and 3 (-AC03), Lower Ohop Valley Restoration Phases 1 (-RST01), 2 (-RST02) and 3 (-RST03), Implement Elements of Nisqually Bacteria TMDL Water Quality Implementation Plan (PRG11-05).
OHL-06	Lower Ohop Creek approximately from SR 161 to confluence with Nisqually River	Low BIBI scores (County Site 29, Tribe Site 107). Elevated water temperatures.	Ohop Creek Property Acquisition Phases 1 (CIP14-OHL-AC01), 2 (-AC02), and 3 (-AC03), Lower Ohop Valley Restoration Phases 1 (-RST01), 2 (-RST02) and 3 (-RST03).
OHU-04	Ohop Lake (40502, 40314 Ski Pk Rd)	Cloudy water in streams/ditches; clearing/logging near stream/lake.	Develop and Implement a Lake Water Quality Management Program (PRG00-15).
OHU-07	Ohop Lake	High phosphorus levels in Ohop Lake; algae. 303(d) violation for Total Phosphorus.	Develop and Implement Lake Water Quality Management Program (PRG00-15), Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
OHU-10	Tributary streams to Ohop Lake	Clearing/logging near stream/lake.	Develop and Implement a Lake Water Quality Management Program (PRG00-15).
OHU-15	38015 Orville Rd E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
OHU-19	Along Twenty-five Mile Cr approximately 500 meters upstream from confluence with Ohop Creek	Cattle in stream	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).
RED-01	Nisqually River outlet to Puget Sound	Nisqually Beach closed by DOH for Biotoxin or pollution.	Nisqually Mainstem Acquisition Phases 1 (CIP11-NIS-AC01), 2 (-AC02), and 3 (-AC03). Implement Elements of Shellfish Protection Program (PRG00-13); Enhance Nisqually River Council Capacity (PRG11-03), Implement Elements of Nisqually Bacteria TMDL Water Quality Implementation Plan (PRG11-05).

TABLE 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
RED-02	Estuary parallel to the Nisqually Estuary a few hundred meters to the east	Red Salmon Creek on state 303(d) list in 1998 for exceeding fecal coliform standards.	Nisqually Mainstem Acquisition Phases 1 (CIP11-NIS-AC01), 2 (-AC02), and 3 (-AC03). Implement Elements of Shellfish Protection Program (PRG00-13); Enhance Nisqually River Council Capacity (PRG11-03), Implement Elements of Nisqually Bacteria TMDL Water Quality Implementation Plan (PRG11-05).
TWU-05	Rapjohn Lake	High turbidity of runoff from adjacent property that is being cleared for timber.	Problem will be referred to DNR for enforcement of logging regulations.
TWU-17	Upper Tanwax Creek	Manure in/near streams. Cattle, pastures, houses and barns in the valley.	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).
TWU-18	37021 103rd Av Ct E	Septic/drain field problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
TWU-20	Upper Tanwax Creek	High turbidity, sediments. Cloudy water in streams/ditches.	Tanwax Creek Wetland Protection Phase 1 (CIP11-TWU-AC01), and Phase 2 (CIP11-TWU-AC02).
TWU-26	Tanwax Lake	Septic failure/seepage; cloudy water in streams/ditches; channel/bank erosion; oil, litter, algae.	Develop and Implement a Lake Water Quality Management Program (PRG00-15). Tanwax Creek Wetland Protection Phase 1 (CIP11-TWU-AC01), and Phase 2 (CIP11-TWU-AC02).
TWU-30	32612 Benbow Dr E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
TWU-32	Benbow Dr E at Lake Whitman	Cloudy water in streams/ditches; channel/bank erosion at Whitman Lake.	Develop and Implement a Lake Water Quality Management Program (PRG00-15). Tanwax Creek Wetland Protection Phase 1 (CIP11-TWU-AC01), and Phase 2 (CIP11-TWU-AC02).

CHAPTER EIGHT
STREAM HABITAT AND RIPARIAN AREAS ANALYSIS

This chapter documents the habitat analysis and summarizes potential measures to preserve and restore habitat conditions in the Nisqually River Basin planning area. Aquatic habitat problems were identified based on nearly 30 years of field data collection by scientists working for the Nisqually Tribe in partnership with scientists from federal, state, and local agencies. The Ecosystem Diagnosis and Treatment (EDT) model was used to analyze the field data, identify limiting factors, and determine habitat restoration and preservation needs and priorities.

Chapter 4 documents the extent of degraded riparian and aquatic habitat in the Nisqually River basin. Table 4-16 includes a list of references that have been used to characterize stream health and aquatic habitat condition. Chapter 5 describes habitat problems identified during the field work and EDT development.

8.1 SUMMARY OF FIELD INVESTIGATIONS AND EDT MODEL DEVELOPMENT

Nisqually Tribe scientists, working in partnership with federal, state and local agencies, have conducted extensive field studies and habitat modeling in the Nisqually watershed since 1977. These studies are summarized in Table 8-1.

Development of the EDT model for the Nisqually Basin began in 1997. The model was developed by Mobrand Biometrics Inc. (MBI) based on the data listed above and technical assistance from scientists with the Nisqually Tribe, the Northwest Indian Fisheries Commission, Washington Department of Fish and Wildlife, and the National Marine Fisheries Service. The EDT model works by analyzing the best available habitat information for all salmon stream reaches in the basin, applying biological rules of how salmon are impacted by changes in habitat, and evaluating which changes have caused the greatest impacts to salmon population parameters. Model outputs for historical and current conditions were found to be consistent with actual salmon population data collected.

During the field work and analyses summarized in Table 8-1, a number of habitat problems were identified. These problems are summarized in Section 8.2 and described in detail for each stream in the basin in Section 8.3.

TABLE 8-1
Habitat Investigations and Analyses

Dates	Activities
1970s	Stream surveys conducted in the Nisqually River watershed
Late 1980s to mid 1990s	Stream surveys conducted in forested areas
1990s	Extensive water quality studies completed
1997-2001	EDT model developed for chinook
2000-present	EDT models updated with new habitat information
2000-present	Habitat studies completed
Post 2000	Fish passage barrier assessment conducted in conjunction with Pierce Conservation District
Post 2000	Riparian vegetation condition assessment conducted in conjunction with Pierce Conservation District
Post 2000	Mainstem Nisqually River off-channel habitat assessment conducted – led by South Puget Sound Salmon Enhancement Group
2001-present	EDT model developed for coho, chum, steelhead, and pink
2001-present	High temperature monitoring completed
2001-present	Yearly macroinvertebrate sampling completed
2002	Detailed habitat assessment of Ohop Creek conducted
2002-2007	Spawning distribution surveys completed

8.2 LIMITING FACTORS

In the Nisqually River Basin, EDT modeling and on-the-ground habitat analysis have been used to identify reach-specific watershed processes and habitat features that are affecting the survival of each species of salmon. Conditions that limit the ability of habitat to fully sustain populations of salmon are limiting factors. These factors typically include degraded estuarine areas, riparian corridors, stream channels, and wetlands, as well as fish passage barriers.

8.2.1 Limiting Watershed Processes

Many of the impaired watershed processes are affecting multiple species of salmon. The major limiting processes that are affecting salmon and trout in the Nisqually River Basin are listed below.

- Dikes have impaired estuarine processes, including tidal exchange, sediment transport, nutrient input (by reducing salt marsh vegetation quantity), food web (loss of estuarine habitat for invertebrates), and tidal channel forming processes.
- In the nearshore, shoreline hardening and fill, mainly associated with the railroad along the Puget Sound shoreline from the Nisqually estuary north to Pt. Defiance, have impaired sediment and wood recruitment processes, prevented tidal exchange (especially in potential pocket estuaries blocked by hanging culverts), and reduced

nutrient and prey species input from the lack of overhanging terrestrial shoreline vegetation.

- Unnatural channel confinement and bank hardening (dikes, riprap, levees, ditching) in some places on the mainstem Nisqually as well as some tributaries, including Ohop Creek, limit channel migration processes and the formation and maintenance of off-channel and instream habitat. These limiting processes also reduce the diversity of instream habitat types, and riparian and wetland function.
- Loss of riparian vegetation has resulted in impaired riparian function, loss of wood recruitment, reduced nutrient cycling, reduced water quality, and reduced instream habitat formation.
- Changes in sediment transport, both increases in fine sediment transport and loss of gravel inputs, have impacted instream habitat in some key tributaries such as Ohop Creek and the Mashel River.

8.2.2 Limiting Habitat Features

Many of the impaired habitat features identified through this work are affecting multiple species of salmon. The major limiting habitat features that are affecting salmon and trout in the Nisqually River Basin are listed below.

- Diking has resulted in a loss of estuarine habitat, particularly intertidal emergent marsh and tidal channel habitat.
- In the nearshore, shoreline hardening along the Puget Sound shoreline from the Nisqually estuary north to Pt. Defiance has altered beach slope and substrate, blocked potential pocket estuaries, and reduced forage fish spawning habitat.
- In the freshwater, unnatural channel confinement and bank hardening (dikes, riprap, levees, ditching) in places on the mainstem Nisqually and several tributaries, including Ohop Creek, have reduced habitat complexity and blocked access to or prevented the creation of side-channel and off-channel habitat.
- There is a lack of mature native riparian vegetation in some areas along the tributaries and the mainstem. This results in a severe lack of large wood in the stream channel, high water temperatures, and reduced food availability in tributaries such as Ohop Creek and the Mashel River.
- Many tributaries have had a decrease in habitat diversity caused by a loss of woody debris, impaired riparian function, and channel modification. In many areas there has been a decline in the amount of pools, pool tailouts, and beaver pond habitat. This negatively affects fry and juveniles that rear in the creek, as well as adults holding in the creek before spawning, and adults seeking suitable spawning areas.
- In the key tributaries, the Mashel River and Ohop Creek, increased fine sediment load smothers incubating eggs, while increased scour and flashiness of flows cause eggs to be

washed away. Unstable banks and mass wasting contribute to this increased sediment load.

- Increased summer peak temperatures are a problem in Ohop Creek and high temperatures and decreased summer/ fall flow are a problem in the Mashel River.

8.3 RESULTS OF EDT ANALYSIS

The EDT model was used to assess riparian and aquatic habitat problems, as described above. The following sections describe the major reasons for loss of salmon productivity, as determined by the EDT model, on the Nisqually mainstem, Red Salmon Creek, Murray Creek, Brighton and Horn Creeks, Tanwax Creek, Kreger Creek, Ohop Creek, and the Mashel River. The primary focus is on salmon because it is the dominant native fish species in the lower Puget Sound basin and is widely regarded as a reliable indicator of overall stream health. Thus, habitat conditions that are favorable for salmon are expected to be favorable for other native species as well. Moreover, Puget Sound Chinook salmon has been listed as threatened and steelhead is under consideration for listing under the Endangered Species Act.

8.3.1 Nisqually Mainstem

Much of the Nisqually mainstem is still in very good condition, especially compared to most other lowland Puget Sound rivers in urbanizing areas. The mainstem of the river is still a very productive habitat for all species of salmon that are currently found in the Nisqually. However, there have been some losses of habitat due to alterations that have happened over the last century. The major types of losses are:

- Decline in habitat diversity
- Decline in channel stability
- Loss of key habitat, including pools, backwater pools, beaver ponds, riffles with small cobble and gravel substrate, and off-channel habitat
- Reduced food availability

Habitat quality varies throughout the Nisqually mainstem. Several reaches are considered some of the last best examples of what a natural free-flowing lowland Puget Sound river should look like. However, there are also locations where the river habitat has been degraded.

Some of the mainstem Nisqually salmon habitat degradation issues are common to many of the reaches. Channel stability while salmon and trout eggs incubate in the gravel has been reduced in certain places by simplification of the channel, disconnection of the channel from its floodplain, and lack of large wood that creates complex instream habitat. Large wood is at less than historical levels in some places along the river's mainstem due to localized losses of mature riparian trees and localized bank hardening that prevents large wood from being held by the river channel. The amount of wood in the river compared to historical levels varies by reach. In general, all the reaches except the Reservation Reaches have some loss of large wood

from historical levels. Section 4.4.1 provides more information on the extent of loss. These changes have also reduced the habitat diversity available for spawners, fry, and rearing juveniles.

Modifications to the channel such as dikes, levees, and riprap bank armoring that confine the channel and prevent natural channel migration are extensive in the lower reach (between Interstate 5 and the railroad grade at river mile 4), the McKenna reaches (from the Highway 507 bridge in McKenna up to the diversion dam at river mile 26.2), and, to a lesser degree, in the Wilcox and Middle reaches (i.e., between the diversion dam and Ohop Creek).

These channel modifications have also led to reduced habitat diversity. These changes and simplifications of the channel, along with the lack of large wood in the river, have a negative effect on the way changes in river flow affect fry, juveniles, and prespawners because there are fewer places for the fish to find refuge from high flows. Food availability for juvenile salmon and trout that rear in the river is estimated to be reduced compared to historic conditions. This is due to both a reduced amount of streamside vegetation providing nutrients, and to a reduced amount of salmon returning (compared to historic runs) that provide fewer salmon carcasses as a nutrient source.

Changes in the amount of key habitat needed for salmon and trout (compared to presumed historical conditions) have also been detrimental in the Nisqually. These changes include a reduction in the amount of pool habitat available, especially in the McKenna reaches (from the SR Highway 507 bridge in McKenna up to the diversion dam at river mile 26.2) and small reductions in the amount of backwater pool, beaver pond, and small cobble and gravel riffle habitats. There have been extreme reductions in the amount of off-channel habitat available compared to historic conditions between Murray Creek and Horn Creek (Nisqually reaches Whitewater 3.3 and McKenna 4.1), and moderate reductions between Lackamas and Toboton Creeks (Nisqually Wilcox 5.2), and between Powell and Kreger Creeks (Nisqually Middle 6.2).

Relatively high summer and early fall water temperatures in the river downstream of the Centralia diversion (river mile 26.2) reduce survival of rearing juveniles as well as impact migrating and spawning adults in the river. Mainstem temperatures should be further investigated and their possible impacts better understood. Fish passage rates at the Centralia Diversion Dam's fish ladder should be investigated to determine whether impaired upstream migration is a serious concern.

There have not been any formal quantitative studies on the sediment budget and transport cycle in the Nisqually River. As noted in Section 4.4.1, sediment flow from the upper Nisqually is disrupted by the Tacoma's Nisqually Hydroelectric Project. The current understanding of the sediment budget and spawning substrate condition of the Nisqually River is based on professional judgment from qualitative assessments.

It is believed that sediment important to salmonids in the mainstem of the river has changed little compared to historic conditions. The amount of fine sediment has probably decreased and bed load gravels and cobbles have probably become coarser in a few selected reaches, but overall the condition of the sediment has probably not changed much.

Preservation value is high throughout the mainstem Nisqually River, with potential benefits to protecting abundance, productivity, and diversity of salmon and trout populations. Restoration value in the Nisqually mainstem is also high (especially in the estuary and lower reach below the railroad at river mile 4, in the McKenna reaches between McKenna and the Centralia Diversion Dam, and in some other areas (between the Centralia powerhouse at river mile 12.7 and Kreger Creek at river mile 34).

Restoration would be expected to lead to substantial improvements, especially in salmon and trout abundance but also in the productivity and diversity of the populations.

8.3.2 Red Salmon Creek

Major reasons for loss of salmon productivity on Red Salmon Creek include:

- Reduced habitat diversity
- Reduced in channel stability
- Loss of pool and beaver pond habitat

The habitat in Red Salmon Creek is in fairly good condition, but there have been some changes to the historic channel such as loss of streamside vegetation, loss of instream wood, and restriction of channel migration in some areas. These factors have led to reduced habitat diversity, which is detrimental to all the life stages of salmon that use the creek. These factors have also led to reduced channel stability, which reduces the survival of juveniles that rear in the creek. These rearing juveniles are also impacted by small losses in the amount of pool and beaver pond habitat types in the creek compared to what was presumably available historically, the pools and beaver ponds having been replaced by other, less valuable habitat types.

8.3.3 Murray Creek

Major reasons for loss of salmon productivity in Murray Creek include:

- Decline in habitat diversity
- Decline in channel stability
- High sediment load
- High water temperature in summer
- Loss of pool habitat
- Lower than historic summer low flows

Disconnection of the channel from its floodplain, lack of streamside vegetation, and a low availability of wood in the creek channel compared to historic conditions are problems in Murray Creek that have led to a decline in habitat diversity. This has a negative effect on fry, juveniles that rear in the creek, and adults returning to spawn. These changes, along with the

ditching of portions of the upper Murray reach and an increase in the amount of bed scour, have also led to a decline in channel stability in most sections of the creek. Poor channel stability reduces the survival of incubating eggs and of fry and juveniles that rear in the creek. The disconnection of the channel from its floodplain and lack of large wood in the stream channel also lead to poor habitat diversity that provides fewer adequate habitats for rearing juveniles to hold in during summer low flows.

Based on nearby land use patterns, Murray Creek is presumed to have high levels of fine sediment. This is a concern because the sediment can reduce survival by smothering incubating eggs and can also negatively affect salmon and trout fry. The decrease in the amount of pool habitat available in the upper Murray reach (from the railroad crossing at river mile 0.4 to the headwaters) compared to what was presumably available historically decreases the survival rates of juveniles that rear in the creek and adults that hold in the creek before spawning. Several culverts in the system are partial barriers that limit the available spawning and rearing habitat for salmon and trout in the creek. There has also been a decline in food availability for juveniles that rear in the creek due to a lack of streamside vegetation providing nutrient input, presumed lower benthos production in the upper parts of the creek, and the fact that fewer salmon return to spawn (providing fewer carcasses with marine-derived nutrients). Summer flows have not been studied but are presumed to be lower than they were historically due to agricultural and residential water use. This would have a negative impact on survival of juvenile salmon and trout rearing in the creek.

The section between the unnamed lake near the Denman marsh and Highway 507 is extensively utilized by chum salmon in years with high chum returns and years with plentiful flow. This section is highly impacted by unrestricted livestock grazing, which has eroded the banks and promoted the growth of invasive grasses.

8.3.4 Brighton and Horn Creek

Major reasons for loss of salmon productivity in Brighton and Horn Creeks include:

- Fish passage barriers
- Decline in channel stability
- Decline in habitat diversity
- High water temperature in summer
- Loss of pool habitat
- Lower than historic summer low flows

The lower Brighton reach (below Harts Lake Loop Road) is primarily good habitat, although it has some minor problems with loss of streamside vegetation, reduced availability of large instream wood, and reduced numbers of salmon carcasses to provide nutrients compared to historic conditions. The wetlands at the mouth of Brighton Creek are a valuable refuge area for juvenile salmonids (both juveniles that were hatched in the creek and juveniles hatched in

other places in the Nisqually River Basin that migrate in from the river). These wetlands and the stream channel at the mouth are in healthy condition except for extensive reed canary grass that dominates the emergent wetland and the riparian vegetation.

The upper Brighton reach is much more degraded than the lower reach, having significant problems with fish access and multiple habitat impacts. At and above Harts Lake Loop Road, numerous culverts block or impede access for juvenile and adult salmon. There are other habitat issues upstream of the barriers as well. Poor channel stability (related to the lack of woody debris, lack of streamside vegetation, some disconnection of the channel from its floodplain), and a high level of fine sediment lead to poor survival for salmon and trout eggs incubating in the gravel. Other problems in upper Brighton Creek above fish barriers include poor habitat diversity, a loss of pool habitat compared to presumed historic conditions, and loss of nutrients provided by returning salmon. The lack of streamside shade in these areas has likely led to increased water temperatures throughout Brighton Creek, which in turn are thought to reduce survival of juvenile salmon and trout that rear in the lower part of the creek in the summer (and would rear in these upper areas if access was restored).

Summer low flows in Brighton Creek have not been studied, but are presumed to be somewhat lower than they were historically due to agricultural and residential use. The impact of these lower flows would be reduced survival of juvenile salmon and trout rearing in the creek (currently only below the barrier at Harts Lake Loop Road).

Problems for salmon in Horn Creek are similar to those in upper Brighton Creek. Like Brighton, Horn Creek has a wetland complex near its mouth in the Nisqually floodplain that is an important refuge area for juvenile salmonids. However, there are also some habitat impacts from alterations of Horn Creek. The wetlands at the mouths of Horn and Harts creeks are substantially affected by man-made flood control structures associated with bank hardening and the Centralia diversion dam on the mainstem of the Nisqually River. These structures prevent the mainstem from freely migrating and flooding into those areas, processes which are important for maintaining habitat functions. The wetlands at the mouths of the creeks that are in the Nisqually River floodplain are slowly filling up with silts and invasive reed canary grass. These would be periodically flushed out by the river under a normal flooding regime.

Disconnection of the channel from its floodplain, loss of streamside vegetation and the amount of fallen trees in the stream, and unnatural ditching and diking of the channel in lower Horn Creek have led to poor habitat diversity and poor channel stability throughout Horn Creek. In Harts Creek, a tributary of Horn Creek, disconnection of the channel from its floodplain, loss of streamside vegetation and large logs in the stream, and unnatural ditching and diking of the channel are extreme, leading to poor habitat diversity, poor channel stability, and poor salmon survival. The numerous impassable or partially passable culverts in Horn Creek are a major problem.

Other habitat issues in Horn and Harts Creeks include the effects of increased summer peak water temperature (due to lack of shade) on eggs, fry, and juveniles in the creek (especially steelhead), and the effects of low summer flows, which are presumed to be lower than they were historically. The impact of these lower summer low flows on rearing juveniles in the creek is made worse by the lack of streamside vegetation and instream wood and declines in

available pool habitat (i.e., deep places in which fish hold). Based on the land use patterns in the Horn Creek subbasin, it is presumed that levels of fine sediment in the creek have increased compared to historic conditions. This is a concern because the increased fine sediment can smother incubating eggs. A reduction in nutrient inputs to the creek due to loss of streamside vegetation and the fact that fewer salmon return to the creek now compared to historically (resulting in fewer salmon carcasses with marine derived nutrients) results in low food availability for fry and juveniles that rear in the creek. There has been a small decline in the amount of pool habitat in Horn Creek and in the amount of beaver pond habitat in upper Horn Creek compared to presumed historical conditions. These changes in available habitat types are detrimental to fry, juveniles, and spawning adults.

Many wetlands in the upper Horn and upper Brighton reaches have been altered. In Horn Creek below 8th Avenue South and above Harts Lake Loop Road, there is a 1-mile-long section that has been straightened, ditched, and cleared of riparian vegetation. This has reduced available key habitat and the ability of this wetland to positively influence downstream habitat by lessening summer low flow problems and reducing sedimentation issues. Many wetlands in the headwater areas of Brighton and Horn Creeks have been greatly influenced by the surrounding agriculture.

8.3.5 Tanwax Creek

Major reasons for loss of salmon productivity in Tanwax Creek include:

- High fine sediment load
- Reduced summer low flows (compared to historic conditions)
- High water temperature in summer
- Loss of habitat diversity
- Lower channel stability
- Reduced food availability

Summer low flows are presumed to be lower and intermittent flows are presumed to be more frequent in Tanwax Creek than they were historically due to water withdrawals, channelization of the creek, and alteration of wetlands that have occurred mostly in the upper part of the sub-basin and have reduced water storage. This reduces the survival of juvenile salmon and trout that rear in the creek. Peak flows are also presumed to be somewhat higher than they were historically due to development of the subbasin. This can lead to increased scouring of eggs in the gravel and can be a problem for salmon and trout fry emerging from the gravel.

The reduced amount of large wood in the creek and the loss of streamside and overhanging vegetation have had numerous impacts. The lack of riparian vegetation available to provide shade has likely led to higher peak summer water temperatures throughout the subbasin, especially in Tanwax Lake and the middle and upper Tanwax reaches, reducing the productivity of juvenile coho and steelhead that rear in the creek. The loss of streamside vegetation is also

associated with reduced nutrient input to the creek, reduced opportunities for fish concealment, and reduced shade, which helps prevent the growth of non-native reed canary grass.

Tanwax Creek and its tributaries (especially in Rapjohn Creek and in the upper Tanwax reach) have poor stream channel stability due to the lack of woody debris and streamside vegetation, the changes to the channel such as ditching that have occurred in areas throughout the creek and its tributaries (except in the lower Tanwax reach), and the increased bed scour that is presumed to occur due to this channelization. This reduced channel stability lowers the survival of salmon and trout eggs, fry, and juveniles. The lack of wood, the channel incision, and the lack of streamside vegetation have also reduced the diversity of habitat available in the creek, which reduces productivity of spawners, pre-spawners, and rearing juveniles throughout the creek. Fine sediment loads in the creek (both turbidity and fine sediment present in the substrate) are presumably elevated compared to historic conditions, based on the amount of disturbance in the subbasin from agriculture, forestry, and residences. This is expected to reduce the survival of eggs incubating in the gravel by smothering them and is also a problem for fry and juvenile steelhead that rear in the creek.

Changes in the composition of habitat types available in the creek have been detrimental to all life stages of salmon that use the creek. Compared to presumed historic conditions, there has been a loss of pool habitat and an increase in glide habitat throughout the creek and its tributaries. There has also been a decline in small cobble riffles for spawning in Tanwax Creek between the mouth and the lake. Some reaches show large losses in the amount of beaver dam pools, backwater pools, and off-channel habitat available compared to historic conditions. These changes are associated with the channel modifications and loss of riparian vegetation that have occurred in the subbasin.

Other issues in Tanwax Creek include the presence of introduced species (especially in the lake and upper tributaries) and the presumed increased predation associated with them, lack of food due to the lower numbers of salmon returning, lack of streamside vegetation, lowered dissolved oxygen in Mud Creek, and flow impacts from water withdrawals.

8.3.6 Kreger Creek

Major reasons for loss of salmon productivity in Kreger Creek include:

- Decline in channel stability
- Decline in habitat diversity
- Increased fine sediment load
- High water temperature in summer
- Loss of valuable habitat types such as pools and beaver ponds

Habitat condition in the lower 0.6 mile of Kreger Creek is very healthy compared to the upper parts of the creek, with minor problems of increased fine sediment load and lack of large instream wood to create channel complexity and stability.

The habitat in the upper Kreger reach is much more degraded. The channel is disconnected from its floodplain and lacks streamside vegetation and instream wood. This, along with modifications and simplifications of the creek's channel such as ditching, reduces habitat diversity and channel stability. Loss of important beaver pond, backwater pool, and small cobble riffle habitat types reduces survival of multiple life stages of salmon and trout in the creek. High water temperatures are a concern between Kreger Lake and the mouth of the creek (where data have been collected) and are presumed to be an issue throughout the creek. Summer flows have not been studied, but are presumed to be lower than they were historically due to agricultural and residential water use. These changes in water temperature and flow have a negative impact on survival of juvenile salmon and trout that rear in the creek. Lack of food for salmon, due to low numbers of carcasses from returning salmon and lack of streamside vegetation providing nutrients, is a problem throughout the creek. Increased predation on juvenile coho and steelhead due to the presence of non-native, introduced fish also reduces survival, especially in Silver Lake.

8.3.7 Ohop Creek

Major reasons for loss of salmon productivity in Ohop Creek include:

- Channel confinement modifications (ditching and channelizing)
- Decline in amount of key habitat and in habitat diversity (loss of large wood and streamside vegetation, loss of pool and riffle habitat)
- Reduced channel stability
- Increased summer stream temperatures
- Predation by non-native fish
- Increased fine sediment levels
- Reduced food availability

High sediment load and low channel stability during egg incubation and rearing are major problems in Ohop Creek between the mouth and the lake. This is caused by a lack of streamside vegetation, by channel incision, by the reduction in the amount of wood in the creek, and by the increased bed scour that is presumed to now occur as a result of the channelization of the creek. The lack of habitat diversity (which is also related to the lack of streamside vegetation, in-stream large wood, and the extensive channelization and ditching of the creek) also reduces the productivity of salmon and trout that spawn and rear in the creek.

Along with the changes to the creek such as ditching, straightening, and the loss of large wood in the creek, the types of habitat available in the creek have changed compared to what is presumed to have been present historically. The creek now has less pool habitat, and in some

areas it also has less riffle, beaver pond, and off channel habitat areas. These changes negatively affect survival at numerous life stages of the salmon and trout in the creek. Other issues in the creek include predation from non-native fish, increased water temperatures (due to loss of streamside vegetation for shade), increased nutrient loads in and below Ohop Lake, and reduced food availability due to loss of streamside vegetation and reductions in the numbers of salmon that return to spawn compared to historic times.

In Twenty-Five Mile Creek (a tributary to Ohop Creek), reduced amounts of streamside vegetation and wood in the stream have led to poor channel stability during egg incubation and rearing and to poor habitat diversity, both of which have reduced the survival of coho salmon. Other concerns in Twenty-Five Mile Creek include a high sediment load that can smother incubating eggs and a somewhat altered flow regime (presumably based on land use) that has high flows that are higher than they were historically. These have led to increased bed scour and reduced survival during egg incubation, and low flows that are lower than they were historically, reducing survival of juvenile salmon and trout that rear in the creek.

8.3.8 Lynch Creek

In Lynch Creek, major problems affecting salmon survival include the high sediment load (presumed, based on nearby sampling), reduced channel stability and habitat diversity (due to some reduction in the amount of instream wood and simplification of the channel and its disconnection from the floodplain in some areas), and a loss of pool habitat compared to presumed historic conditions. In addition, accentuated high flows and increased 'flashiness' of flow (i.e., quicker in-stream flow responses to rainfall events and higher peak flows) compared to presumed historic conditions in Lynch Creek reduce survival of salmon and trout in the creek.

8.3.9 Mashel River

Major reasons for loss of salmon productivity in the Mashel River include:

- Decline in habitat diversity, pool habitat, and habitat suitable for spawning
- Decline in channel stability and increased scour of streambed material
- Unnatural channel narrowing from bank hardening and dikes
- High sediment load in the water from increased soil erosion
- High water temperature in summer
- Accentuated high and low flows

Throughout the Mashel watershed, simplification of the channel, disconnection of the channel from its floodplain, and the lack of available large trees (to fall in the creek and create complex habitat and cover) have reduced the diversity of the habitat available in the stream compared to what was available historically. This is a problem for all salmon species, including coho and steelhead that rear in the river, as well as fry and adult spawners of all species.

In the Mashel-Eatonville reach (between the Little Mashel River and Boxcar Canyon), habitat diversity is especially low due to changes to the natural channel confinement, such as rip rap used to confine the river into a narrow channel. High levels of fine sediment, channel bed scour, and lowered channel stability are a problem for salmon and trout eggs incubating in the Mashel River and its tributaries. The fine sediment settles into the gravel and can smother the eggs, while scouring of the channel can remove eggs from the gravel and increase bank erosion and fine sediment input.

The accentuated flow patterns present in the system, with higher high flows and lower summer flows than they presumably were historically, have a negative effect on salmon during multiple life stages, especially fry colonization, juvenile rearing, and pre-spawner holding life stages. Changes in the types of habitat available compared to presumed historic conditions present problems as well. A decline in the amount of pool habitat is a problem, especially for rearing coho and for adult salmon that hold in the river before spawning. Small declines in the amount of pool tailout and small cobble riffle habitat available are a problem for adults seeking suitable areas to spawn.

Other problems in the Mashel subbasin include a lack of food (from decaying salmon carcasses or overhanging vegetation, both of which were historically more abundant) and increased summer temperatures (related to a loss of vegetation providing shade), which have a negative effect on juvenile salmon that rear in the creek year round.

8.3.10 EDT Analysis Summary

The results from the EDT analysis, by reach, are presented in Table 8-2. The EDT analysis provided two types of results: 1) a prioritization of stream reaches for both preservation and restoration, and 2) scores for a series of habitat attributes indicating the level of impact problems have had on the survival of fish species. The EDT results for coho salmon were used because coho distribution covers the largest area in the basin and includes multiple life stages. Other species needs are covered within habitat attributes that are beneficial for coho. In other words, coho are in more places and at more times than other species. By addressing the habitat issues identified in the coho EDT model, other salmonid species habitat issues will also be addressed.

TABLE 8-2
Habitat Investigations and Analyses

KEY: ● - Heavy negative impact on survival of species, ● - Moderate negative impact on survival of species, ● - Mild negative impact on survival of species.

Problem ID	Location	Restoration	Preservation	Channel Stability	Chemicals	Competition (with hatch)	Competition (other species)	Flow	Flood	Habitat Diversity	Harassment/ Poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment Load	Temperature	Withdrawals	Key Habitat Quality
BRI-01	Brighton Cr-1_a	High	Medium						●	●						●			●
BRI-03	Brighton Cr-1_b	High	Medium	●				●	●	●						●			●
BRI-05	Brighton Cr-1_c	High	Medium							●									●
BRI-08	Brighton Cr-1_d	High	Medium	●				●	●	●	●					●			●
BRI-13	Brighton Cr-1_e	High	Medium																
HRN-01	Horn Cr-1	High	Medium	●				●	●	●						●	●		●
HRN-03	Horn Cr-2_a	High	Medium	●		●		●	●	●					●	●			●
HRN-06	Horn Cr-2_b	High	Medium	●		●		●	●	●					●	●			●
HRN-10	Horn Cr-2_c	High	Medium	●				●	●	●						●			●
HRT-01	Harts Creek-1_a	High	Medium	●				●	●	●	●					●			●
HRT-02	Harts Creek-1_b	High	Medium	●		●		●	●	●	●					●	●		●

TABLE 8-2
Habitat Investigations and Analyses

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Problem ID	Location	Restoration	Preservation	Channel Stability	Chemicals	Competition (with hatch)	Competition (other species)	Flow	Flood	Habitat Diversity	Harassment/ Poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment Load	Temperature	Withdrawals	Key Habitat Quality
HRT-06	Harts Creek-1_c	High	Medium	Mild				Mild	Mild	Moderate						Moderate			Moderate
HRT-08	Harts Creek-1_d	High	Medium	Mild				Mild	Mild	Moderate	Mild					Moderate			Moderate
KRG-01	Kreger Cr-1	Medium	Medium						Mild	Mild						Mild			Mild
KRG-02	Kreger Cr-2	Medium	Medium	Mild				Mild	Mild	Moderate	Mild					Mild	Mild		Moderate
KRG-03	Kreger Lake	Medium	Medium							Mild									Mild
KRG-06	Kreger Cr-3	Medium	Medium	Mild				Mild	Mild	Moderate						Mild			Moderate
KRG-10	Silver Lake	Medium	Medium																
LMR-01	Little Mashel R	High	Medium	Mild				Mild	Mild	Mild						Mild			Mild
LYN-01	Lynch Cr	High	High	Mild				Mild	Mild	Moderate						Mild			Moderate
MAL-01	Lower Mashel-A_A	Highest	Highest	Moderate				Moderate	Moderate	Severe						Moderate	Moderate		Severe
MAL-03	Lower Mashel-A_B	Highest	Highest	Moderate				Moderate	Moderate	Moderate						Moderate	Mild		Moderate
MAL-04	Lower Mashel-B	Highest	Highest	Severe		Mild		Severe	Moderate	Severe	Mild					Moderate	Moderate		Severe

TABLE 8-2
Habitat Investigations and Analyses

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Problem ID	Location	Restoration	Preservation	Channel Stability	Chemicals	Competition (with hatch)	Competition (other species)	Flow	Flood	Habitat Diversity	Harassment/ Poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment Load	Temperature	Withdrawals	Key Habitat Quality
MAM-01	Middle Mashel R-1	Highest	High	Moderate				Moderate	Moderate	Heavy						Moderate	Mild		Heavy
MAM-03	Middle Mashel R-2	Highest	High	Moderate				Moderate	Moderate	Heavy						Moderate	Mild		Heavy
MAM-04	Beaver Cr-1	High	Medium						Mild	Mild						Mild			Mild
MAM-05	Beaver Cr-2	High	Medium	Mild				Moderate	Moderate	Moderate						Heavy	Mild		Moderate
MAU-01	Upper Mashel R	High	High	Mild				Mild	Mild	Mild						Mild			Mild
MAU-02	Busy Wild Cr-1	High	Medium	Heavy		Mild		Moderate	Moderate	Heavy						Moderate	Mild		Heavy
MAU-03	Busy Wild Cr-2	High	Medium	Mild				Mild	Mild	Mild						Mild	Mild		Mild
MUR-01	Murray Cr-1	Medium	Medium	Mild						Mild						Mild			Mild
MUR-02	Murray Cr-2_a	Medium	Medium	Mild				Moderate	Mild	Moderate						Moderate	Mild		Moderate
MUR-06	Murray Cr-2_b_A	Medium	Medium	Mild				Moderate	Moderate	Moderate						Moderate	Mild		Moderate
MUR-14	Murray Cr-2_b_B	Medium	Medium	Mild				Moderate	Mild	Moderate						Moderate	Mild		Moderate
MUR-19	Murray Cr-3_a	Medium	Medium	Mild				Mild	Mild	Mild						Mild			Mild

TABLE 8-2
Habitat Investigations and Analyses

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Problem ID	Location	Restoration	Preservation	Channel Stability	Chemicals	Competition (with hatch)	Competition (other species)	Flow	Flood	Habitat Diversity	Harassment/ Poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment Load	Temperature	Withdrawals	Key Habitat Quality
MUR-21	Murray Cr-3_b	Medium	Medium	Mild				Mild	Mild	Moderate						Mild			Moderate
NIS-02	Nisqually2a-LowerReach	Highest	High	Moderate				Moderate	Mild	Heavy	Heavy			Mild		Heavy			Heavy
NIS-04	Nisqually2B.1-LowerReach	Low	Highest	Moderate				Mild	Mild		Mild			Moderate	Mild		Mild		
NIS-05	Nisqually2B.2-LowerReach	Low	Highest	Moderate				Mild	Moderate					Moderate	Moderate		Mild		
NIS-06	Nisqually2B.3-LowerReach	Low	Highest	Moderate					Mild					Moderate	Mild		Mild		
NIS-07	Nisqually2B.4-LowerReach	Low	Highest	Moderate				Mild	Moderate						Mild		Mild		
NIS-08	Nisqually3.1-Wwater	High	Highest	Moderate				Mild	Mild	Heavy						Moderate	Mild		Heavy
NIS-09	Nisqually3.2-Wwater	High	Highest	Heavy				Moderate	Moderate	Heavy							Mild		Heavy
NIS-10	Nisqually3.3-Wwater	High	Highest	Heavy				Moderate	Moderate	Heavy							Mild		Heavy
NIS-12	Nisqually4.1-Mckenna	Highest	Highest	Heavy				Heavy	Heavy	Heavy	Heavy			Mild	Mild		Moderate		Heavy
NIS-13	Nisqually4.2-Mckenna	Highest	Highest	Moderate				Moderate	Mild	Heavy	Heavy						Mild		Heavy
NIS-15	Nisqually5.1-Wilcox	Medium	Highest	Heavy				Moderate	Moderate	Heavy									Heavy

TABLE 8-2
Habitat Investigations and Analyses

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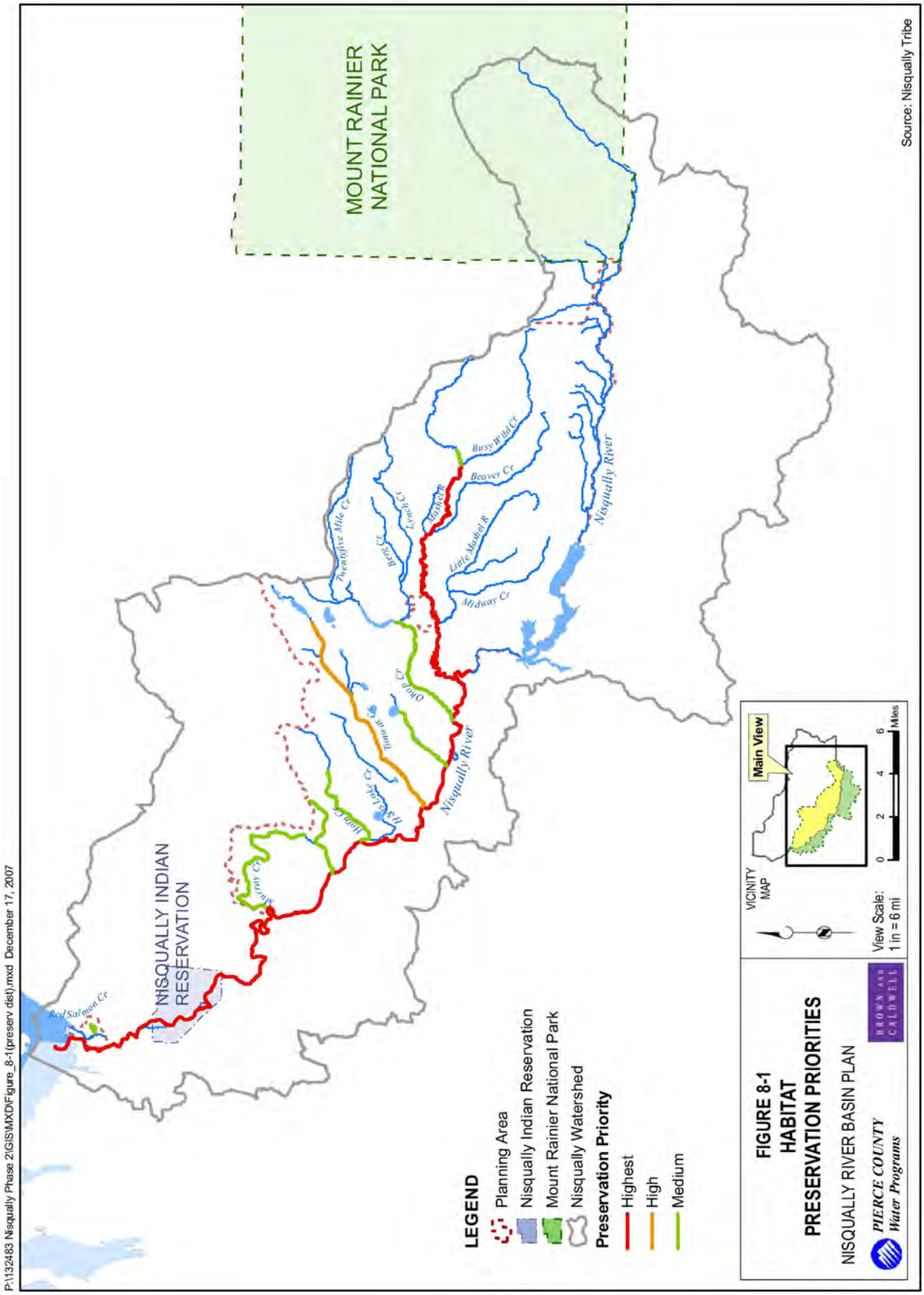
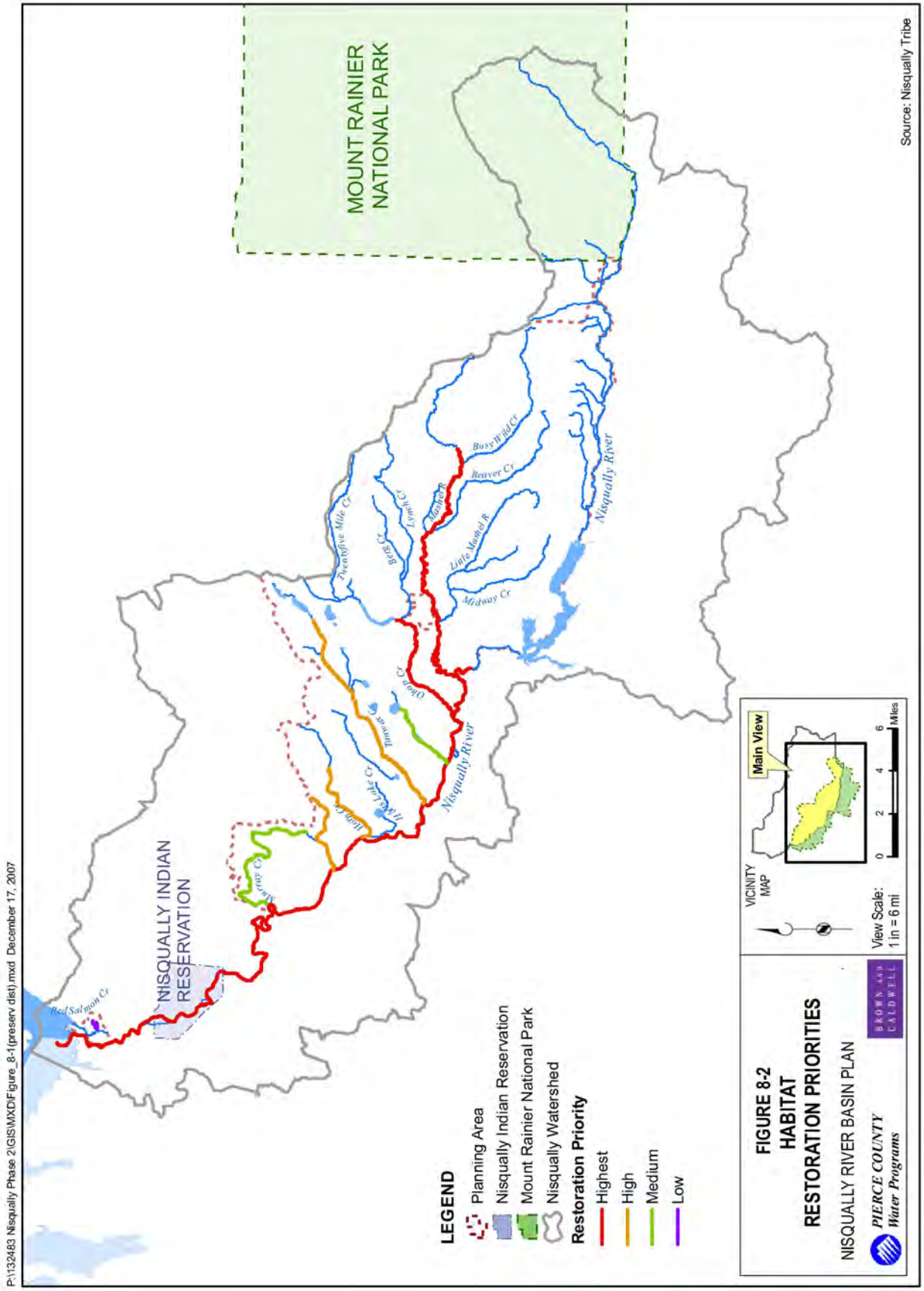
Problem ID	Location	Restoration	Preservation	Channel Stability	Chemicals	Competition (with hatch)	Competition (other species)	Flow	Flood	Habitat Diversity	Harassment/ Poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment Load	Temperature	Withdrawals	Key Habitat Quality
NIS-17	Nisqually5.2-Wilcox	Medium	Highest	●				●	●	●									●
NIS-18	Nisqually5.3-Wilcox	Medium	Highest	●				●	●	●									●
NIS-19	Nisqually6.1-MiddleReach	Medium	Highest	●				●	●	●									●
NIS-20	Nisqually6.2-MiddleReach	Medium	Highest	●				●	●	●									●
NIS-21	Nisqually6.3-MiddleReach	Medium	Highest	●				●	●	●									●
NIS-22	Nisqually7A-UpperReach	Low	Highest	●				●	●	●									●
NIS-23	Nisqually7B-UpperReach	Low	Highest	●						●									●
OHL-01	Ohop Cr-1	Highest	Medium	●				●	●	●	●		●	●		●	●		●
OHU-01	Ohop Cr-2	Highest	Medium					●		●					●	●			●
OHU-03	Ohop Lake	High	High			●		●	●	●					●				●
OHU-16	Twentyfive Mile Cr	High	High	●				●	●	●						●			●
OHU-17	Trib0094	Low	Medium																

TABLE 8-2
Habitat Investigations and Analyses

KEY: ● - Heavy negative impact on survival of species, ● - Moderate negative impact on survival of species, ● - Mild negative impact on survival of species.

Problem ID	Location	Restoration	Preservation	Channel Stability	Chemicals	Competition (with hatch)	Competition (other species)	Flow	Flood	Habitat Diversity	Harassment/ Poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment Load	Temperature	Withdrawals	Key Habitat Quality
RED-04	Red Salmon Creek	Low	Medium	Mild				Mild		Moderate									Moderate
TWL-01	Tanwax Cr-1	High	High	Mild				Mild	Mild	Moderate						Moderate	Mild		Moderate
TWL-02	Tanwax Cr-2	High	High	Mild				Moderate	Mild	Moderate						Moderate	Mild		Moderate
TWL-03	Cranberry	Low	Medium							Mild									Mild
TWU-01	Tanwax Cr-3_a	High	High	Moderate				Moderate	Mild	Moderate	Mild					Moderate	Mild		Moderate
TWU-02	Rapjohn	Low	Medium	Mild				Mild	Mild	Moderate						Mild			Moderate
TWU-03	Mud	Low	Medium	Mild				Mild	Mild	Mild						Mild			Mild
TWU-07	Tanwax Cr-3_b	High	High	Moderate		Mild		Moderate	Mild	Heavy	Mild					Moderate	Moderate		Heavy
TWU-12	Trout Creek	Low	Medium																
TWU-22	Tanwax Lake	High	High	Mild		Mild		Mild	Moderate	Moderate	Mild				Mild	Mild	Mild		Moderate
TWU-29	Tanwax Upper Tributaries	Low	Medium	Moderate		Mild	Mild	Moderate	Moderate	Heavy					Moderate	Moderate			Heavy


MOUNT RAINIER NATIONAL PARK
NISQUALLY INDIAN RESERVATION
Red Salmon Cr
Busy Wild Cr
Beaver Cr
Nisqually River
Little Mashel R
Midway Cr
Twenty Five Mile Cr
Ohop Cr
Tanwax Cr
Alder Lake
Nisqually River
Source: Nisqually Tribe
LEGEND
Planning Area
Nisqually Indian Reservation
Mount Rainier National Park
Nisqually Watershed
Preservation Priority
Highest
High
Medium
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
FIGURE 8-1
HABITAT
PRESERVATION PRIORITIES
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL
P:\132483 Nisqually Phase 2\GIS\MXD\Figure_8-1(preserv dist).mxd December 17, 2007


MOUNT RAINIER NATIONAL PARK
NISQUALLY INDIAN RESERVATION
Red Salmon Cr
Busy Wild Cr
Beaver Cr
Nisqually River
Twenty-five Mile Cr
Bear Cr
Lower Cr
Little Mashel R
Midway Cr
Ohop Cr
Powell Cr
Pleasant Valley Cr
Mashel R
Mashel Cr
Source: Nisqually Tribe
LEGEND
Planning Area
Nisqually Indian Reservation
Mount Rainier National Park
Nisqually Watershed
Restoration Priority
Highest
High
Medium
Low
VICINITY MAP
Main View
View Scale: 1 in = 6 mi
0 2 4 6 Miles
FIGURE 8-2
HABITAT
RESTORATION PRIORITIES
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
P:\132483 Nisqually Phase 2\GIS\MXD\Figure_8-1(preserv dist).mxd December 17, 2007

The Nisqually estuary and Puget Sound nearshore areas are of highest importance for protection and restoration because all Nisqually salmon species migrate through (or rear in) these areas. The habitat analyses for Nisqually salmon and trout indicate that these should be highest priority areas. Model results combined with an understanding of the relative value of estuary habitat suggest that restoration of the estuary habitat will result in significant increases in the productivity and abundance of multiple species of Nisqually salmon.

The mainstem Nisqually is used by all salmon species for spawning and some species for rearing, but it is also functions as a migration corridor for all species. Fry or juveniles use the Nisqually to migrate downstream, and adults use it to migrate upstream. Because of the high level of use by all salmon species, high quality habitat in the mainstem is important. High quality habitat includes healthy riparian function, availability of woody debris, and natural channel confinement to improve habitat diversity, channel stability, and flow patterns. Many locations on the mainstem are still in very good condition and are a high priority for protection. Approximately 70 percent of the riparian area along the river that is used by salmon is in protected ownership. The mainstem reaches most in need of overall restoration are the lower reach and the McKenna reaches. There are more targeted restoration needs in other mainstem reaches where there is localized habitat degradation.

The two most important tributaries for protection and restoration are the Mashel River and Ohop Creek. Further protection is important along these tributaries where habitat is still intact or in danger of being degraded. In addition, salmon and trout will benefit from restoration of habitat diversity and key habitat in the degraded reaches of these two streams.

The geographic priorities discussed above, in combination with the priority actions for specific stocks, are provided below. (See also the Nisqually Chinook Recovery Plan [NCRT, 2001] and the 2005 – 2007 Nisqually Salmon Habitat Workplan.)

1. Protect habitat in the Nisqually estuary, South Sound nearshore, and the mainstem Nisqually.
2. Restore degraded habitat in the Nisqually estuary. (Key projects are already underway to implement this action.)
3. Restore degraded habitat in the South Sound nearshore. (A plan is currently being developed to implement this action.)
4. Protect and restore the Mashel River. Restoration of habitat in the Lower Mashel and Middle Mashel reaches near Eatonville is of particular importance. (Key projects are already underway to implement this action.)
5. Protect and restore Lower Ohop Creek.
6. Restore Nisqually mainstem habitat in the lower and McKenna reaches.
7. Restore habitat in localized degraded areas along the Nisqually mainstem, other than the lower and McKenna reaches.

8.4 POTENTIAL SOLUTIONS

This section describes how habitat problems identified in the Nisqually River basin will be addressed. Recommendations were developed to address the following:

- Problems identified during fieldwork
- Preservation of high priority habitat reaches
- Restoration of high priority reaches by addressing the major reasons for loss of salmon productivity.

The aquatic habitat problems have multiple causes that will require a range of solutions, from non-structural programmatic actions to structural measures. The capital improvement program (CIP) projects developed to address habitat problems include:

- Removing fish passage barriers
- Wetland, instream, and riparian habitat restoration
- Revegetation projects
- Wetland, channel migration zone, and floodplain preservation through property acquisition

Removing fish passage barriers consists primarily of replacing existing culverts with large embedded or bottomless culverts. The Pierce Conservation District culvert survey identified numerous culverts as partial or complete fish passage barriers. Some of these culverts need to be assessed to confirm they are barriers and to collect data to develop replacement projects. Additional studies are described in Section 8.4.5.

Restoring the Nisqually estuary mainly entails the removal of dikes that prevent the saltwater from inundating former tidal lands. The Nisqually Tribe, the US Fish and Wildlife Service, and Ducks Unlimited are implementing major restoration projects in the Nisqually estuary. Restoring the nearshore may involve actions such as removal of bank hardening structures and replacing hanging culverts with larger bottomless culverts or bridges to allow the reconnection of pocket estuaries. Since actions required to restore habitat in the nearshore have not been identified, a comprehensive assessment of the shoreline habitat is being conducted by the South Puget Sound Salmon Enhancement Group with assistance from the Tribe.

Projects on the Mashel River include restoration of mature riparian vegetation; softening, reduction, or removal of bank-hardening structures to allow more channel migration; and addition of large wood in the channel. The South Sound Salmon Enhancement Group, the Nisqually Tribe, the Nisqually Land Trust, and the Pierce Stream Team are now implementing many of these actions on the Mashel. The Town of Eatonville has assisted with habitat projects in its jurisdiction. On Ohop Creek, the Nisqually Tribe, the Pierce Conservation District, the Natural Resources Conservation Service, and the USFWS have completed a comprehensive habitat assessment to develop restoration options was completed. The assessment called for moving the creek channel (which is currently a man-made ditch) to its original floodplain,

adding large wood to the newly constructed meandering stream channel, and restoring riparian vegetation and the surrounding connected wetlands. The South Puget Sound Salmon Enhancement Group is the sponsor for the Ohop restoration work.

Programmatic solutions can benefit existing aquatic habitat and prevent future degradation. For instance, programs can preserve high quality habitat areas, provide maintenance of areas being restored, and monitor water quality, erosion, channel incision, and other measures of the health of natural systems.

Table 8-4 summarizes the actions recommended to address aquatic habitat problems, including 21 CIP projects, 8 programmatic measures, and 16 studies to fill information gaps. Proposed programmatic measures and CIP projects are described in greater detail in Chapter 9; Figures 9-1 through 9-8 show CIP project locations. Proposed studies to fill information gaps are described in Section 8.4.5.

8.4.1 Problems Resolved or Not Addressed in the Basin Plan

During Basin Plan development, it was found that two of the habitat problems are already being addressed by Nisqually Tribe projects. Fourteen habitat problems were found to be outside the authority of the Pierce County Public Works and Utilities. These problems were included in the original list because they were reported to the County. Also, based on further investigation, two problems require no action.

8.4.2 Maintenance and Enforcement Issues

No problems were identified as maintenance or enforcement issues.

8.4.3 Capital Improvement Program Projects

Twenty-one CIP projects were developed to address the aquatic habitat problems. The projects include removing dikes; creating a dam bypass channel; riparian, wetland, and instream restoration and preservation; and projects to improve fish passage. The projects are listed in Table 8-4. Chapter 9 describes each of the projects and Figures 9-1 through 9-8 show the habitat project locations.

8.4.4 Potential Programmatic Measures

Eight programmatic measures are recommended that will serve to improve aquatic habitat and address problems as summarized in Table 8-4. These consist of:

1. **PRG00-06**, Develop and Implement an Education, Outreach, and Technical Assistance Program
2. **PRG00-15**, Develop and Implement a Lake Water Quality Management Program
3. **PRG00-16**, Develop and Implement Countywide Vegetation Management

4. **PRG11-02**, Nutrient Enhancement using Salmon Carcasses
5. **PRG11-03**, Enhance Nisqually River Council Capacity

8.4.5 Problems Requiring More Detailed Data or Analysis

Sixteen studies are recommended to fill information gaps, as listed below.

1. **ST11-BRI-ST01,** Brighton Creek Barrier Removal Assessment (62nd Ave. S.)
2. **ST11-HRN-ST01,** Horn Creek Barrier Removal Assessment (368th St. S.)
3. **ST11-HRT-ST01,** Harts Creek / Harts Lake Habitat Assessment
4. **ST11-MUR-ST01,** Murray Creek Restoration Assessment
5. **ST11-MUR-ST02,** Murray, Brighton and Horn Creek Wetlands Restoration Assessment
6. **ST11-MUR-ST03,** Murray Creek Barrier Removal Assessment (48th Ave. S., RM 6.2)
7. **ST11-MUR-ST04,** Murray Creek Barrier Removal Assessment (pipeline crossing, RM 7.2)
8. **ST11-NIS-ST01,** Mainstem Nisqually LWD Assessment and Restoration Plan
9. **ST11-TWL-ST01,** Cranberry and Rapjohn Lakes Assessment
10. **ST11-TWL-ST02,** Lower Tanwax Sediment Reduction Assessment
11. **ST11-TWU-ST01,** Tanwax Valley Restoration Assessment
12. **ST11-TWU-ST02,** Eatonville Cutoff Road Culvert Replacement Assessment (Mud Creek)
13. **ST11-TWU-ST03,** Eatonville Cutoff Road Culvert Replacement Assessment (Tanwax Creek)
14. **ST11-TWU-ST04,** Trout Creek at 352nd Street East Culvert Replacement Assessment
15. **ST14-OHU-ST01,** Clay City Sediment Reduction Assessment
16. **ST20-LMR-ST01,** Lower Mashel Restoration Assessment

Section 9.3.4 contains descriptions and cost estimates for each of the recommended studies.

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
BRI-01	EDT Reach Brighton Cr-1_a	Riparian/aquatic habitat assessment reach with High restoration and Medium protection priorities.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Murray, Brighton and Horn Creek Wetlands Restoration Assessment (ST11-MUR-ST02).
BRI-02	Brighton Creek crossing of Harts Lake Loop Rd approx. 500 m upstream of confluence with Nisqually R.	Culvert was classified as a fish barrier due to its elevation above the channel bottom.	X			Brighton Creek Culvert Replacement (CIP11-BRI-FP01).
BRI-03	EDT Reach Brighton Cr-1_b	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Murray, Brighton and Horn Creek Wetlands Restoration Assessment (ST11-MUR-ST02).
BRI-04	Brighton Creek crossing of 66th Ave S approx. 550 m south of 360th St S	Culvert was classified as a fish barrier (Pierce Conservation District culvert survey).				Problem is outside the County's jurisdiction. It is located on private property.
BRI-05	EDT Reach Brighton Cr-1_c	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.		X		Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG11-06), Enhance Nisqually River Council Capacity (PRG11-03).
BRI-07	Brighton Creek crossing of 62nd Ave S approx. 400 m south of 360th St S	Culvert was classified as a fish barrier (EDT analysis).			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Brighton Creek Barrier Removal Assessment (ST11-BRI-ST01).
BRI-08	EDT Reach Brighton Cr-1_d	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.		X		Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG11-06), Enhance Nisqually River Council Capacity (PRG11-03).

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
BRI-13	EDT Reach Brighton Cr-1_e	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Murray, Brighton and Horn Creek Wetlands Restoration Assessment (ST11-MUR-ST02).
BRI-15	2410 SR 702 S	Culvert was classified as a fish barrier (Pierce Conservation District culvert survey and EDT analysis).				Problem is outside the County's jurisdiction. It will be referred to WSDOT.
HRN-01	EDT Reach Horn Cr-1	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Murray, Brighton and Horn Creek Wetlands Restoration Assessment (ST11-MUR-ST02).
HRN-03	EDT Reach Horn Cr-2_a	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.		X		Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG11-06), Enhance Nisqually River Council Capacity (PRG11-03).
HRN-05	Horn Creek crossing of 368th Ave S	Culvert was classified as a fish barrier (Pierce Conservation District culvert survey and EDT analysis).			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Horn Creek Barrier Removal Assessment (ST11-HRN-ST01).
HRN-06	EDT Reach Horn Cr-2_b	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.		X		Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG11-06), Enhance Nisqually River Council Capacity (PRG11-03).
HRN-10	EDT Reach Horn Cr-2_c	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Murray, Brighton and Horn Creek Wetlands Restoration Assessment (ST11-MUR-ST02).

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
HRT-01	EDT Reach Harts Creek-1_a	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Harts Creek/Harts Lake Habitat Assessment (ST11-HRT-ST01).
HRT-02	EDT Reach Harts Creek-1_b	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Harts Creek/Harts Lake Habitat Assessment (ST11-HRT-ST01).
HRT-03	Hart's Creek west of Wilcox Dairy	Harts Lake drains to the Nisqually River through a man-made channel which provides low habitat value.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Harts Creek/Harts Lake Habitat Assessment (ST11-HRT-ST01).
HRT-06	EDT Reach Harts Creek-1_c	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Harts Creek/Harts Lake Habitat Assessment (ST11-HRT-ST01).
HRT-07	Hart's Creek west of Wilcox Dairy	Culvert was classified as a fish barrier (Pierce Conservation District culvert survey and EDT analysis).				Problem is outside the County's jurisdiction. It is located on a private road.
HRT-08	EDT Reach Harts Creek-1_d	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Harts Creek/Harts Lake Habitat Assessment (ST11-HRT-ST01).
KRG-01	EDT Reach Kreger Cr-1	Riparian/aquatic habitat assessment reach with Medium restoration and Medium preservation priorities.		X		Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG11-06), Enhance Nisqually River Council Capacity (PRG11-03).

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
KRG-02	EDT Reach Kreger Cr-2	Riparian/aquatic habitat assessment reach with Medium restoration and Medium preservation priorities.		X		Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG11-06), Enhance Nisqually River Council Capacity (PRG11-03).
KRG-03	EDT Reach Kreger Lake	Riparian/aquatic habitat assessment reach with Medium restoration and Medium preservation priorities.		X		Develop and Implement a Lake Water Quality Management Program (PRG00-15).
KRG-06	EDT Reach Kreger Cr-3	Riparian/aquatic habitat assessment reach with Medium restoration and Medium preservation priorities.		X		Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG11-06), Enhance Nisqually River Council Capacity (PRG11-03).
KRG-10	EDT Reach Silver Lake	Riparian/aquatic habitat assessment reach with Medium restoration and Medium preservation priorities.		X		Develop and Implement a Lake Water Quality Management Program (PRG00-15).
LGR-01	Stream crossing SR7 approx 200 meters north of 497th St E	Culvert requires repair for fish passage.				There is no recommended action since there is a natural fish passage barrier downstream of this culvert.
LMR-01	EDT Reach Little Mashel R	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Lower Mashel Restoration Assessment (ST20-LMR-01).
LYN-01	EDT Reach Lynch Cr	Riparian/aquatic habitat assessment reach with High restoration and High preservation priorities.		X		Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
MAL-01	EDT Reach Lower Mashel-A_A	Riparian/aquatic habitat assessment reach with Highest restoration and Highest preservation priorities.	X			Mashel Small Properties Acquisition (CIP20-MAL-AC03), Mashel Eatonville Reach Instream Restoration Phase II (CIP20-MAL-RST01), Mashel Eatonville Reach Riparian Revegetation (CIP20-MAL-VC01).
MAL-03	EDT Reach Lower Mashel-A_B	Riparian/aquatic habitat assessment reach with Highest restoration and Highest preservation priorities.	X			Mashel River Property Acquisition (CIP20-MAL-AC01), Mashel Shoreline Buffer Acquisition (-AC02), Mashel Small Properties Acquisition (-AC03), Mashel Eatonville Reach Instream Restoration Phase II (-RST01), Mashel Eatonville Reach Riparian Revegetation (-VC01).
MAL-04	EDT Reach Lower Mashel-B	Riparian/aquatic habitat assessment reach with Highest restoration and Highest preservation priorities.	X			Mashel Small Properties Acquisition (CIP20-MAL-AC03), Mashel Eatonville Reach Instream Restoration Phase II (CIP20-MAL-RST01), Mashel Eatonville Reach Riparian Revegetation (CIP20-MAL-VC01).
MAM-01	EDT Reach Middle Mashel R-1	Riparian/aquatic habitat assessment reach with Highest restoration and High preservation priorities.				Reach is located on designated forest land and is outside the County's jurisdiction.
MAM-03	EDT Reach Middle Mashel R-2	Riparian/aquatic habitat assessment reach with Highest restoration and High preservation priorities.				Reach is located on designated forest land and is outside the County's jurisdiction.
MAM-04	EDT Reach Beaver Cr-1	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.				Reach is located on designated forest land and is outside the County's jurisdiction.
MAM-05	EDT Reach Beaver Cr-2	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.				Reach is located on designated forest land and is outside the County's jurisdiction.

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
MAU-01	EDT Reach Upper Mashel R	Riparian/aquatic habitat assessment reach with High restoration and High preservation priorities.				Reach is located on designated forest land and is outside the County's jurisdiction.
MAU-02	EDT Reach Busy Wild Cr-1	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.				Reach is located on designated forest land and is outside the County's jurisdiction.
MAU-03	EDT Reach Busy Wild Cr-2	Riparian/aquatic habitat assessment reach with High restoration and Medium preservation priorities.				Reach is located on designated forest land and is outside the County's jurisdiction.
MUR-01	EDT Reach Murray Cr-1	Riparian/aquatic habitat assessment reach with Medium restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following studies are recommended to fill the data gap: Murray Creek Restoration Assessment (ST11-MUR-ST01), Murray, Brighton and Horn Creek Wetlands Restoration Assessment (ST11-MUR-ST02).
MUR-02	EDT Reach Murray Cr-2_a	Riparian/aquatic habitat assessment reach with Medium restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following studies are recommended to fill the data gap: Murray Creek Restoration Assessment (ST11-MUR-ST01), Murray, Brighton and Horn Creek Wetlands Restoration Assessment (ST11-MUR-ST02).
MUR-03	Culvert under railroad tracks approximately 600 meters upstream of confluence with Nisqually River	Culvert was classified as fish barrier. Also, culvert is damaged.				Problem is outside the County's jurisdiction. It will be referred to BNSF railroad. Culvert fish passability and replacement options, however, will be addressed as part of the Murray Creek Restoration Assessment (St11-MUR-ST01).

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
MUR-05	Murray Creek crossing of Chehalis Railroad, approximately 40 meters east of Hwy 507	Culvert under Chehalis Railroad was classified as a fish barrier (Pierce Conservation District culvert survey and EDT analysis).				Problem is outside the County's jurisdiction. It will be referred to Chehalis Railroad.
MUR-06	EDT Reach Murray Cr-2_b_A	Riparian/aquatic habitat assessment reach with Medium restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following studies are recommended to fill the data gap: Murray Creek Restoration Assessment (ST11-MUR-ST01), Murray, Brighton and Horn Creek Wetlands Restoration Assessment (ST11-MUR-ST02).
MUR-11	Murray Creek crossing of Hinkleman Road approximately 600 meters east 72nd Avenue S	Culvert was classified as a fish barrier (EDT analysis).				Pierce Conservation District data indicate this culvert is not a barrier to fish passage.
MUR-14	EDT Reach Murray Cr-2_b_B	Riparian/aquatic habitat assessment reach with Medium restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following studies are recommended to fill the data gap: Murray Creek Restoration Assessment (ST11-MUR-ST01) and Murray, Brighton, and Horn Creek Wetlands Restoration Assessment (ST11-MUR-ST02).
MUR-19	EDT Reach Murray Cr-3_a	Riparian/aquatic habitat assessment reach with Medium restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following studies are recommended to fill the data gap: Murray Creek Restoration Assessment (ST11-MUR-ST01) and Murray, Brighton, and Horn Creek Wetlands Restoration Assessment (ST11-MUR-ST02).
MUR-20	Approximately 300 meters north of 31117 48th Avenue S	Culvert was classified as a fish barrier (Pierce Conservation District culvert survey).			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Murray Creek Barrier Removal Assessment (ST11-MUR-ST03).

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
MUR-21	EDT Reach Murray Cr-3_b	Riparian/aquatic habitat assessment reach with Medium restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following studies are recommended to fill the data gap: Murray Creek Restoration Assessment (ST11-MUR-ST01) and Murray, Brighton, and Horn Creek Wetlands Restoration Assessment (ST11-MUR-ST02)
MUR-22	Murray Creek crossing under pipeline between 40th Ave S and 48th Ave S	Culvert was classified as fish barrier due to steep slopes (Pierce Conservation District culvert survey). Also, culvert is damaged.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Murray Creek Barrier Removal Assessment (ST11-MUR-ST04).
NIS-01	EDT Reach Nisqually1-Estuary	Riparian/aquatic habitat assessment reach with Highest restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS -AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-02	EDT Reach Nisqually2a-LowerReach	Riparian/aquatic habitat assessment reach with Highest restoration and High preservation priorities.	X	X	X	Red Salmon Slough Estuary Restoration Phase III (CIP08-RED-RST01), Nisqually Mainstem Acquisitions (CIP11-NIS-AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-04	EDT Reach Nisqually2B.1-LowerReach	Riparian/aquatic habitat assessment reach with Low restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS-AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
NIS-05	EDT Reach Nisqually2B.2-LowerReach	Riparian/aquatic habitat assessment reach with Low restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS-AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-06	EDT Reach Nisqually2B.3-LowerReach	Riparian/aquatic habitat assessment reach with Low restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS-AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-07	EDT Reach Nisqually2B.4-LowerReach	Riparian/aquatic habitat assessment reach with Low restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS-AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-08	EDT Reach Nisqually3.1-Whitewater	Riparian/aquatic habitat assessment reach with High restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS -AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-09	EDT Reach Nisqually3.2-Whitewater	Riparian/aquatic habitat assessment reach with High restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS -AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
NIS-10	EDT Reach Nisqually3.3-Whitewater	Riparian/aquatic habitat assessment reach with High restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS -AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-12	EDT Reach Nisqually4.1-Mckenna	Riparian/aquatic habitat assessment reach with Highest restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS-AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-13	EDT Reach Nisqually4.2-Mckenna	Riparian/aquatic habitat assessment reach with Highest restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS -AC02, -AC03), Nisqually Wilcox Side-Channel (-RST01), Mainstem Off-Channel Restoration (-RST03), Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following studies are recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01) and Murray, Brighton, and Horn Creek Wetland restoration Assessment (ST11-MUR-ST02).
NIS-14	Nisqually River, approximately 700 m south of Horn Creek confluence	Centralia Diversion inhibits passage of some fish and is identified as an obstruction in EDT analysis.				Problem is outside the County's jurisdiction. It will be referred to Centralia City Light.

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
NIS-15	EDT Reach Nisqually5.1-Wilcox	Riparian/aquatic habitat assessment reach with Medium restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS-AC02, -AC03), Nisqually Wilcox Side-Channel (-RST01), Wilcox Flats Off-Channel Restoration (-RST02), Mainstem Off-Channel Restoration (-RST03), Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-17	EDT Reach Nisqually5.2-Wilcox	Riparian/aquatic habitat assessment reach with Medium restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS-AC02, -AC03), Wilcox Flats Off-Channel Restoration (-RST02), Mainstem Off-Channel Restoration (-RST03), Nisqually Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-18	EDT Reach Nisqually5.3-Wilcox	Riparian/aquatic habitat assessment reach with Medium restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS -AC02, -AC03), Wilcox Flats Off-Channel Restoration (-RST02), Mainstem Off-Channel Restoration (-RST03), Nisqually Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-19	EDT Reach Nisqually6.1-MiddleReach	Riparian/aquatic habitat assessment reach with Medium restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS -AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
NIS-20	EDT Reach Nisqually6.2-MiddleReach	Riparian/aquatic habitat assessment reach with Medium restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS -AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Nisqually Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-21	EDT Reach Nisqually6.3-MiddleReach	Riparian/aquatic habitat assessment reach with Medium restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS -AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Nisqually Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-22	EDT Reach Nisqually7A-UpperReach	Riparian/aquatic habitat assessment reach with Low restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS-AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Nisqually Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
NIS-23	EDT Reach Nisqually7B-UpperReach	Riparian/aquatic habitat assessment reach with Low restoration and Highest preservation priorities.	X	X	X	Nisqually Mainstem Acquisitions (CIP11-NIS-AC02, -AC03), Mainstem Off-Channel Restoration (-RST03), Nisqually Salmon Carcass Nutrient Enhancement (PRG11-02), Countywide Vegetation Management (PRG00-16). Information gaps also exist and the following study is recommended: Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01).
OHL-01	EDT Reach Ohop Cr-1	Riparian/aquatic habitat assessment reach with Highest restoration and Medium preservation priorities.	X	X	X	Ohop Creek Acquisitions (CIP14-OHL-AC01, -AC02, -AC03), Lower Ohop Valley Restoration Phases 1 (CIP14-OHL-RST01), 2 (-RST02), and 3 (-RST03).

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
OHU-01	EDT Reach Ohop Cr-2	Riparian/aquatic habitat assessment reach with Highest restoration and Medium preservation priorities.		X		Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05).
OHU-03	EDT Reach Ohop Lake	Riparian/aquatic habitat assessment reach with High restoration and High preservation priorities.		X		Develop and Implement a Lake Water Quality Management Program (PRG00-15).
OHU-12	Ohop Lake	No more frogs due to ditch cleaning. Clearing/logging near stream.		X		Develop and Implement a Lake Water Quality Management Program (PRG00-15).
OHU-14	Ohop Lake shoreline near 38509 Orville Rd E	Loss of native vegetation along shoreline.		X		Develop and Implement a Lake Water Quality Management Program (PRG00-15).
OHU-16	EDT Reach Twentyfive Mile Cr	Riparian/aquatic habitat assessment reach with High restoration and High preservation priorities.	X		X	Part of the problem is addressed by project: Upper Ohop Shoreline Protection (CIP14-OHU-AC01 and –AC02). More data or analyses are required to address aspects of the problem. The following study is recommended: Clay City Sediment Reduction Assessment (ST14-OHU-ST01).
OHU-17	EDT Reach Trib0094	Riparian/aquatic habitat assessment reach with Low restoration and Medium preservation priorities.	X			Upper Ohop Shoreline Protection (CIP14-OHU-AC01 and –AC02).
OHU-18	Misc. tributary crossing of railroad tracks approximately 1 mile south of Clay City Rd	Culvert was classified as fish barrier. Also, culvert is damaged.				Problem is outside the County's jurisdiction. It will be referred to the railroad.
RED-03	EDT Reach Nearshore	Riparian/aquatic habitat assessment reach with Highest restoration and Highest preservation priorities.				The Nisqually Tribe is addressing this problem with their Nisqually Estuary restoration.

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
RED-04	EDT Reach Red Salmon Creek	Riparian/aquatic habitat assessment reach with Low restoration and Medium preservation priorities.				The Nisqually Tribe is working on a restoration project that addresses this problem.
TWL-01	EDT Reach Tanwax Cr-1	Riparian/aquatic habitat assessment reach with High restoration and High preservation priorities.	X		X	Part of the problem is addressed by projects: Lower Tanwax Riparian Enhancement (CIP11-TWL-RST01), Tanwax Creek Wetland Protection Phases 1 and 2 (CIP11-TWU-AC01 and –AC02). The following study is recommended to fill information gaps on the problem: Lower Tanwax Sediment Reduction Assessment (ST11-TWl-ST02).
TWL-02	EDT Reach Tanwax Cr-2	Riparian/aquatic habitat assessment reach with High restoration and High preservation priorities.	X		X	Part of the problem is addressed by projects: Lower Tanwax Riparian Enhancement (CIP11-TWL-RST01), Tanwax Creek Wetland Protection Phases 1 and 2 (CIP11-TWU-AC01 and –AC02). The following study is recommended to fill information gaps on the problem: Lower Tanwax Sediment Reduction Assessment (ST11-TWl-ST02).
TWL-03	EDT Reach Cranberry	Riparian/aquatic habitat assessment reach with Low restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Cranberry and Rapjohn Lakes Assessment (ST11-TWL-ST01).
TWU-01	EDT Reach Tanwax Cr-3_a	Riparian/aquatic habitat assessment reach with High restoration and High preservation priorities.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Tanwax Valley Restoration Assessment (ST11-TWU-ST01).
TWU-02	EDT Reach Rapjohn	Riparian/aquatic habitat assessment reach with Low restoration and Medium preservation priorities.		X		Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG11-06), Enhance Nisqually River Council Capacity (PRG11-03).

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
TWU-03	EDT Reach Mud	Riparian/aquatic habitat assessment reach with Low restoration and Medium preservation priorities.			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Eatonville Cutoff Road Culvert Replacement Assessment (ST11-TWU-ST02).
TWU-06	Tanwax Creek crossing of Eatonville Cutoff E	Culvert was classified as a partial fish barrier (EDT analysis).	X		X	Part of the problem is addressed by project: Tanwax Creek Wetland Protection (CIP11-TWU-AC01). More data or analyses are required to address other aspects of the problem. The following study is recommended: Eatonville Cutoff Road Culvert Replacement Assessment (ST11-TWU-ST03).
TWU-07	EDT Reach Tanwax Cr-3_b	Riparian/aquatic habitat assessment reach with High restoration and High preservation priorities.			X	More data or analyses are required to address this problem. The following studies are recommended to fill the data gap: Tanwax Valley Restoration Assessment (ST11-TWU-ST01), Eatonville Cutoff Road Culvert Replacement Assessment (ST11-TWU-ST03).
TWU-10	Mud Creek crossing of Eatonville Cutoff E (approx. 170 m south of 372nd St E)	Culvert was classified as a partial fish barrier (Pierce Conservation District culvert survey).			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Eatonville Cutoff Road Culvert Replacement Assessment (ST11-TWU-ST02).
TWU-12	EDT Reach Trout Creek	Riparian/aquatic habitat assessment reach with Low restoration and Medium preservation priorities.		X		Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG11-06), Enhance Nisqually River Council Capacity (PRG11-03).
TWU-13	352 St E crossing of creek leading to Trout Lake	Culvert was classified as a fish barrier due to steep slope and outfall drop height (Pierce Conservation District culvert survey).			X	More data or analyses are required to address this problem. The following study is recommended to fill the data gap: Trout Creek at 352nd Street East Culvert Replacement Assessment (ST11-TWU-ST04).

TABLE 8-4
Habitat Problem Recommendations

Problem ID	Location	Description	Recommendations			
			CIP	Programmatic Measure	Study	Description
TWU-22	EDT Reach Tanwax Lake	Riparian/aquatic habitat assessment reach with High restoration and High preservation priorities.	X		X	Part of the problem is addressed by project: Tanwax Creek Wetland Protection Phases 1 and 2 (CIP11-TWU-AC01 and –AC02). More data or analyses are required to address other aspects of the problem. The following study is recommended: Eatonville Cutoff Road Culvert Replacement Assessment (ST11-TWU-ST03).
TWU-29	EDT Reach Tanwax Upper Tributaries	Riparian/aquatic habitat assessment reach with Low restoration and Medium preservation priorities.	X		X	Part of the problem is addressed by project: Tanwax Creek Wetland Protection Phases 1 and 2 (CIP11-TWU-AC01 and –AC02). More data or analyses are required to address other aspects of the problem. The following study is recommended: Eatonville Cutoff Road Culvert Replacement Assessment (ST11-TWU-ST03).

CHAPTER NINE
BASIN PLAN

This chapter contains the Nisqually River Basin Plan (Basin Plan). The chapter contains a set of recommended capital improvement projects[9] (CIP), programmatic measures[10], and studies that address the stormwater and surface water management problems identified in previous chapters.

The Basin Plan establishes the direction that Surface Water Management will take within the Nisqually River Basin over the next 5 to 10 years. The recommended measures are intended to reduce flood and storm drainage hazards, improve water quality, improve aquatic habitat potentially affected by surface water management methods, ensure coordinated and responsible use of public resources, and guide new development.

Chapter 9 is organized as follows:

9.1 Summary of Plan Recommendations.

9.2 Plan Approach to Basin Needs: a description of key assumptions and analysis behind the recommendations.

9.3 Specific Recommendations: descriptions of individual capital improvement projects, programmatic measures, and studies to close data gaps.

9.4 Implementation

9.5 Problems and CIP Solutions Cross-Reference

9.1 SUMMARY OF PLAN RECOMMENDATIONS

The Nisqually River Basin Plan contains 36 capital improvement projects, 21 programmatic measures, and 18 studies to address flooding, erosion, water quality, and stream habitat problems resulting from surface water runoff in the basin.

Capital improvement projects and programmatic measures have been divided into "High-Priority," "Medium-Priority," and "Low-Priority"[11] groups. Studies were not prioritized with the capital improvement projects and the programmatic measures. Priority groups are based on scores from prioritization worksheets common to all basin plans. Worksheets document the project's or program's potential for various aspects of flood reduction, improvement of water

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9 A capital improvement project has a cost of $75,000 or more and improves the physical condition of the drainage system, the performance of the system, and/or reduces site-specific or cumulative adverse stormwater impacts.

10 Programmatic measures are nonstructural solutions, such as changing particular Pierce County procedures, providing technical assistance, enforcing regulations, and offering public information.

11 "Low-Priority" does not mean "not a priority." "No Priority" actions have already been excluded from this Basin Plan. Rather, "Low-Priority" means the project rated lower than other needs in the basin. Examples of these include projects with only a single benefit; the rating system is weighted toward multiple benefits.

quality, aquatic habitat protection, and other benefits using approximately 40 criteria. (Appendix J contains a ranking sheet for each CIP and each programmatic measure.) The top 25 % of the projects are designated high-priority, the middle 50 % are medium-priority, and the remaining 25 % are assigned low-priority. Estimated costs of recommendations by priority group over the 10-year implementation period are as follows:

"High-Priority" Recommendations: $6,491,170

"Medium-Priority" Recommendations: $11,657,010

"Low-Priority" Recommendations: $4,715,600

In addition, further studies to fill information gaps totaling $1,363,500 have been identified. Table 9-1 presents the estimated costs of the Nisqually River Basin Plan recommendations by project type and priority group.

TABLE 9-1
Estimated Costs of Plan Recommendations

Project Type	High-Priority	Medium-Priority	Low-Priority
Capital Improvement Projects	$1,682,670	$11,340,010	$4,388,600
Programmatic Measures	$4,808,500	$317,000	$327,000
Studies	$1,363,500		
Total Estimated Cost:	**$24,227,280**		

Table 9-2 contains the list of High-Priority projects, rating scores, and estimated costs. Table 9-3 presents the Medium-Priority projects. Table 9-4 shows the Low-Priority projects. The project order within each table reflects project cost, from least costly to most costly.

TABLE 9-2
High-Priority Recommended Projects

ID Code	Project Title	Rating Score	Estimated Cost
PRG00-02	Update Stormwater Management Manual	385	$1,000
PRG00-08	Develop and Implement a BMP Manual for Pierce County Surface Water Management Maintenance Activities	385	$6,000
PRG00-04	Develop and Implement a Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation	385	$7,000
PRG00-06	Develop and Implement an Education, Outreach, and Technical Assistance Program	396	$28,000
CIP08-RED-RST01	Red Salmon Slough Estuary Restoration Phase III	297	$60,270

CIP08-RED-RST01	Red Salmon Slough Estuary Restoration Phase III	297	$60,270
PRG00-05	Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality	291	$92,000
PRG00-01	Implement a Low Impact Development Program	348	$116,000
PRG00-13	Implement Elements of Shellfish Protection Program	310	$116,000
PRG00-16	Develop and Implement Countywide Vegetation Management Program	325	$136,500
PRG00-03	Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit	398	$170,000
PRG11-01(b)	Revise Flood Hazard Maps Nisqually River Wilcox Flats Reach	264	$80,000
PRG00-09	Develop and Implement an Invasive Species Management Program	361	$806,000
CIP11-TWU-AC01	Tanwax Creek Wetland Protection Phase 1	251	$811,200
CIP11-TWU-AC02	Tanwax Creek Wetland Protection Phase 2	251	$811,200
PRG00-15	Develop and Implement a Lake Water Quality Management Program	362	$2,765,000
PRG11-03	Enhance Nisqually River Council Capacity	332	$375 ,000
		Total Estimated Cost:	**$6,006,170**

TABLE 9-3
Medium-Priority Recommended Projects

ID Code	Project Title	Rating Score	Estimated Cost
PRG00-11	Beaver Management Policy	217	NA
PRG00-12	Encourage Installation of Permanent Buffer Markings and/or Signage	243	$6,000
PRG00-14	Develop and Implement a Habitat Monitoring Program	196	$6,000
PRG11-05	Implement Elements of Nisqually River Bacteria TMDL Water Quality Implementation Plan	240	$58,000
PRG11-04	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems	183	$116,000
PRG00-07	Develop and Implement a Surface Water Monitoring Program	239	$131,000
CIP20-MAL-RST01	Mashel Eatonville Reach Instream Restoration Phase II	242	$149,215
CIP11-KRG-C01	Silver Lake Culvert Replacement	151	$217,600

TABLE 9-3
Medium-Priority Recommended Projects

ID Code	Project Title	Rating Score	Estimated Cost
CIP11-NIS-AC04	Wilcox Flats Repetitive Loss Acquisition	198	$222,300
CIP20-MAL-VC01	Mashel Eatonville Reach Riparian Revegetation	221	$226,800
CIP19-ASH-C01	Culvert Replacement at 278th Avenue East	147	$288,100
CIP11-NIS-RST01	Nisqually River Wilcox Side-Channel	148	$302,300
CIP14-OHL-RST01	Lower Ohop Valley Restoration Phase 1 (Segments D, E, and F)	242	$404,595
CIP11-BRI-C01	Upper Brighton Creek Culvert Replacements	180	$448,300
CIP14-OHU-AC01	Upper Ohop Shoreline Protection (Hancock-Ohop) Phase 1	177	$572,100
CIP14-OHU-AC02	Upper Ohop Shoreline Protection (Hancock-Ohop) Phase 2	177	$572,100
CIP14-OHL-RST02	Lower Ohop Valley Restoration Phase 2 (Segments A, B, and C)	242	$606,600
CIP14-OHL-AC04	Ohop Creek Repetitive Loss Property Acquisition	195	$606,800
CIP14-OHL-AC01	Ohop Creek Property Acquisition Phase 1	241	$617,800
CIP14-OHL-AC02	Ohop Creek Property Acquisition Phase 2	174	$618,900
CIP14-OHL-AC03	Ohop Creek Property Acquisition Phase 3	174	$618,900
CIP20-MAL-AC01	Mashel River Property Acquisition	161	$663,000
CIP11-NIS-RST03	Mainstem Off-Channel Restoration	148	$747,200
CIP19-COP-AC01	Upper Nisqually River Property Acquisition	213	$748,300
CIP14-OHL-RST03	Lower Ohop Valley Restoration Phase 3 (Segments G, H, I, J, K, and L)	242	$799,600
CIP20-MAL-AC02	Mashel Shoreline Buffer Acquisition	171	$848,700
CIP11-NIS-AC02 (renumbered to CIP11-NIS-AC01)	Nisqually River Mainstem Acquisition Phase 2	195	$1,060,800
CIP11-NIS-AC03 (renumbered to CIP-NIS-AC02)	Nisqually River Mainstem Acquisition Phase 3	195	$1,060,800
CIP20-MAL-AC03	Mashel Small Properties Acquisition	174	$617,800
		Total Estimated Cost:	**$12,717,810**

TABLE 9-4
Low-Priority Recommended Projects

ID Code	Project Title	Rating Score	Estimated Cost
PRG00-10	Require Flood Disclosure Statements on Property Titles	123	$7,000
CIP11-CLR-C01	West Clear Lake Road Culvert	69	$108,100
CIP11-HRN-FP01	Horn Creek Barrier Removal (waterfall at RM1.0)	114	$126,100
CIP11-TWU-C02	Webster Road Culvert Replacement	102	$136,600
CIP11-TWL-C01	Culvert Replacement at 365th Street East	76	$180,100
CIP11-TWU-C03	Culvert Replacement at Thomas Road	82	$196,800
CIP11-TWU-C01	Benbow Drive Culvert Replacement	143	$198,600
CIP11-MUR-C01	Tisch Road South Culvert Replacement	60	$230,700
CIP11-HRN-FP02	Horn Creek Barrier Removal (Hart Lake Loop Rd.)	136	$282,500
CIP11-KRG-C02	Dean Kreger Road Culvert Replacement and Slope Stabilization	128	$285,900
CIP11-HRT-C01	Hart's Lake Loop Road Culvert Replacement	139	$288,300
PRG11-02	Nutrient Enhancement using Salmon Carcasses	81	$320,000
CIP11-NIS-RST02	Wilcox Flats Off-Channel Restoration	142	$384,500
CIP11-HRN-C01	364th Street East Culvert Replacement	76	$443,100
CIP11-TWL-RST01	Lower Tanwax Riparian Enhancement	145	$738,600
CIP11-BRI-FP01	Brighton Creek Culvert Replacement (Harts Lake Loop Rd.)	121	$788,700
		Total Estimated Cost:	**$4,715,600**

9.1.1 Capital Improvement Projects

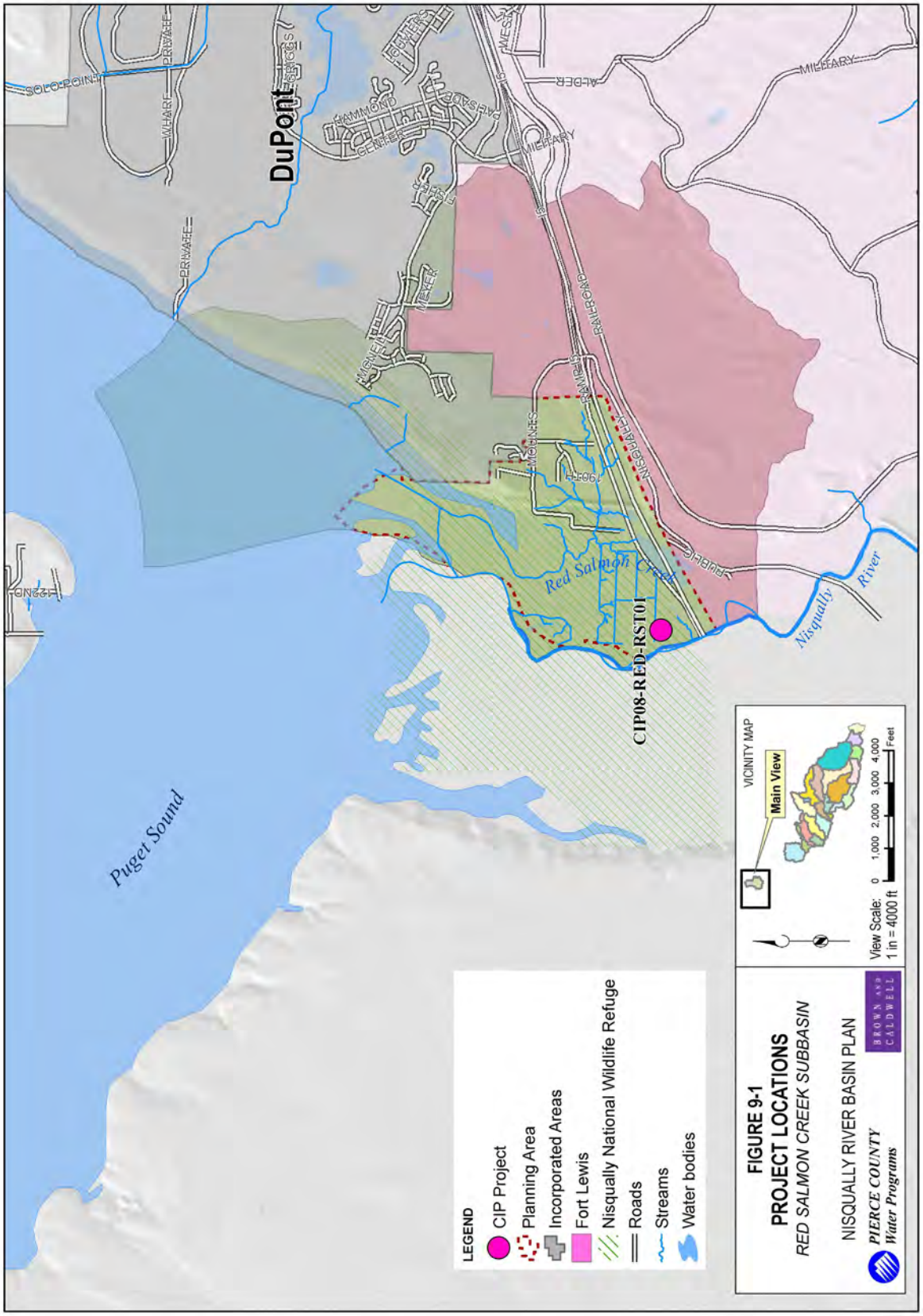
The Nisqually River Basin Plan proposes an array of capital improvement projects. Recommended CIP projects often address multiple problems reflecting the interrelationship of environmental factors.

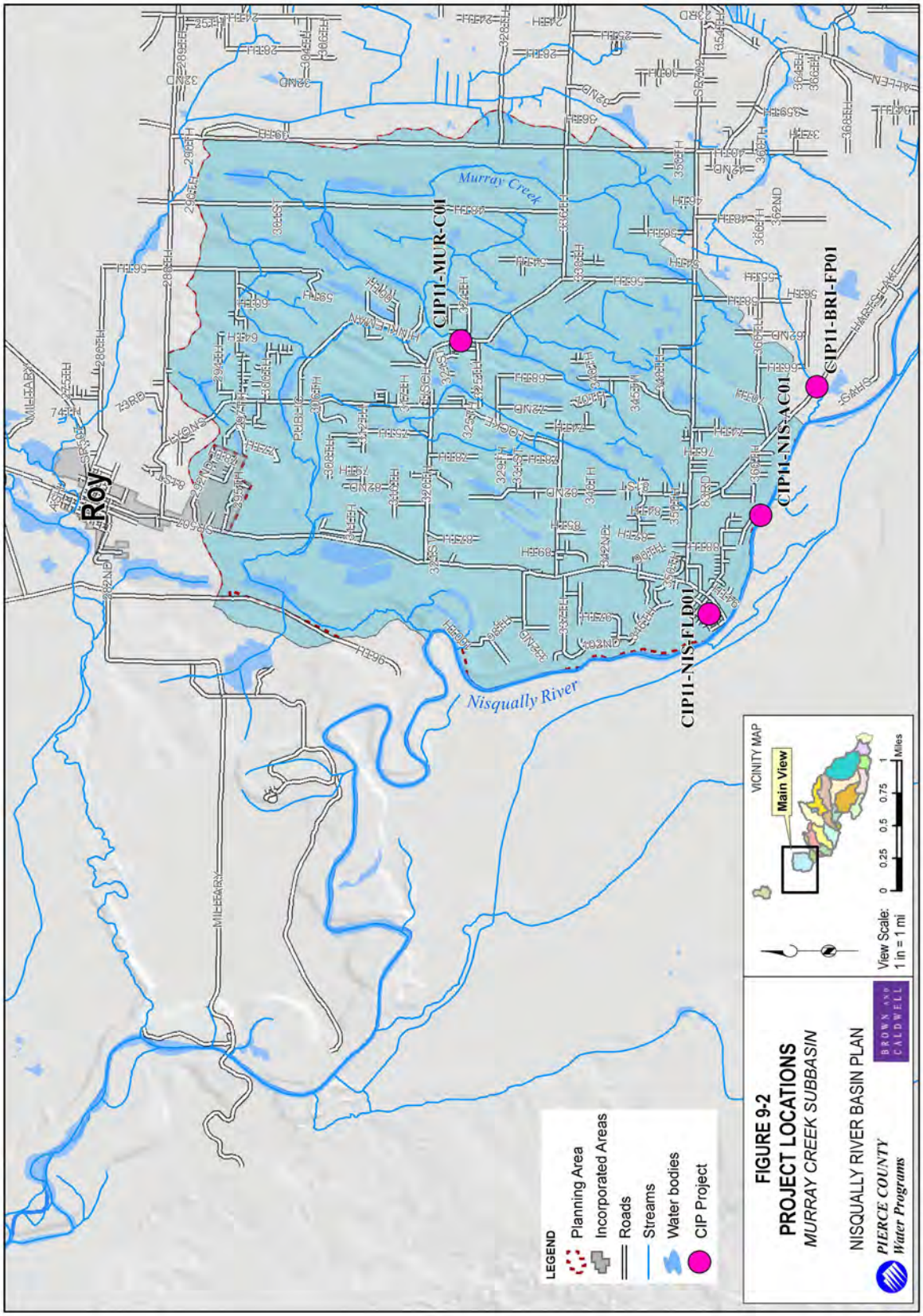
For example, habitat problems are often a secondary effect of problems related to surface water, storm drainage, and water quality. Culverts that are a barrier to fish passage are frequently too narrow in diameter to convey the surface water flows generated during storms, so they create backwater flooding. Even though projects can be categorized many ways, a single designation for the primary type of activity addressed by each CIP was selected as summarized below:

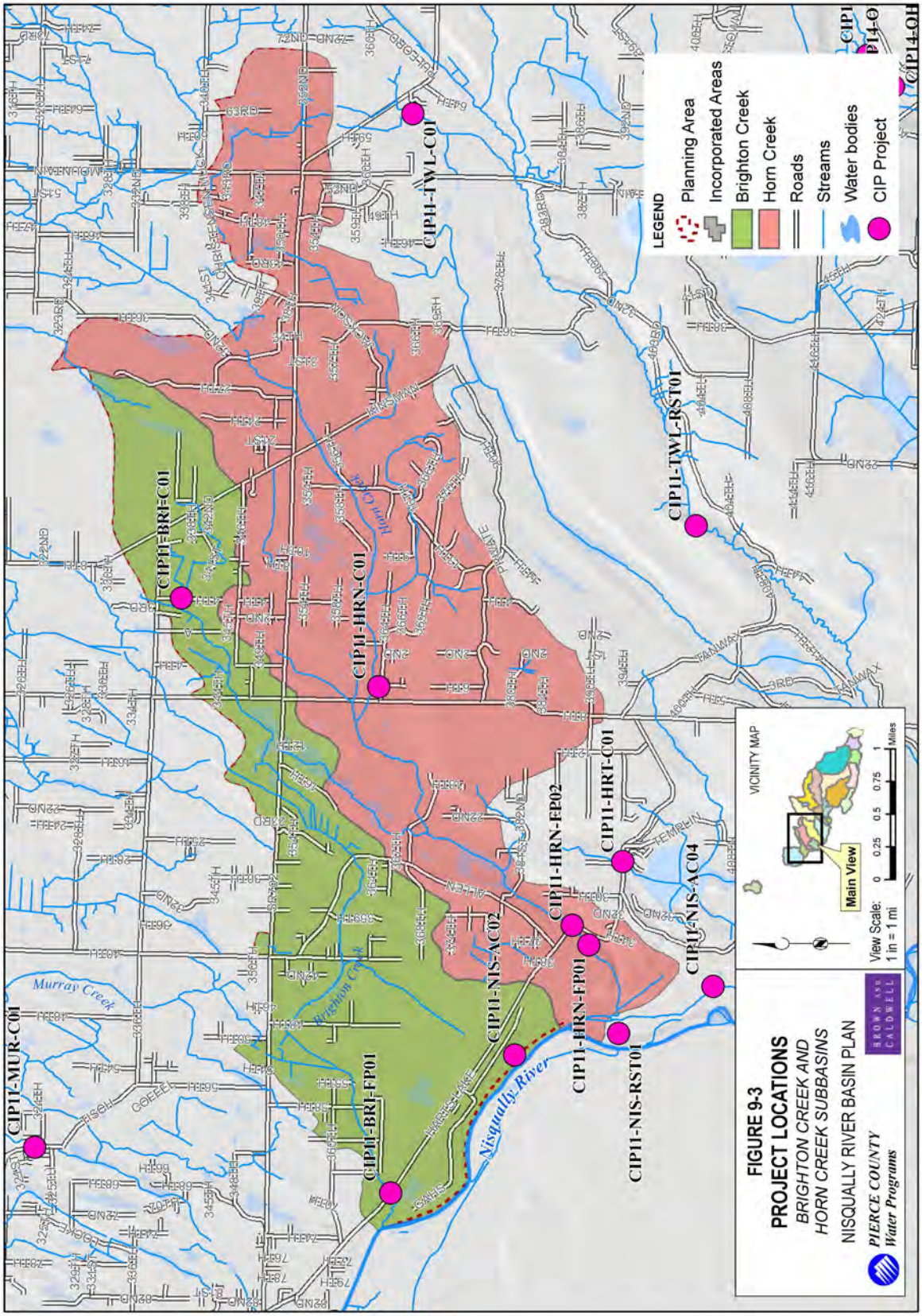
- Habitat Restoration – 9 CIP projects
- Culvert Replacements – 12 CIP projects

- Property Acquisition – 11 CIP projects
- Removal of Fish Barriers – 3 CIP projects
- Revegetation – 1 CIP project
- Flood Mitigation – 1 project placeholder

Figures 9-1 through 9-7 show the generalized locations of the recommended projects. A general location is provided to promote a focus on project concepts and elicit agreement at the planning stage before investing considerable funds in detailed analyses of project sites and design details. Section 9.3, Specific Recommendations, describes each of capital project, an estimated cost, and a project score (which is a measure of how well each capital project is in line with the Basin Plan objectives and key Pierce County Comprehensive Plan policies).


LEGEND
CIP Project
Planning Area
Incorporated Areas
Fort Lewis
Nisqually National Wildlife Refuge
Roads
Streams
Water bodies
Puget Sound
DuPont
Red Salmon Creek
Nisqually River
CIP08-RED-RST01
VICINITY MAP
Main View
View Scale: 0 1,000 2,000 3,000 4,000 Feet
1 in = 4000 ft
FIGURE 9-1
PROJECT LOCATIONS
RED SALMON CREEK SUBBASIN
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL


Roy
Murray Creek
Nisqually River
CIP11-MUR-C01
CIP11-BRI-FP01
CIP11-NIS-AC01
CIP11-NIS-FL01
LEGEND
Planning Area
Incorporated Areas
Roads
Streams
Water bodies
CIP Project
VICINITY MAP
Main View
View Scale: 1 in = 1 mi
0 0.25 0.5 0.75 1 Miles
FIGURE 9-2
PROJECT LOCATIONS
MURRAY CREEK SUBBASIN
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL


LEGEND
Planning Area
Incorporated Areas
Brighton Creek
Horn Creek
Roads
Streams
Water bodies
CIP Project
CIP11-TWL-C01
CIP11-TWL-RST01
CIP11-BRI-C01
CIP11-HRN-C01
CIP11-HRT-C01
CIP11-HRN-FP02
CIP11-HRN-FP01
CIP11-NIS-AC02
CIP11-NIS-AC04
CIP11-NIS-RST01
CIP11-BRI-FP01
CIP11-MUR-C01
Murray Creek
Brighton Creek
Horn Creek
Nisqually River
VICINITY MAP
Main View
View Scale: 1 in = 1 mi
0 0.25 0.5 0.75 1 Miles
FIGURE 9-3
PROJECT LOCATIONS
BRIGHTON CREEK AND
HORN CREEK SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL

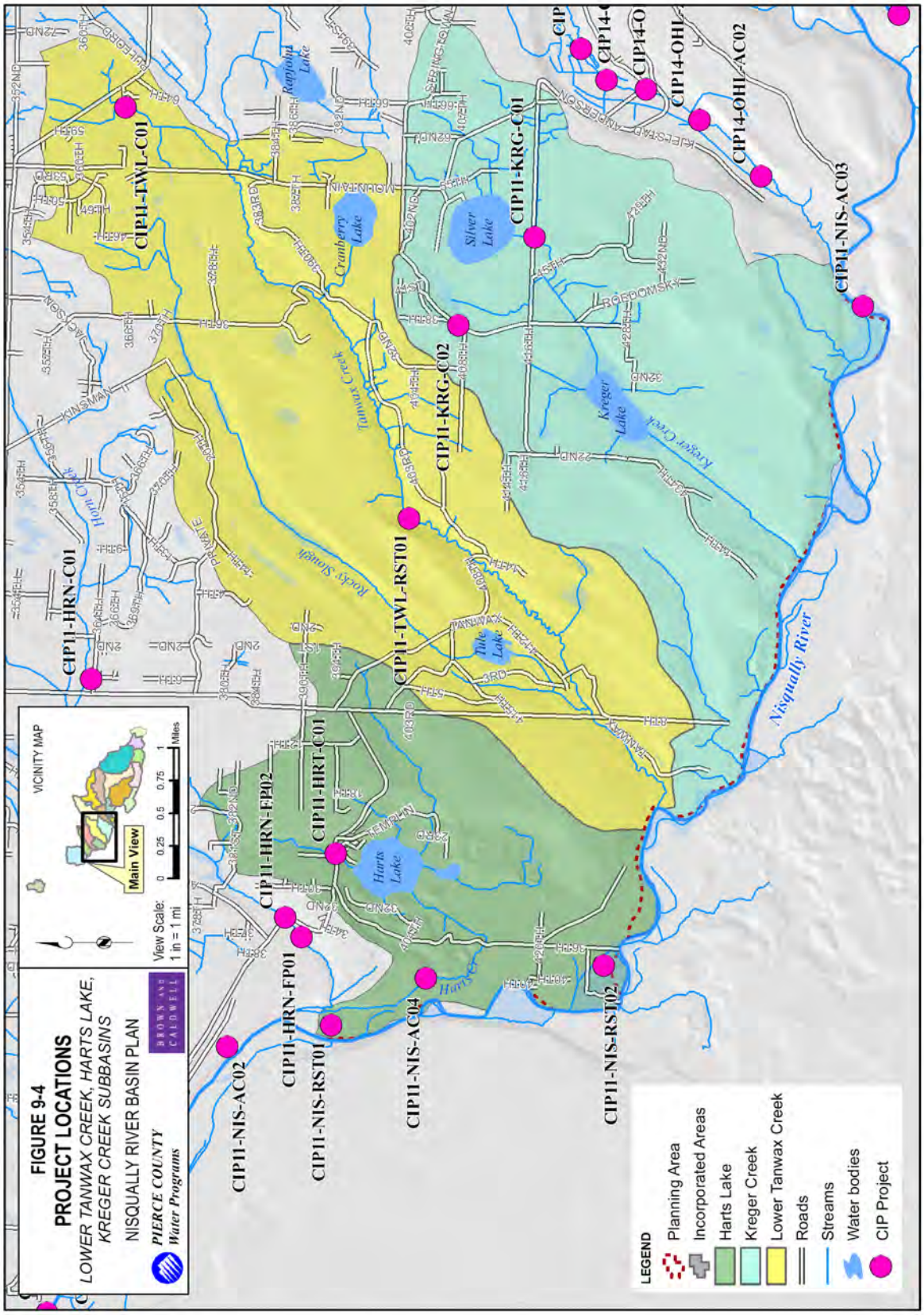


FIGURE 9-4
PROJECT LOCATIONS
LOWER TANWAX CREEK, HARTS LAKE, KREGER CREEK SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL
VICINITY MAP
Main View
View Scale: 1 in = 1 mi
0 0.25 0.5 0.75 1 Miles
CIP11-HRN-C01
CIP11-TWL-C01
CIP11-HRN-FP02
CIP11-HRN-FP01
CIP11-HRT-C01
CIP11-NIS-AC02
CIP11-NIS-RST01
CIP11-NIS-AC04
CIP11-TWL-RST01
CIP11-KRG-C02
CIP11-KRG-C01
CIP11-NIS-RST02
CIP14-OHL-AC02
CIP11-NIS-AC03
Harts Lake
Cranberry Lake
Rapjohn Lake
Silver Lake
Kreger Lake
Tule Lake
Tanwax Creek
Rocky Stream
Kreger Creek
Nisqually River
LEGEND
Planning Area
Incorporated Areas
Harts Lake
Kreger Creek
Lower Tanwax Creek
Roads
Streams
Water bodies
CIP Project

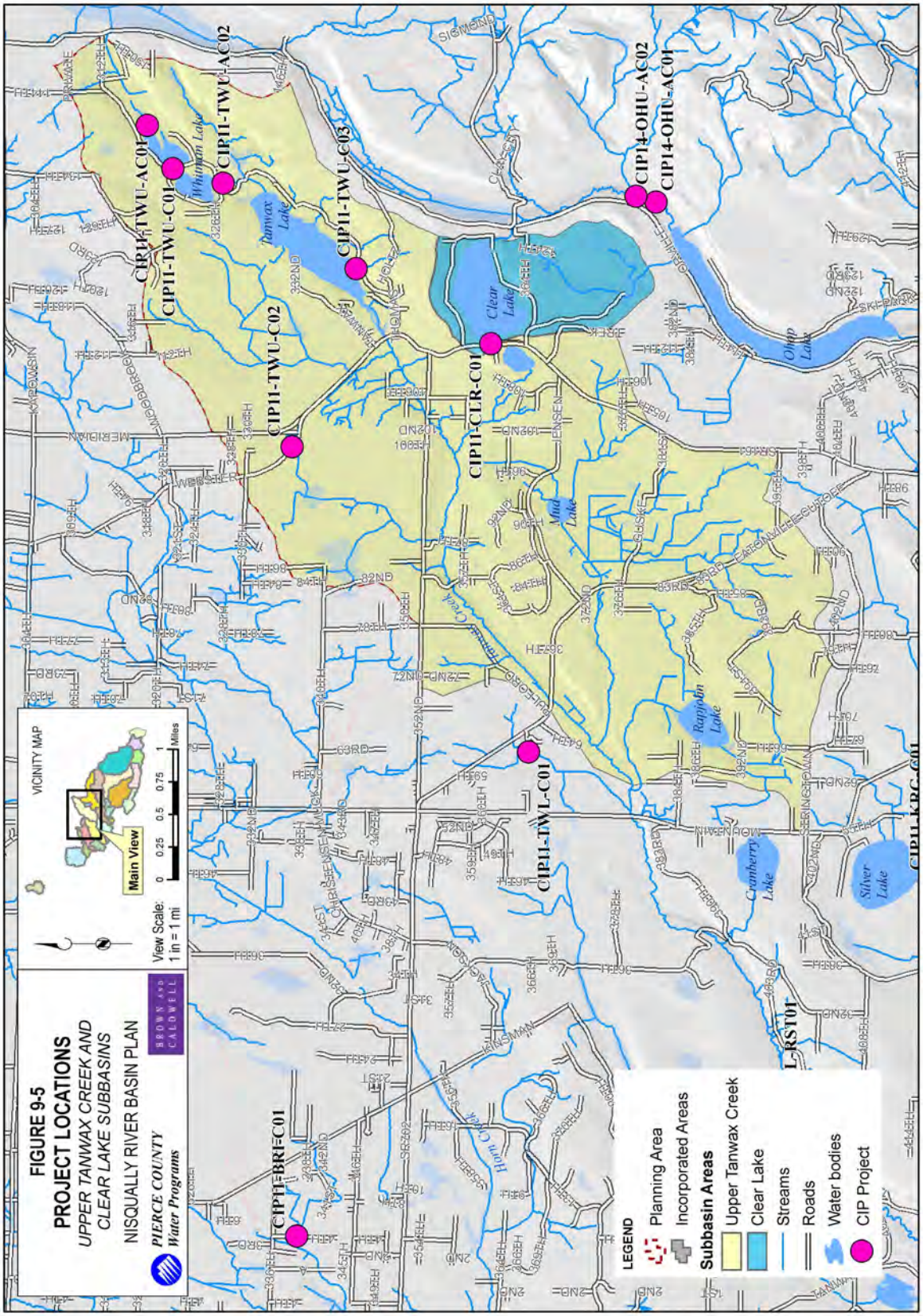


FIGURE 9-5
PROJECT LOCATIONS
UPPER TANWAX CREEK AND
CLEAR LAKE SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL
View Scale:
1 in = 1 mi
0 0.25 0.5 0.75 1 Miles
VICINITY MAP
Main View
LEGEND
Planning Area
Incorporated Areas
Subbasin Areas
Upper Tanwax Creek
Clear Lake
Streams
Roads
Water bodies
CIP Project
CIP11-BRI-C01
CIP11-TWU-C01
CIP11-TWU-AC01
CIP11-TWU-AC02
CIP11-TWU-C02
CIP11-TWU-C03
CIP11-TWL-C01
CIP11-CLR-C01
CIP14-OHU-AC01
CIP14-OHU-AC02
L-RST01
Whitman Lake
Tanwax Lake
Clear Lake
Mud Lake
Rainbow Lake
Cranberry Lake
Silver Lake
Ohop Lake

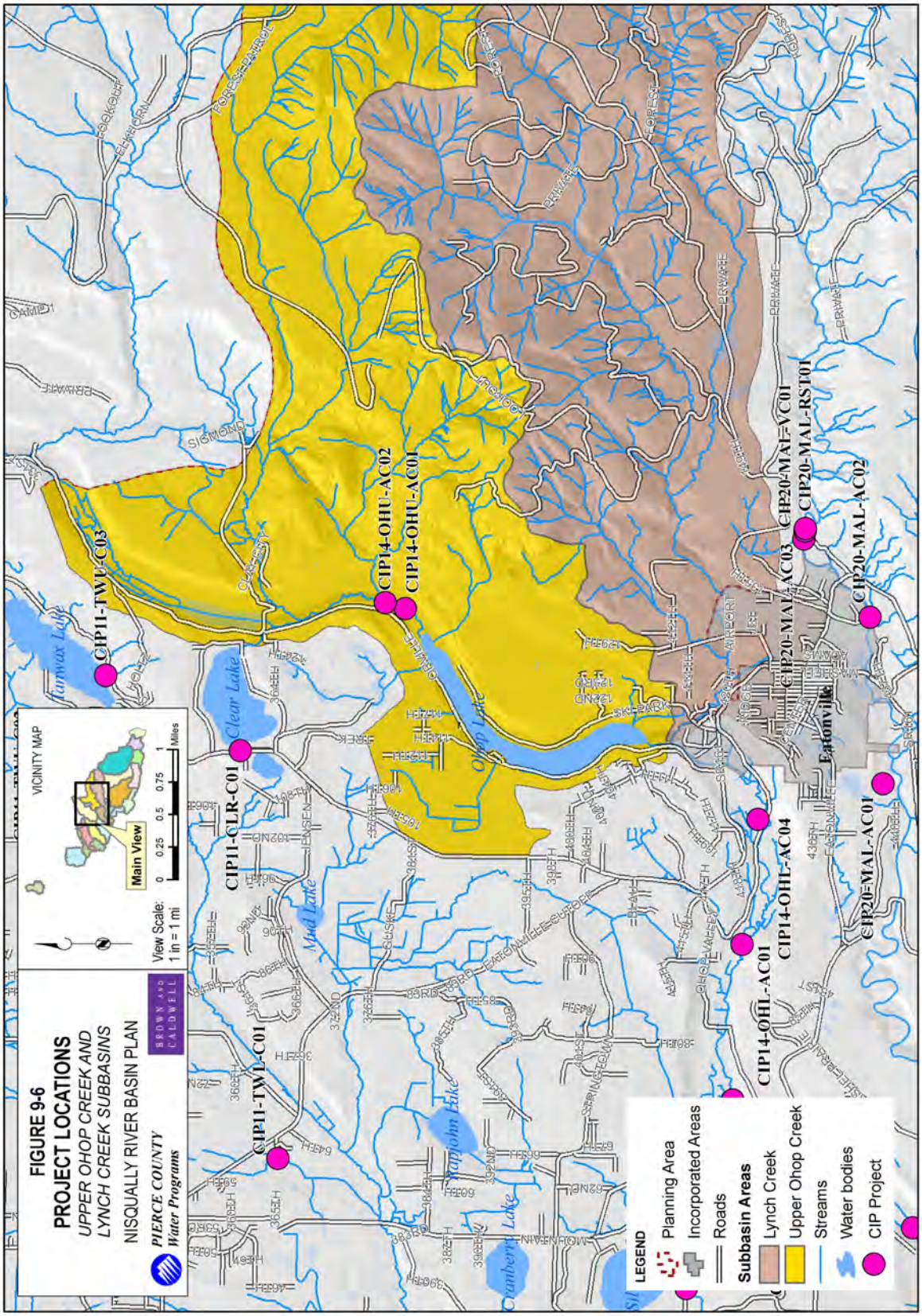
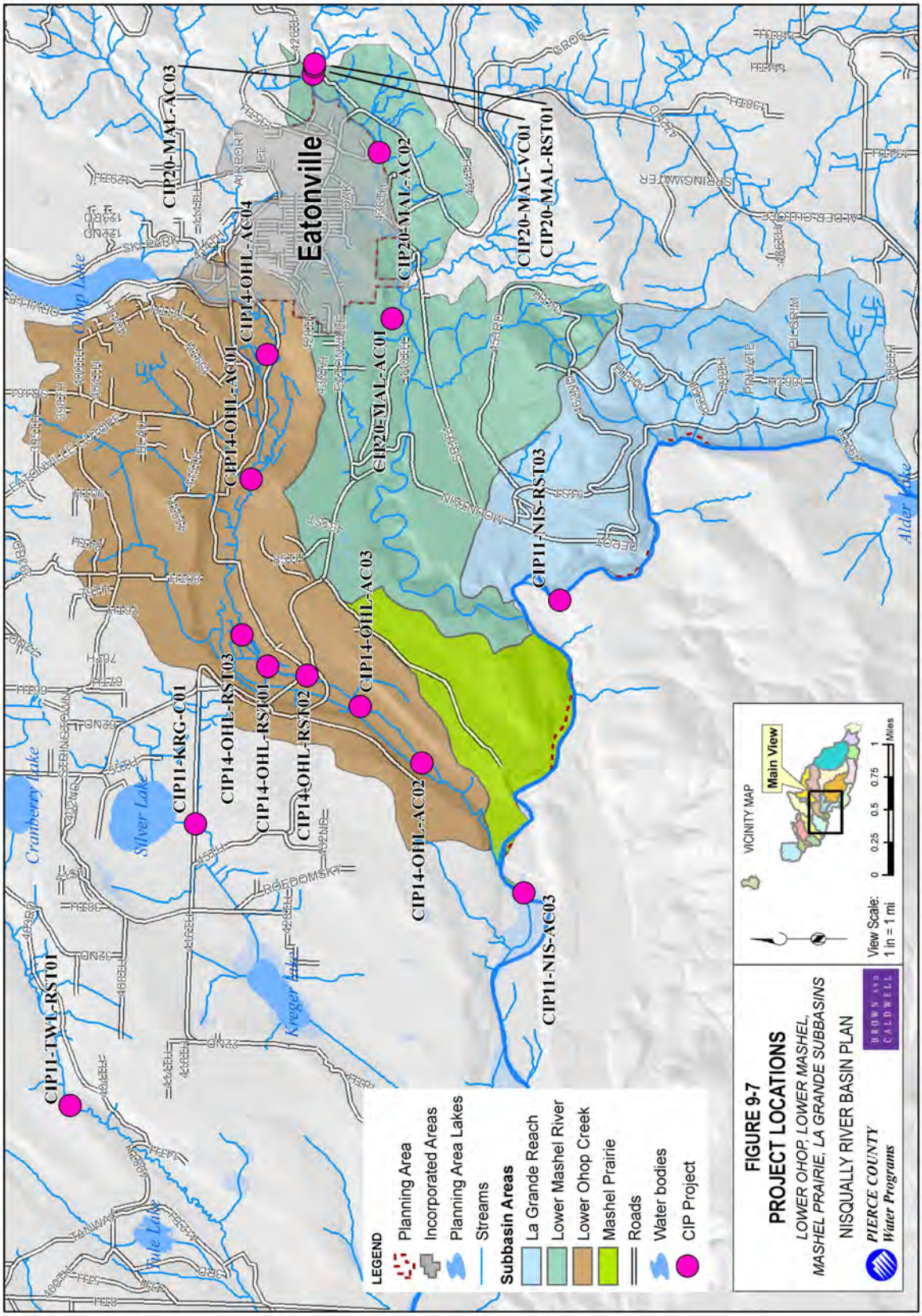
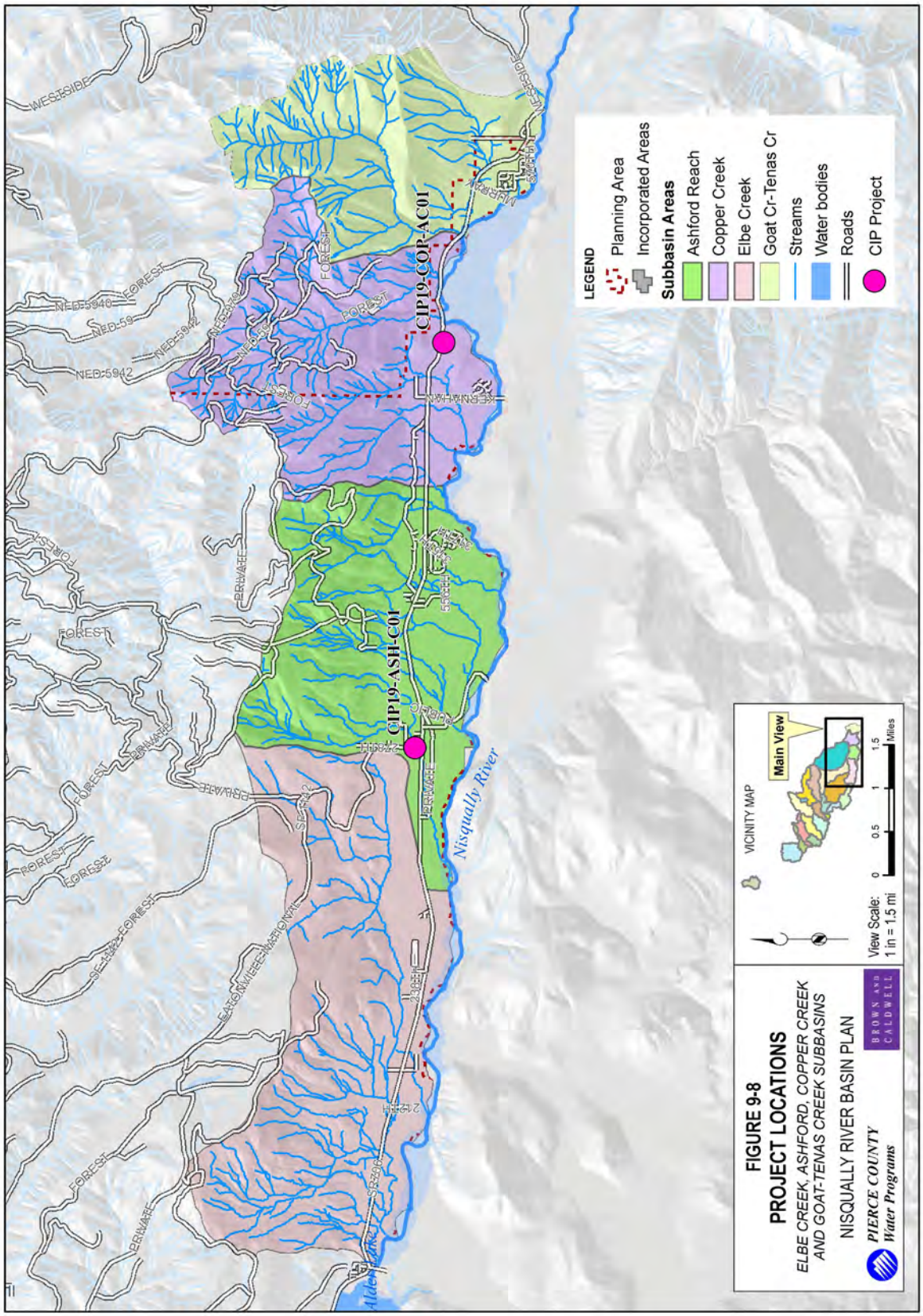


FIGURE 9-6
PROJECT LOCATIONS
UPPER OHOP CREEK AND
LYNCH CREEK SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL
View Scale:
1 in = 1 mi
0 0.25 0.5 0.75 1 Miles
VICINITY MAP
Main View
LEGEND
Planning Area
Incorporated Areas
Roads
Subbasin Areas
Lynch Creek
Upper Ohop Creek
Streams
Water bodies
CIP Project
CIP11-TWU-C03
CIP11-CLR-C01
CIP11-TWL-C01
CIP14-OHU-AC02
CIP14-OHU-AC01
CIP14-OHL-AC01
CIP14-OHL-AC04
CIP20-MAL-AC03
CIP20-MAL-VC01
CIP20-MAL-RST01
CIP20-MAL-AC02
CIP20-MAL-AC01
Eatonville
Clear Lake
Mud Lake
Ohop Lake
Yapjohn Lake
Cranberry Lake
Fairview Lake


Eatonville
CIP20-MAL-AC03
CIP14-OHL-AC04
CIP14-OHL-AC01
CIP20-MAL-AC02
CIP20-MAL-VC01
CIP20-MAL-RST01
CIP20-MAL-AC01
CIP11-NIS-RST03
CIP14-OHL-AC03
CIP14-OHL-RST03
CIP14-OHL-RST01
CIP14-OHL-RST02
CIP11-KRG-C01
CIP14-OHL-AC02
CIP11-NIS-AC03
CIP11-TWL-RST01
Ohop Lake
Cranberry Lake
Silver Lake
Kreger Lake
Alder Lake
LEGEND
Planning Area
Incorporated Areas
Planning Area Lakes
Streams
Subbasin Areas
La Grande Reach
Lower Mashel River
Lower Ohop Creek
Mashel Prairie
Roads
Water bodies
CIP Project
VICINITY MAP
Main View
View Scale: 1 in = 1 mi
0 0.25 0.5 0.75 1 Miles
FIGURE 9-7
PROJECT LOCATIONS
LOWER OHOP, LOWER MASHEL, MASHEL PRAIRIE, LA GRANDE SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY Water Programs
BROWN AND CALDWELL


LEGEND
Planning Area
Incorporated Areas
Subbasin Areas
Ashford Reach
Copper Creek
Elbe Creek
Goat Cr-Tenas Cr
Streams
Water bodies
Roads
CIP Project
CIP19-COP-AC01
CIP19-ASH-C01
Nisqually River
VICINITY MAP
Main View
View Scale:
1 in = 1.5 mi
0
0.5
1
1.5
Miles
FIGURE 9-8
PROJECT LOCATIONS
ELBE CREEK, ASHFORD, COPPER CREEK
AND GOAT-TENAS CREEK SUBBASINS
NISQUALLY RIVER BASIN PLAN
PIERCE COUNTY
Water Programs
BROWN AND CALDWELL

9.1.2 Programmatic Measures

The Basin Plan recommends 21 programmatic measures. The term "programmatic" relates to a plan of action or procedure for addressing a drainage need or problem. Programmatic measures include regulations, policy guidelines, site design standards, operational policies, technical assistance, enforcement, public outreach, and educational programs. Some of the programmatic recommendations are specific to the Nisqually River Basin. Other programmatic activities would be undertaken with countywide applicability, with the basin paying its share of program costs. The Nisqually River Basin contributes approximately 3 % of the revenue from storm drainage and surface water management fees, and it is assumed that this would be its share of the countywide program cost unless an alternative contribution is more appropriate.

The total number of recommended programmatic measures and the number given a high-priority reflect a policy in the Pierce County Comprehensive Plan that advocates use of non-structural solutions to storm drainage problems before committing to hard-engineered solutions. Pierce County Code 19A.30.220.B.2 states, "Nonstructural measures should be preferred over structural measures." Recommended programmatic measures, grouped by priority, are as follows:

High-Priority Programmatic Measures

- PRG00-01: Implement a Low Impact Development Program
- PRG00-02: Update Stormwater Management Manual
- PRG00-03: Increase Inspections for Compliance with Stormwater Requirements and National Pollutant Discharge Elimination System (NPDES) Permit
- PRG00-04: Develop and Implement a Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation
- PRG00-05: Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality
- PRG00-06: Develop and Implement an Education, Outreach, and Technical Assistance Program
- PRG00-08: Develop and Implement a BMP Manual for Pierce County Surface Water Management Maintenance Activities
- PRG00-09: Develop and Implement an Invasive Species Management Program
- PRG00-13: Implement Elements of Shellfish Protection Program
- PRG00-15: Develop and Implement a Lake Water Quality Management Program
- PRG00-16: Develop and Implement Countywide Vegetation Management Program
- PRG11-01(b): Revise Flood Hazard Maps Nisqually River Wilcox Flats Reach
- PRG11-03: Enhance Nisqually River Council Capacity

Medium-Priority Programmatic Measures

- PRG00-07: Develop and Implement a Surface Water Monitoring Program
- PRG00-11: Beaver Management Policy
- PRG00-12: Encourage Installation of Permanent Buffer Markings and/or Signage
- PRG00-14: Develop and Implement a Habitat Monitoring Program
- PRG11-04: Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems
- PRG11-05: Implement Elements of Nisqually River Bacteria TMDL Water Quality Implementation Plan

Low-Priority Programmatic Measures

- PRG00-10: Require Flood Disclosure Statements on Property Titles
- PRG11-02: Nutrient Enhancement using Salmon Carcasses

The estimated cost of implementing the recommended programmatic measures for the Nisqually River Basin over the 10-year implementation period is $5,342,500.

9.1.3 Additional Studies

The Basin Plan recommends 18 basin-specific studies. Study results will provide information needed to address current basin issues that cannot be resolved without additional data collection and analysis. Study results will assist in the next update of the Basin Plan and implementation of recommended projects with an improved understanding of basin characteristics. Recommended studies are as follows:

- ST11-BRI-ST01 - Brighton Creek Barrier Removal Assessment (62nd Ave. S.)
- ST11-HRN-ST01 - Horn Creek Barrier Removal Assessment (368th St. S.)
- ST11-HRT-ST01 - Harts Creek/Harts Lake Habitat Assessment
- ST11-MUR-ST01 - Lower Murray Restoration Assessment
- ST11-MUR-ST02 - Murray, Brighton and Horn Creek Wetlands Restoration Assessment
- ST11-MUR-ST03 - Murray Creek Barrier Removal Assessment (48th Ave. S., RM 6.2)
- ST11-MUR-ST04 - Murray Creek Barrier Removal Assessment (pipeline crossing, RM 7.2)
- ST11-MUR-ST05 - Murray Creek Hydrologic Study and Flood Hazard Mapping
- ST11-TWL-ST01 - Cranberry and Rapjohn Lakes Assessment
- ST11-TWL-ST02 - Lower Tanwax Sediment Reduction Assessment
- ST11-TWU-ST01 - Tanwax Valley Restoration Assessment

- ST11-TWU-ST02 - Eatonville Cutoff Road Culvert Replacement Assessment (Mud Creek)
- ST11-TWU-ST03 - Eatonville Cutoff Road Culvert Replacement Assessment (Tanwax Creek)
- ST11-TWU-ST04 - Trout Creek at 352nd Street East Culvert Replacement Assessment
- ST14-OHU-ST01 - Clay City Sediment Reduction Assessment
- ST19-NIS-ST03 - Analysis of Flooding at State Route 7 in Community of Elbe
- ST20-LMR-ST01 - Lower Mashel Restoration Assessment

The estimated cost of the studies is $1,363,500.

9.1.4 Implementation Strategy

In theory, implementation starts with "High-Priority" projects and activities, then "Medium-Priority," followed by "Low-Priority" projects and activities. In practice, the order of project implementation varies to reflect such factors as availability of funds; availability of staff and professional service resources; links to projects with different priorities; cooperation with private landowners; projects completed by agencies other than Pierce County Public Works and Utilities; and new information, regulations, or public concerns. Additionally implementing "low priority" projects at the same time as implementing "medium" or "high" priority can result in reach-wide, leveraged benefits.

The annual Capital Facilities Element of the Comprehensive Plan for Pierce County, Washington reflects the specific annual strategy for CIPs. Programmatic measures and CIPs also appear in the annual budget for Surface Water Management.

Surface Water Management is the primary implementer for the recommendations contained in this Basin Plan. Funding of the recommendations is mainly through Pierce County's surface water management fees collected within the basin, but may also include state and federal grants and local fund sources. The Nisqually River Basin Plan anticipates full implementation over a 10-year period beginning in 2009. Actual duration of full implementation and the timing of specific projects and programs are determined through annual budget decisions of the County Council and County Executive, first in the yearly update of the Capital Facilities Element of the County Comprehensive Plan, and secondly in the operating budget for Pierce County Surface Water Management.

9.2 PLAN APPROACH TO BASIN NEEDS

9.2.1 Preference for Non-Structural Solutions

The 1991 Pierce County Storm Drainage and Surface Water Management Plan and the Capital Facilities Element of the Comprehensive Plan for Pierce County contain the following policy: "Nonstructural measures should be preferred over structural measures." In keeping with this

policy, the Nisqually River Basin Plan recommends 25 non-structural, or programmatic, measures. Examples include:

- Implement a Low Impact Development Program
- Develop and Implement a Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation
- Develop and Implement a Lake Water Quality Management Program

Section 9.3.3 below describes the recommended programmatic measures.

9.2.2 Mainstem Flooding

Unlike Surface Water Management's other basin plans, the Nisqually River Basin Plan must address large river flooding problems. The Nisqually River mainstem flooding problems are complex and have the potential to cause extensive damage, particularly in the McKenna area; where between 60 and 68 privately owned parcels were flooded in a February 1996 event (personal communication with Dennis Dixon, Pierce County, 2006). Another area of concern in the Nisqually River Park community near the Mount Rainier National Park boundary where County-maintained levees sustained extensive damage during a flood event in November 2006. Channel aggradation due to high sediment loads could affect flood elevations and inundation areas

Based on current County policies, it was determined that capital improvement projects should be implemented to mitigate flooding at the community of McKenna. These policies will soon be under review and could change in the near future. As discussed in Chapter 6, the existing hydrology data, hydraulic modeling, and floodplain mapping for the Nisqually River are outdated and insufficient for accurate evaluation, design, and implementation of sound flood hazard reduction measures. Mainstem flood control measures can be quite costly, and implementing ineffective measures could have serious consequences. Therefore, this Basin Plan includes a programmatic recommendation that prescribes several studies designed to fill the key data gaps and allow Surface Water Management to select the most appropriate and cost-effective measures. The Lower Nisqually River Flood Mitigation Program (PRG11-01) recommends a series of actions including:

- Revise Flood Hazard Mapping – Wilcox Flats Reach of Nisqually River

Cost estimates should be regarded as very preliminary and subject to change based on the outcome of the McKenna area studies listed above.

9.2.3 Economic Development

Pierce County is a government and provider of public facilities and services working toward the economic health of the County and the region. Sound management of storm drainage facilities, flood hazard reduction, and protection of surface water quality makes Pierce County a more desirable place to live and work, acts as an incentive for new businesses to locate here, and

encourages existing businesses to stay and expand. Basin plans lay out the surface water management needs of the basins given existing and planned development. These are the facilities and services needed to support planned levels of growth laid out in the County Comprehensive Plan. Facilities bring predictability to businesses. Public funds build facilities and programs that serve economic growth consistent with adopted land use plans and regulations.

9.2.4 Critical Areas Conservation

As described in Chapters 6 and 8, stormwater drainage, flooding, and loss of aquatic habitat are ongoing surface water management problems in the Nisqually River Basin. These problems can be partially addressed through conservation of critical areas, including preservation of lands that are prone to flooding, riparian corridors, wetlands, and associated buffer areas. The Basin Plan presumes that conservation for general public benefit is best achieved through acquisition—either fee-simple or another legal instrument such as a conservation easement. The purchase prices of both are almost the same.

The Nisqually River Basin Plan recommends property acquisitions for conservation of critical areas or mitigation of adverse effects of urban development in eight different areas of the basin. In addition to preventing or reducing a flood threat, several of these sites would preserve wetlands. Land acquisitions along four rivers/creeks are recommended as part of a series of restoration CIPs (refer to Section 9.3.2).

9.2.5 Public Involvement and Education

A goal of public involvement is to improve public understanding of the various surface water management issues in the Nisqually River Basin, including erosion and sedimentation control, flood hazard reduction, and aquatic habitat restoration and protection. Individual recommendations of this Basin Plan should be incorporated into a comprehensive public education program that informs Nisqually River Basin residents about conditions of the creeks and its watersheds, any planned capital improvement projects, and the actions of individual residents that can contribute to restoration and protection of the surface and ground water resources of the Nisqually River Basin.

A countywide watershed education program would help to educate watershed citizens about the consequences of actions and encourage them to change their habits to protect the creeks and watersheds. Specific activities would be targeted to both young and adult audiences and would be related to existing community programs. The publicly owned parts of creeks lend themselves to citizen involvement in stream and riparian restoration projects and can call attention to watershed activities and events in the Nisqually River Basin.

Programmatic measure PRG00-06 (Develop and Implement an Education, Outreach, and Technical Assistance Program) could include some of the components and recommendations of this Basin Plan and could provide for public involvement and information in the Nisqually River Basin as part of the countywide program.

9.2.6 Compliance with Storm Drainage and Flood Hazard Regulations

Compliance with existing storm drainage and critical areas regulations will help mitigate the adverse effects of future development. For example, alteration of floodplains and wetland areas was identified in Chapter 4 as a problem in the Nisqually River Basin. In addition, existing Washington State, federal, and local regulations provide for water quality, habitat, critical areas, and land use protection. However, compliance with regulations typically requires formal and informal enforcement, inspections, technical assistance, public information, and education.

This Basin Plan reflects Pierce County's commitment to compliance with local regulations related to flooding and water quality management, in addition to the requirements of federal and state regulations such as the federal Clean Water Act and Code of Federal Regulations, state water quality standards, Endangered Species Act, Federal Emergency Management Agency (FEMA) floodplain regulations and Community Rating System (CRS), state Hydraulic Code, Shoreline Management Act, and Growth Management Act. A compliance assurance program, implemented in a fair and consistent manner, would improve natural resource and surface water management within the Nisqually River Basin. Programmatic measure PRG00-03, Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit, is a measure that addresses compliance assurance.

Protection of stream channels from encroachment by uses with adverse effects can also be addressed through compliance with environmental regulations. The County has development regulations intended to protect critical habitat areas (Title 18E, Pierce County Code) and requirements to control erosion and sedimentation during land clearing, grading, construction, and in the long-term. As an NPDES municipal stormwater permit holder, the County is required to have a program that includes the legal authority to investigate drainage problems and inspect development sites to ensure that practices in the County conform to NPDES terms and protect water quality. When administering the regulations is not enough to protect water quality, capital facilities to treat stormwater are required.

Local critical areas rules, NPDES requirements, and other federal and state rules define certain uses and activities that are prohibited within surface waters, streams, and/or their buffers. Use and activity regulations prohibit new development and existing landowners from undertaking new activities that could degrade water quality, increase erosion, cause riparian damage, or lead to flooding. Some examples of prohibited activities include destroying or altering riparian vegetation through clearing, harvesting, cutting, intentional burning, shading, or planting; application of pesticides, fertilizers, and/or other chemicals; constructing, reconstructing, demolishing, or altering the size of any structure; or activities that alter water temperature. Development in channel migration zones (CMZs) is regulated under the Critical Areas Ordinance (see Pierce County Code 18E.70).

9.2.7 Drainage and Flood Hazard Management

Chapter 6 described existing and future drainage and flood hazard problem areas throughout the Nisqually River Basin. The Basin Plan identifies projects and programs that will reduce flood hazards.

The Basin Plan contains a range of approaches to meet the goal of flood hazard reduction. Pierce County participates in the National Flood Insurance Program administered by FEMA. FEMA also offers communities the opportunity to receive additional benefits through the Community Rating System. This program makes subsidized flood insurance available to citizens in communities that voluntarily take actions to reduce flood hazards. A community's rating affects the flood insurance rates its citizens pay. Pierce County has one of the lowest flood insurance rates available. Pierce County was the first county in the nation to achieve a Class 5 rating through implementation of programs that reduced flood risks. In part, due to its basin planning program, Pierce County's rating was raised to a "Class 3" jurisdiction in 2007.

Flood Hazards

Mapping of flood hazard areas should be improved. Over 80 individual flooding and drainage problems were identified in the Nisqually River Basin. Figures 5-2 through 5-12 show the distribution of problems is widespread and occur in all parts of the basin.

According to the current Pierce County Flood Hazard Area maps (see Figure 4-15), approximately 940 acres (4.5 %) of the Nisqually River Basin are located within an unnumbered Flood Zone A, the area that statistically is anticipated to be flooded once every 100 years. Flood Hazard maps also show more than 1,300 acres (approximately 6.3 %) within the Flood Zone B, the area that statistically is flooded once every 500 years (see Figure 4-15).

Unnumbered Zone A and Flood Zone B floodplain designations do not provide sufficient information (in the form of base flood elevations) to ensure appropriate protection. These mapped floodplains do not always reflect the actual topographic and hydrologic conditions in the basin.

Recent 2-foot contour interval mapping shows that the mapped floodplain in many areas does not align with the topography. The hydrologic analysis also showed that peak flow rates were substantially higher than rates used by FEMA to develop the original floodplain maps.

Programmatic Measures for Flood Hazard Reduction

The Basin Plan supports programmatic measures that will reduce flood hazard impacts, with a particular focus on addressing flooding resulting from debris-blocked culverts and ditches. These include:

- Lower Nisqually River Flood Mitigation
- Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit

- Develop and Implement a BMP Manual for Pierce County Surface Water Management Maintenance Activities
- Beaver Management Policy

Studies Benefiting Flood Hazard Reduction

Studies could lead to additional capital improvement projects that reduce flood hazards. The studies recommended include:

- Eatonville Cutoff Road Culvert Replacement Assessment
- Murray Creek Hydrologic Study and Flood Hazard Mapping

In addition, a number of CIP projects have been proposed in the Nisqually River Basin to alleviate localized flooding problems through stormwater facility improvements. Other CIP projects involve the acquisition of ponding or flood-prone areas.

9.2.8 Water Quality

In January 2007, the Washington State Department of Ecology (Ecology) issued Pierce County a Phase I Municipal Stormwater NPDES and State Waste Discharge Permit. The NPDES permit covers stormwater discharges from County-owned drainage systems throughout unincorporated Pierce County. One condition of the permit requires that Pierce County update its stormwater management requirements for new development, redevelopment, and construction sites so that they are equivalent to the requirements in Ecology's 2005 Stormwater Manual for Western Washington.

The new permit also requires that the County regulations allow "Low Impact Development" (LID). These permit conditions are intended to reduce the potential for water quality and stream channel stability problems due to construction and development. Therefore, this Basin Plan includes programmatic measures to update the County stormwater management manual and implement LID.

Ecology has identified several water bodies within the Nisqually River planning area as "polluted" or not meeting state water quality criteria. Many of the lakes in the basin have been identified by Ecology as "waters of concern." Non-point sources, such as livestock pollution and septic systems, are the primary cause of the water quality problems.

To address these problems, the Basin Plan prescribes a number of programmatic measures, including public education, riparian area management, lake management, small farm planning, surface water monitoring, septic system inspection coordination, and support for the Nisqually River Council's non-point source control program.

Ecology recently completed a Water Quality Implementation Plan designed to reduce fecal coliform pollution in Lynch Creek, Ohop Creek, and Red Salmon Creek. Surface Water Management participated in the development of that plan and has committed to assist in its

implementation. This Basin Plan includes a programmatic measure for Surface Water Management' TMDL implementation activities.

9.2.9 Riparian and Aquatic Habitat Protection

Much of the Nisqually River mainstem is still in very good condition, especially compared to most other lowland Puget Sound rivers in urbanizing areas. The mainstem of the river is still a very productive habitat for all species of salmon that are currently found in the Nisqually River. However, there have been some losses of habitat due to declines in channel stability, habitat diversity, food availability, and key habitat features.

Based on 30 years of data collection and analysis, the Nisqually River Tribe identified the Nisqually River mainstem and estuary as its top priority for habitat restoration and preservation. The Nisqually River Tribe, the U.S. Fish & Wildlife Service (USWFS), and Ducks Unlimited have already implemented large restoration projects in the estuary.

The habitat data analysis determined that the two most important tributaries for protection and restoration are the Mashel River and Ohop Creek. Some reaches of these tributaries have been degraded due to channelization, lack of large woody debris, riparian canopy removal, and other factors.

The aquatic habitat problems have multiple causes that will require a range of solutions, from non-structural programmatic actions to structural measures. The solutions were tailored to address the main causes of habitat degradation, as determined through field observations and analysis.

The capital improvement program projects developed to address habitat problems include:

- Wetland, channel migration zone, and floodplain preservation through property acquisition
- Removing fish passage barriers
- Wetland, instream, and riparian habitat restoration
- Revegetation projects

For the Nisqually River mainstem, this Basin Plan recommends CIPs to help restore and protect the portion of the Nisqually River estuary that lies within Pierce County's jurisdiction. This would complement the estuary restoration efforts of USFWS, Ducks Unlimited, and the Nisqually River Tribe.

The Basin Plan also includes CIPs to acquire and protect key habitat areas on the mainstem. In addition, the plan recommends a number of programmatic measures to help control invasive plants and enhance riparian vegetation along the mainstem. The habitat CIP recommended in this Basin Plan would be implemented by a partnership of the Nisqually River Tribe, Surface Water Management and possibly other entities. Surface Water Management share would be intended to meet local match obligations of State and/or Federal grants, estimated at 15 % of the total cost.

On the Mashel River, projects include restoration of mature riparian vegetation; softening, reduction, or removal of bank hardening structures to allow more channel migration; and addition of large wood in the channel. On Ohop Creek, the Nisqually River Tribe, the Pierce Conservation District, the Natural Resources Conservation Service, and the USFWS developed a restoration plan that involves moving the creek channel (which is currently a man-made ditch) to its original floodplain, adding large wood to the newly constructed meandering stream channel, and restoring riparian vegetation and the surrounding connected wetlands.

Most of the identified problems on the smaller tributaries (e.g., Brighton Creek, Murray Creek) involve barriers, poor riparian vegetation, etc. Removing fish passage barriers consists primarily of replacing existing culverts with large embedded or bottomless culverts. Some culverts need further assessment to confirm they are barriers and to collect data to develop replacement projects.

Programmatic solutions can benefit existing aquatic habitat and prevent future degradation. For instance, programs can preserve high quality habitat areas and provide maintenance of areas being restored, while monitoring programs can track water quality, erosion and channel incision, and other measures of the health of natural systems.

9.3 SPECIFIC RECOMMENDATIONS

The CIPs and programmatic measures have been individually ranked according to a common ranking system used by all of the Basin Plans for Pierce County. Each of the potential capital improvement projects and programmatic recommendations were evaluated using approximately 40 specific criteria that assign points for the project/program's potential for various aspects of flood reduction (approximately 35 % of the total score), water quality protection or improvement (30 %), natural resource improvement (30 %), and other factors such as multiple use, education, and recreation (5 %). A ranking sheet for each CIP and programmatic measure is at the end of this chapter.

Recommended projects and programs were put in rank order, based on their numeric benefit score (project score). Then, high, medium, or low status was assigned as follows:

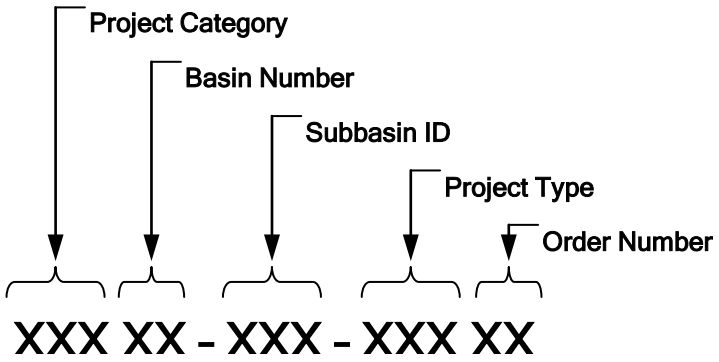
- High-Priority: 25 % of total number of recommendations
- Medium-Priority: 50 % of total number of recommendations
- Low-Priority[12]: 25 % of total number of recommendations

Within each priority category, projects and programs were ranked from lowest cost to highest cost. This directs County financial resources to where they do the most good for the capital invested. Tables 9-2, 9-3, and 9-4 present the recommended capital improvement projects and programmatic measures.

12 Note: "Low-Priority" does not mean "no benefit" for flood control, water quality protection, or natural resource protection. All of the recommendations in the Basin Plan benefit the objectives. "Low-Priority" means that the project rated lower than other needs in the basin. Projects that are ranked "Medium-Priority" or "Low-Priority" may be built before "High-Priority" projects to ensure the optimal benefit from other projects, such as upstream fish habitat improvements synchronized with downstream barrier removal.

9.3.1 Project Identification Codes

Each recommendation has a unique project identification code. Project identification codes use the following general format:



Project Category: This is a two- or three-letter designation as to the type of recommendation, where:

CIP	Capital Improvements Program
PRG	Programmatic
ST	Study

Basin Number: This is a County-designated two-digit number for identifying major divisions of drainage basins. Measures of countywide applicability are 00. Basin numbers for the Nisqually River Basin are as follows:

08	Lower Nisqually River
11	Mid-Nisqually River
18	Ohop Creek
19	Upper Nisqually River
20	Mashel River

Subbasin ID: This is a three-letter abbreviation identifying the reach or subbasin designated within the Basin Plan. This is used only for CIP projects and studies; it is omitted from programmatic recommendations. The abbreviations are defined as follows:

ASH	Ashford Reach	MAL	Lower Mashel River
BRI	Brighton Creek	MUR	Murray Creek
CLR	Clear Lake	NIS	Nisqually River
COP	Copper Creek	OHL	Lower Ohop Creek

HRT	Harts Lake	OHU	Upper Ohop Creek
HRN	Horn Creek	RED	Red Salmon Creek
KRG	Kreger Creek	TWL	Lower Tanwax Creek
LMR	Little Mashel River	TWU	Upper Tanwax Creek

Project Type: This is a one-, two-, or three-letter code indicating the general category of project that best describes the project activities. This is used only for CIP projects and studies; it is omitted from programmatic recommendations. The codes are defined as follows:

AC	Property Acquisition
C	Culvert
CHN	Channelization
FLD	Flood Mitigation
FP	Fish Passage
RST	Restoration
VC	Vegetation Control

9.3.2 Capital Improvement Projects

The Basin Plan contains 36 capital improvement projects to address the flooding, water quality, and aquatic habitat problems in the Nisqually River Basin. This section presents CIP projects sorted by County subbasin.

Each CIP is listed in Table 9-5 along with the project score, estimated cost, and priority ranking. Spreadsheets summarizing the concept-level cost estimates for each project are at the end of this chapter.

TABLE 9-5
Capital Improvement Projects, Scoring, Costs, and Priorities

ID	Project Name	Project Score	Estimated Cost	Priority
CIP08-RED-RST01	Red Salmon Slough Estuary Restoration Phase III	297	$60,270	High
CIP11-BRI-C01	Upper Brighton Creek Culvert Replacements	180	$448,300	Medium
CIP11-BRI-FP01	Brighton Creek Culvert Replacement (Harts Lake Loop Rd.)	121	$788,700	Low
CIP11-CLR-C01	West Clear Lake Road Culvert	69	$108,100	Low
CIP11-HRN-C01	364th Street East Culvert Replacement	76	$443,100	Low
CIP11-HRN-FP01	Horn Creek Barrier Removal (waterfall at RM1.0)	114	$126,100	Low
CIP11-HRN-FP02	Horn Creek Barrier Removal (Hart Lake Loop Rd.)	136	$282,500	Low
CIP11-HRT-C01	Hart's Lake Loop Road Culvert Replacement	139	$288,300	Low
CIP11-KRG-C01	Silver Lake Culvert Replacement	151	$217,600	Medium
CIP11-KRG-C02	Dean Kreger Road Culvert Replacement and Slope Stabilization	128	$285,900	Low
CIP11-MUR-C01	Tisch Road South Culvert Replacement	60	$230,700	Low
CIP11-NIS-AC02 (renumbered to AC01)	Nisqually River Mainstem Acquisition Phase 2	195	$1,060,800	Medium
NIS				
CIP11-NIS-AC04	Wilcox Flats Repetitive Loss Acquisition	198	$222,300	Medium
CIP11-NIS-RST01	Nisqually River Wilcox Side-Channel	148	$302,300	Medium
CIP11-NIS-RST02	Wilcox Flats Off-Channel Restoration	142	$384,500	Low
CIP11-NIS-RST03	Mainstem Off-Channel Restoration	148	$747,200	Medium
CIP11-TWL-C01	Culvert Replacement at 365th Street East	76	$180,100	Low
CIP11-TWL-RST01	Lower Tanwax Riparian Enhancement	145	$738,600	Low
CIP11-TWU-AC01	Tanwax Creek Wetland Protection Phase 1	251	$811,200	High
CIP11-TWU-AC02	Tanwax Creek Wetland Protection Phase 2	251	$811,200	High
CIP11-TWU-C01	Benbow Drive Culvert Replacement	143	$198,600	Low
CIP11-TWU-C02	Webster Road Culvert Replacement	102	$136,600	Low
CIP11-TWU-C03	Culvert Replacement at Thomas Road	82	$196,800	Low
CIP14-OHL-AC01	Ohop Creek Property Acquisition Phase 1	241	$617,800	Medium
CIP14-OHL-AC02	Ohop Creek Property Acquisition Phase 2	174	$618,900	Medium
CIP14-OHL-AC03	Ohop Creek Property Acquisition Phase 3	174	$618,900	Medium
CIP14-OHL-AC04	Ohop Creek Repetitive Loss Property Acquisition	195	$606,800	Medium
CIP14-OHL-RST01	Lower Ohop Valley Restoration Phase 1 (Segments D, E, and F)	242	$404,595	Medium
CIP14-OHL-RST02	Lower Ohop Valley Restoration Phase 2 (Segments A, B, and C)	242	$606,600	Medium
CIP14-OHL-RST03	Lower Ohop Valley Restoration Phase 3 (Segments G, H, I, J, K, and L)	242	$799,600	Medium
CIP14-OHU-AC01	Upper Ohop Shoreline Protection (Hancock-Ohop) Phase 1	177	$572,100	Medium

TABLE 9-5
Capital Improvement Projects, Scoring, Costs, and Priorities

ID	Project Name	Project Score	Estimated Cost	Priority
CIP14-OHU-AC02	Upper Ohop Shoreline Protection (Hancock-Ohop) Phase 2	177	$572,100	Medium
CIP19-ASH-C01	Culvert Replacement at 278th Avenue East	147	$288,100	Medium
CIP19-COP-AC01	Upper Nisqually River Property Acquisition	213	$748,300	Medium
CIP20-MAL-AC01	Mashel River Property Acquisition	161	$663,000	Medium
CIP20-MAL-AC02	Mashel Shoreline Buffer Acquisition	171	$848,700	Medium
CIP20-MAL-AC03	Mashel Small Properties Acquisition	174	$617,800	Medium
CIP20-MAL-RST01	Mashel Eatonville Reach Instream Restoration Phase II	242	$149,215	Medium
CIP20-MAL-VC01	Mashel Eatonville Reach Riparian Revegetation	221	$226,800	Medium
		Total Estimated Cost:	**$17,411,280**	

Capital Improvement Project Descriptions

Lower Nisqually River – County Basin No. 08

Project Number: CIP08-RED-RST01

Project Name: Red Salmon Slough Estuary Restoration Phase III

Cost Estimate: $60,270 (County share)

Project Score: 297

Problem: An old defunct bridge and long bridge approach/access dike cut off the entrance to Red Salmon Slough of the Nisqually River Estuary and therefore hinder tidal exchange in the slough. The more than 4,000-foot-long dike also prevents a surface water connection between the slough and the river except for flooding events or the rare ultra-high tides. This isolation has led to degraded habitat on both sides of the dike, eroding salt marshes, and reductions in nutrient and sediment exchange. It also is hindering the recovery of recently restored salt marsh areas inside the slough and restricts access to emigrating juvenile salmonids.

Solution: Remove the last remaining dikes on Nisqually River Tribe's estuary property. The total project cost is estimated at $401,800, of which $70,000 is currently funded and $331,800 is needed. This project would be a partnership of the Nisqually River Tribe, Surface Water Management and possibly other entities. Surface Water Management share would be intended to meet local match obligations of State and/or Federal grants, estimated at 15 % of the total cost, or $60,270.

Benefit: This project allows proper tidal inundation of the non-salt marsh areas and improves habitat for the *Nisqually River1-Estuary* EDT reach (problem NIS-02). This project would also

provide improved habitat for a variety of aquatic wildlife species.

Mid-Nisqually River – County Basin No. 11

Project Number: CIP11-BRI-C01

Project Name: Upper Brighton Creek Culvert Replacements

Cost Estimate: $448,300

Project Score: 180

Problem: A large depression in the vicinity of 4th Avenue East, 336th Street East, and Kinsman Road becomes inundated for long periods during the wet season. Various flooding-related problems have been reported in the area, including:

1. New culvert installed at Kinsman Road exacerbated downstream flooding (BRI-21).
2. Flooding of private property after new culvert installed at Kinsman Road (BRI-19).
3. Flooding over the roadway at 4th Avenue East, flooding of private property (BRI-18).
4. Flooding over the roadway at corner of 336th Street East and 4th Avenue East (BRI-17).
5. Saturated ground has degraded conditions for livestock (discussions with residents).

An analysis of the drainage system found that the Kinsman Road culvert (upstream of the depression) is adequately sized to pass the 100-year flow rate without overtopping Kinsman Road. A group of four culverts under 341st Street East (private road upstream of the depression) is not adequately sized to convey the 25-year flow rate. The culvert at 8th Avenue East (private road downstream of the depression) also does not have adequate capacity to convey the 25-year flow rate without overtopping the road.

The culvert at 336th Street East drains a small area that does not flow into the depression, and is adequately sized to convey the 25-year discharge. Site visits on two different occasions found that 336th Street East had been raised, presumably due to problems with water on the roadway.

Solution: The Kinsman Road culvert should remain in place because it is adequately sized. The four culverts under 341st Street East (two 18-inch CMP and two 24-inch CMP) should be replaced with a 10-foot by 3-foot concrete box culvert. The culvert under 8th Avenue East should be replaced with a 9-foot by 6-foot concrete box culvert.

The culvert at 336th Street East should remain in place, but the downstream drainage should be cleaned out and checked for beaver dams.

The following pre-design studies should be completed prior to implementation:

- A survey of the stream channel and culvert invert elevations to verify proper drainage.
- A hydrologic analysis to evaluate downstream flooding effects.
- A wetlands evaluation to determine if any habitat mitigation would be required.

Benefit: The project will prevent roadway flooding and improve upstream drainage, including

the depression (problems BRI-18, BRI-19, and BRI-21). The improved drainage will not only reduce flooding of private property, but also allow landowners to keep livestock out of the waterway.

Project Number: CIP11-BRI-FP01

Project Name: Brighton Creek Culvert Replacement (Harts Lake Loop Rd.)

Cost Estimate: $788,700

Project Score: 121

Problem: A culvert on Harts Lake Loop Road located near river mile (RM) 0.5 is a total barrier due to its elevation above the channel bottom.

Solution: Replace the existing 36-inch culvert with a 23-foot-wide bottomless aluminum arch culvert installed with its invert in the channel bottom.

Benefit: Allows fish passage and natural flows. This project improves habitat for *Brighton Creek* (problem BRI-02).

Project Number: CIP11-CLR-C01

Project Name: West Clear Lake Road Culvert Installation

Cost Estimate: $108,100

Project Score: 69

Problem: A residential questionnaire reported water from State Route 161 drains down West Clear Lake Road East and causes flooding of private property. Field observations confirmed that runoff flows over West Clear Lake Road and onto the driveway of a private residence, flowing toward the house. It is not clear where the runoff is draining from, but examination of available topographic data (5-foot contours from the County's GIS data library) indicated that a small area (< 0.5 acres) of State Route 161 and West Clear Lake Road potentially drain toward the problem site. The peak 100-year flow rate for this drainage area was estimated to be approximately 1.5 cfs. The County's drainage database shows a ditch along West Clear Lake Road, but the ditch appears to be overgrown and may have accumulated sediment.

Solution: Maintenance of the existing drainage ditch along the west side of West Clear Lake Road is proposed to improve conveyance. In addition, 35 lineal feet of trench drain should be installed in front of the problem site to intercept surface flows. The trench drain will be connected to the existing County drainage ditch with 25 lineal feet of 6-inch diameter pipe.

The drainage ditches along the west side of State Route 161 should also be checked for sediment and debris. This solution is based on field observations and existing information (e.g. 5-ft contours), therefore, a survey should be conducted prior to detailed design to confirm the assumed area contributing to the flooding problem and viability (i.e. adequate grade) for connecting a pipe from the trench drain to drainage ditch.

Benefit: This project controls stormwater and prevents flooding of a residential structure (problem CLR-01).

Project Number: CIP11-HRN-C01

Project Name: 364th Street East Culvert Replacement

Cost Estimate: $443,100

Project Score: 76

Problem: This problem area is relatively flat, but is surrounded by a large, steep drainage basin. There is a 12-inch concrete culvert under 8th Ave South and another 12-inch concrete culvert under 364th Street East. To the east of this intersection, there is a culvert under a private driveway. Hydraulic analyses show that the ditches along 364th Street, west of the culverts are slightly undersized. The hydraulic analyses also showed that all three 12-inch culverts in the area do not have sufficient capacity to convey the runoff from the 25-year design event.

Solution: The 12-inch culvert at the intersection of 364th Street East should be replaced with an 11-foot wide by 3-foot high, 3-sided concrete box culvert to convey the 100-year flow. The 12-inch culvert at 8th Ave South should be replaced with a 3-foot wide by 2-foot high concrete box culvert to pass the 100-year flow rate. The culvert to the east of the intersection also requires a 3-foot wide by 2-foot high concrete box culvert in order to pass the 100-year event; however, the purpose of this culvert is unclear because there is no road or driveway at that location. The area downstream of the culvert under 364th Street should be cleared. Box culverts are proposed due to limited ground cover. This solution is based on field observations and existing information (e.g. 5-ft contours), therefore, a survey should be conducted prior to detailed design to confirm the assumed channel and culvert geometry (e.g. bed slope, culvert invert elevations, channel depth, and roadway elevations).

Benefit: This project alleviates roadway flooding and addresses problem HRN-09.

Project Number: CIP11-HRN-FP01

Project Name: Horn Creek Barrier Removal (waterfall at RM 1.0)

Cost Estimate: $126,100

Project Score: 114

Problem: A man-made waterfall at RM 1.0 severely limits upstream migration of salmon.

Solution: Bypass man-made waterfall with rock weir along east side of the channel.

Benefit: Allows for fish passage. This project improves habitat for the *Horn Cr-2_a* EDT reach (problem HRN-04).

Project Number: CIP11-HRN-FP02

Project Name: Horn Creek Barrier Removal (Harts Lake Loop Road)

Cost Estimate: $282,500

Project Score: 136

Problem: A culvert located at RM 1.2 at Harts Lake Loop Road is only 33 % passable due to a velocity barrier. Roadway flooding was also reported at this crossing, and a hydraulic analysis confirmed that the culvert did not have sufficient capacity to convey the 100-year discharge.

Solution: Remove the existing 48-inch concrete pipe culvert and replace with a 19-foot-wide bottomless aluminum arch culvert. Downstream barrier (CIP11-HRN-FP01) should be improved first.

Benefit: Allows for fish passage. This project improves habitat for the *Horn Cr-2_a* EDT reach (problem HRN-04).

Project Number: CIP11-HRT-C01

Project Name: Hart's Lake Loop Road Culvert Replacement

Cost Estimate: $288,300

Project Score: 139

Problem: Roadway flooding was reported on Harts Lake Loop Road at an unnamed tributary just north of Hart's Lake. The analysis shows that the existing 24-inch concrete culvert is undersized. During a site visit on May 16, 2007, it was noted that vegetation at the inlet and outlet of the culvert was very overgrown and could be contributing to the flooding problem.

Solution: The 100-year flow rate was used for design in accordance with WDFW fish passage requirements. A hydraulic analysis showed that an 11-foot wide by 6-foot high, 3-sided concrete box culvert would provide adequate conveyance capacity to pass the 100-year discharge while providing for fish passage. The distance from the top of the road to the ditch invert is approximately 5 feet; a 6-foot high box culvert which is countersunk will fit with less than 2 feet of cover. The inlet and outlet should be cleared of excessive vegetation. This solution is based on field observations and existing information (e.g. 5-ft contours), therefore, a survey should be conducted prior to detailed design to confirm the assumed channel and culvert geometry (e.g. bed slope, culvert invert elevations, channel depth, and roadway elevations).

Benefit: This project alleviates roadway flooding and addresses problem HRT-10.

Project Number: CIP11-KRG-C01

Project Name: Silver Lake Culvert Replacement

Cost Estimate: $217,600

Project Score: 151

Problem: The property just south of Silver Lake has historically flooded between Silver Lake and 416th Street East. Hydraulic analyses indicate that the two 54-inch culverts under 416th Street East have sufficient capacity to convey the 100-year flow rate. However, there is a 48-inch CMP culvert under a private road approximately 200 feet downstream of the 416th Street culverts that does not have adequate capacity to pass the flow. Backwater from this culvert causes upstream flooding.

Solution: The hydraulic analysis showed that a 10-foot by 6-foot concrete box culvert would convey the 100-year flood event flow without causing backwater at the inlet. This project will require coordination with the property owner before implementation. This solution is based on field observations and existing information (e.g. 5-ft contours), therefore, a survey should be conducted prior to detailed design to confirm the assumed channel and culvert geometry (e.g. bed slope, culvert invert elevations, channel depth, and roadway elevations).

Benefit: This project mitigates private property flooding south of Silver Lake and addresses flooding problem KRG-09.

Project Number: CIP11-KRG-C02

Project Name: Dean Kreger Road Culvert Replacement and Slope Stabilization

Cost Estimate: $285,900

Project Score: 128

Problem: This problem is located in a relatively steep area near Dean Kreger Road where runoff has created an eroded slope and an incised channel through private property. The problem area contains four culverts. Two of the culverts are under Dean Kreger Road and the other two are under a private driveway. The culverts under Dean Kreger Road are both 12” diameter concrete pipes. One of the culverts under the driveway is 24” in diameter and the other is 10” in diameter. The erosion problem is in the channels between Dean Kreger Road and the driveway, which is about 80 feet long with a slope of nearly 20%. The incision has lead to drops of 8 and 10 feet from the two culverts under Dean Kreger Road to the channels. Runoff is ultimately conveyed to a wetland area about 200 feet downstream from the culverts under the private driveway.

Recommendation: A pre-design study is recommended to further evaluate the hydrology and downstream wetland to ensure all recommendations are adequate to prevent future problems. Preliminary analysis indicates that the two culverts under Dean Kreger Road should be replaced with a 24” CMP culvert (southern crossing) and 18” CMP culvert (northern crossing) to convey the 100-year flow. The culverts sizes are based on the 100-yr discharge and not fish passage, because the existing data suggest the channels below the culverts do not provide fish habitat. The two existing culverts under the driveway appear to be adequately sized and therefore do not need to be replaced.

The channels that convey water from Dean Kreger Road to the wetland should be sized to a

bottom width of 2-ft, side slope of 2:1, and a height of 1.5-ft. This channel would provide 1-ft of freeboard during the 100-yr event. The channels should be armored or grade control structures (e.g., check dams) should be installed to reduce channel erosion. Armoring has been assumed for the planning-level cost estimate listed above. The eroded slopes downstream of Dean Kreger Road should be regraded and stabilized. Energy dissipaters should be installed at the discharge points for the channels to prevent erosion from occurring in the wetland.

Benefit: This project will stabilize the eroded slope downstream of Dean Kreger Road and mitigate roadway flooding.

Project Number: CIP11-MUR-C01

Project Name: Tisch Road South Culvert Replacement

Cost Estimate: $230,700

Project Score: 60

Problem: Roadway flooding was reported along Tisch Road South near 324th Street South. A drainage ditch flows from south to north along Tisch Road South and then crosses under Tisch Road through a 12-inch CMP culvert. Roadway flooding was observed on the upstream side of the culvert and in the upstream ditch along the road. During a site visit on May 16, 2007, it was noted that the channels are overgrown with vegetation.

The hydraulic analysis shows roadway overtopping of the 12-inch CMP culvert near 324th Street South for the 25-year flow rate. Analyses show that the two ditches conveying water to this culvert have sufficient capacity.

Solution: The analyses show that a 3-sided, 10-foot wide by 3-foot high concrete box culvert would convey the 100-year design event. The proposed culvert also provides fish passage per WDFW's "Stream Simulation" design methodology. The box culvert is used to account for limited cover. This solution is based on field observations and existing information (e.g. 5-ft contours), therefore, a survey should be conducted prior to detailed design to confirm the assumed channel and culvert geometry (e.g. bed slope, culvert invert elevations, channel depth, and roadway elevations).

Benefit: This project alleviates roadway flooding and addresses problem MUR-18.

Project Number: CIP11-NIS-AC02,03 (Renumbered as CIP11-NIS-AC01, 02)

Project Name: Nisqually River Mainstem Acquisition Phase 2,3

Cost Estimate: $1,060,800

Project Score: 195

Problem: Lands important to salmon habitat include areas near the Nisqually River Mainstem. Unauthorized removal of large trees in a riparian corridor renders restoration extremely difficult.

Solution: Purchase approximately 100 acres along the Nisqually River Mainstem to preserve riparian function and channel migration zones. Acquire parcels to block with other parcels already in protected status. The focus of the protection is in the McKenna and Wilcox Farm areas. The project was divided up into phases for budgetary purposes; however, phases can be combined or completed independently. Properties identified for acquisition should be prioritized with the highest priority properties included in the earliest phases.

Benefit: Acquisition of high quality habitat or areas that are a priority for restoration is a primary strategy for long-term benefit to aquatic habitat. This project preserves riparian function and channel migration zones near the Nisqually River Mainstem. This project improves habitat for various Nisqually River EDT reaches (problems NIS-01,02,04,05,06,07,08,09,10,12,13,15,17,18,19,20,21,22, and 23.) This project also reduces flooding problems due to potential removal of residences and the flow regulating effect of mature riparian forests.

Project Number: CIP11-NIS-AC04

Project Name: Wilcox Flats Repetitive Loss Property Acquisition

Cost Estimate: $222,300

Project Score: 198

Problem: The Wilcox Flats area has been identified as a repetitive loss area. FEMA has identified a repetitive loss property near the end of 41st Avenue South. The property owner filed insurance claims in 1980, 1982, 1990, 1991, 1994, 1995, and 1996. According to the property owner, the floodwaters do not flow directly onto the property from the Nisqually River, but originate from an unnamed creek east of the property. The source of the unnamed creek is unknown, but it is ephemeral. The creek may be a historical channel of the Nisqually River that currently drains a local drainage and may serve as an overflow channel during high river flows. It is estimated that there are approximately seven additional properties within this area subject to similar repetitive flooding as the identified property.

Solution: The Pierce County Repetitive Loss Plan (2001) recommended land acquisition as the preferred solution. Although previous attempts to purchase the property have failed due to lack of interest from the property owner, it is recommended that another attempt be

made to acquire the property in case conditions have changed.

Acquire available properties identified as a repetitive loss property or properties within the repetitive loss area that could potentially sustain future flood damages.

Benefit: This project mitigates flooding in the area of Wilcox Flats and addresses problem NIS-16.

Project Number: CIP11-NIS-RST01

Project Name: Nisqually River Wilcox Side-Channel

Cost Estimate: $302,300

Project Score: 148

Problem: Due to floodplain restrictions by large channel-redirecting riprap levees, there is a lack of side-channels and off-channel wetlands. These levees ensure that the river maintains its course and flows over the Centralia Diversion Dam on the west side of the valley. In addition, the dam blocks some upstream salmon migration, especially chum salmon. Annual flooding also breaks through a weak dike along a connected oxbow channel and bypasses the dam by flowing into lower Horn Creek.

Solution: The project would create an artificial year-round side channel of the Nisqually River that would bypass the Centralia Diversion Dam and increase the off-channel rearing and spawning habitat on Wilcox Farms.

Benefit: This would provide access for juvenile fish to additional off-channel wetlands. It would also provide an alternative route for migrating adult salmon past the Centralia Dam. This would also relieve some flooding pressure at this vulnerable location. This project improves habitat for the *Nisqually River4.2-McKenna* and *Nisqually River5.1-Wilcox* EDT reaches (problems NIS-13 and NIS-15).

Project Number: CIP11-NIS-RST02

Project Name: Wilcox Flats Off-Channel Restoration

Cost Estimate: $384,500

Project Score: 142

Problem: The Nisqually River Land Trust owns several dozen vacation lots abandoned after the floods of 1996/97. Various alterations had been made to the lots before they were transferred to the Land Trust. The alterations include, but are not limited to, forest clearing, road building, and introduction of invasive plants. The alterations have limited benefits that the riparian and floodplain forest can provide to salmonids and other aquatic wildlife.

Solution: Restore Wilcox Flats between RM 28 and 29.5 through revegetation projects. Sub-projects would include riparian enhancement along 3/4 mile of mainstem, at least 1/2 mile of side channels, and all areas within the river's channel migration zone. The revegetation in

these areas will cover 170 acres.

Benefit: Restoration of Wilcox Flats. This project would improve habitat for the Nisqually River 5.1-Wilcox, Nisqually River 5.2-Wilcox, and Nisqually River 5.3-Wilcox EDT reaches (problems NIS-15, NIS-17, and NIS-18).

Project Number: CIP11-NIS-RST03

Project Name: Mainstem Off-Channel Restoration

Cost Estimate: $747,200

Project Score: 148

Problem: An off-channel habitat assessment completed by the South Puget Sound Salmon Enhancement Group and the Nisqually River Tribe in 2004 evaluated the presence and condition of off-channel habitat throughout the Nisqually River mainstem. Off-channel habitat modifications have led to a reduction in habitat diversity. These changes and simplification of the channel, along with the lack of large wood in the river, have a negative effect on fry, juvenile, and prespawners because there are fewer places for fish to find refuge from high flows. The report identified high priority sites for restoration of off-channel habitat.

Solution: Existing off-channel habitat should be incorporated into the active river ecosystem as much as possible. The order of priority for restoration actions at these sites should be: 1) restoring the channel migration zone (i.e., removing impediments to allow the river to maintain the sites), 2) restoring fish access to the site, and 3) restoring native vegetation surrounding the off-channel habitat areas. Also, there is a need for additional landowner outreach, identifying new willing landowners and then designing and implementing key projects.

Benefit: This project will provide more places for fish to find refuge from high flows, allowing juveniles to survive in this region of the river. This project improves habitat for various Nisqually River EDT reaches (problems NIS-01, 02, 04, 05, 06, 07, 08, 09, 10, 12, 13, 15, 17, 18, 19, 20, 21, 22, and 23). These wetlands are also important habitats for other aquatic and avian wildlife such as amphibians and migratory waterfowl.

Project Number: CIP11-TWL-C01

Project Name: Culvert Replacement at 365th Street East

Cost Estimate: $180,100

Project Score: 76

Problem: Flooding over the roadway was reported at 365th Street East near Weyerhaeuser Elementary School. A drainage ditch flowing from north to south drains an area of approximately 315 acres of mixed forest, pasture, and rural residential land use. The culvert appears to have some damage at the inlet.

The drainage basin was delineated in GIS using 5-foot contour data. Land use was estimated using aerial photography and tax parcel information. Discharges were calculated using WWHM3 for the 2-, 5-, 10-, 25-, and 100-year storm events. The 25-year flow rate was calculated to be 25 cfs. The existing 18-inch concrete culvert does not have adequate capacity to convey the 25-year flow.

Solution: Replace the existing 18-inch culvert with a 3-sided concrete box culvert, 7-foot wide by 4-foot high, to convey the 100-year flow rate and provide the necessary geometry for fish passage. The top of the box culvert is assumed to be set at the elevation of the existing roadway with no cover to address depth and cover limitations. This solution is based on field observations and existing information (e.g. 5-ft contours), therefore, a survey should be conducted prior to detailed design to confirm the assumed channel and culvert geometry (e.g. bed slope, culvert invert elevations, channel depth, and roadway elevations).

Benefit: This project alleviates roadway flooding and addresses problem TWL-06.

Project Number: CIP11-TWL-RST01

Project Name: Lower Tanwax Riparian Enhancement

Cost Estimate: $738,600

Project Score: 145

Problem: The lower Tanwax Creek flows for 4.5 miles through a 98-acre riparian wetland that has been cleared and now consists of small shrubs and large amounts of reed canary grass. The reduced amount of large wood in the creek and the loss of streamside and overhanging vegetation have had numerous impacts. The lack of riparian vegetation available to provide shade has likely led to higher peak summer water temperatures throughout the subbasin, reducing the productivity of juvenile coho and steelhead that rear in the creek. The loss of streamside vegetation is also associated with reduced nutrient input to the creek, opportunities for fish concealment, and shade to prevent the growth of non-native reed canary grass.

Solution: Streamside vegetation plantings in selected reed canary grass dominated areas.

Benefit: This project will lower the peak summer water temperatures throughout the subbasin, help increase the nutrient input into the creek, and reduce the growth of non-native reed canary grass. This project improves habitat for the *Tanwax Cr-1* and *Tanwax Cr-2* EDT reaches (problems TWL-01 and TWL-02).

Project Number: CIP11-TWU-AC01

Project Name: Tanwax Creek Wetland Protection Phase 1

Cost Estimate: $811,200

Project Score: 251

Problem: Many of the small lowland streams that are tributaries of Tanwax Creek have intermittent flow problems and probably elevated stream temperatures due to the lack of a forest canopy. These tributaries provide limited habitat capacity to anadromous salmonids due to their small size, intermittent flows, and inaccessibility. Habitat alterations similar to those in the mainstem have taken place in most of these tributaries. Lack of wood and riparian vegetation, and substantial fine sediment inputs, also limit the function of this habitat. The over-wintering refuge and migration pathway potential give these tributaries unique importance, especially for coho, steelhead, and cutthroat.

Solution: Identify and protect key wetlands that maintain flow in Tanwax Creek. This project is Phase 1 of a two continual phases. The project was divided up into phases for budgetary purposes; however, phases can be combined or completed independently. Properties identified for acquisition should be prioritized with the highest priority properties included in the earliest phases.

Benefit: Acquisition of high quality habitat or areas that are a priority for restoration is a primary strategy for long-term benefit to aquatic habitat. This project will protect over-wintering refuges and migration pathways that are used by coho, steelhead, and cutthroat. These wetlands are also important habitats for other aquatic and avian wildlife such as amphibians and migratory waterfowl. This project improves habitat for the *Tanwax Cr-1* and *Tanwax Cr-2, Tanwax Cr-3_a, Tanwax Cr-3_b, Tanwax Lake, and Upper Tributaries* EDT reaches (problems TWL-01, TWL-02, TWU-06, TWU-22, and TWU-29).

Project Number: CIP11-TWU-AC02

Project Name: Tanwax Creek Wetland Protection Phase 2

Cost Estimate: $811,200

Project Score: 251

Problem: Many of the small lowland streams that are tributaries of Tanwax Creek have intermittent flow problems and probably elevated stream temperatures due to the lack of a forest canopy. These tributaries provide limited habitat capacity to anadromous salmonids due to their small size, intermittent flows, and inaccessibility. Habitat alterations similar to those in the mainstem have taken place in most of these tributaries. Lack of wood and riparian vegetation, and substantial fine sediment inputs, also limit the function of this habitat. The over-wintering refuge and migration pathway potential give these tributaries unique importance, especially for coho, steelhead, and cutthroat.

Solution: Identify and protect key wetlands that maintain flow in Tanwax Creek. This project is Phase 2 of a two continual phases. The project was divided up into phases for budgetary purposes; however, phases can be combined or completed independently. Properties identified for acquisition should be prioritized with the highest priority properties included in the earliest phases.

Benefit: Acquisition of high quality habitat or areas that are a priority for restoration is a primary strategy for long-term benefit to aquatic habitat. This project will protect over-wintering refuges and migration pathways that are used by coho, steelhead, and cutthroat. These wetlands are also important habitats for other aquatic and avian wildlife such as amphibians and migratory waterfowl. This project improves habitat for the *Tanwax Cr-1* and *Tanwax Cr-2, Tanwax Cr-3_a, Tanwax Cr-3_b, Tanwax Lake, and Upper Tributaries* EDT reaches (problems TWL-01, TWL-02, TWU-06, TWU-22, and TWU-29).

Project Number: CIP11-TWU-C01

Project Name: Benbow Drive Culvert Replacement

Cost Estimate: $198,600

Project Score: 143

Problem: Benbow Drive East is located between Twin Lakes and Whitman Lake, and crosses the low area where overflow from the Twin Lakes drains into Whitman Lake. Field observations noted debris at the culvert inlet and signs of roadway overtopping. The existing crossing consists of two 24-inch concrete culverts with a debris cage surrounding both inlets. During a site visit on May 16, 2007, it was noted that the debris cage had collected a considerable amount of debris, and that is could be restricting flow into the culverts. Also, the downstream ends of the culverts were completely submerged.

A hydrologic analysis was completed to verify sufficient capacity of the roadway culverts. The area draining to the culverts was estimated to be about 235 acres of mixed forest and agricultural land use. The 100-year flow rate was estimated to be 69 cfs. Hydraulic calculations found that the existing parallel 24-inch culverts are not adequately sized to convey the 100-year flow rate without overtopping the road.

Solution: The hydraulic analyses indicated a 3-sided concrete box culvert, 9-foot wide by 5-foot high would convey the 100-year flood event flow with no overtopping. Road raising is avoided by placing the top of the box culvert, which is designed for H-20 loading, at the roadway grade with no cover. The box culvert also provides fish passage per the WDFW “No Slope” requirements. The debris barrier should be reinstalled and cleared with routine maintenance. Alternatively, a debris barrier or trash rack requiring less maintenance could be installed. This solution is based on field observations and existing information (e.g. 5-ft contours), therefore, a survey should be conducted prior to detailed design to confirm the assumed channel and culvert geometry (e.g. bed slope, culvert invert elevations, channel depth, and roadway elevations).

Benefit: This project mitigates roadway at Benbow Drive and private property flooding at Twin Lakes and addresses flooding problems TWU-34 and TWU-35.

Project Number: CIP11-TWU-C02

Project Name: Webster Road Culvert Repair

Cost Estimate: $136,600

Project Score: 102

Problem: Roadway flooding was reported at Webster Road near the intersection with State Route 161. Field observations noted that the culvert under Webster Road, approximately 1,200 feet northwest of State Route 161, is damaged at the inlet. The 18-inch CMP culvert is bent at the inlet in a way that is an obvious hindrance to conveyance.

It was noted during a site visit that the cover over the culvert does not meet the minimum 2-foot requirement. The culvert also had rusted along the bottom, which may indicate standing water for a long period of time. Local residents suggested that there are beavers in the area and that they may have contributed to backups.

Preliminary analysis, using field measured dimensions of the two road-side ditches flowing to the culvert indicates that the channels are properly sized. It was noted during a site visit on August 21, 2007, that just east of the culvert under Webster Road East is a driveway culvert that is blocked by overgrown vegetation in the surrounding channels.

Solution: Since the culvert is damaged and rusted, it should be replaced. A 3-sided concrete box culvert, 5-foot wide by 3-foot high would adequately convey the 100-year flow rate without a submerged inlet. Limitations in cover are addressed by the top of the box culvert assumed to set at the existing roadway grade. The box culvert design meets WDFW requirements for fish passage using the "Stream Simulation" methodology. It is also recommended that the channels in proximity to the culvert be cleared of overgrown vegetation. It is also recommended that the nearby 12-inch culvert to the east be removed or repaired and cleaned out. This solution is based on field observations and existing information (e.g. 5-ft contours), therefore, a survey should be conducted prior to detailed design to confirm the assumed channel and culvert geometry (e.g. bed slope, culvert invert elevations, channel depth, and roadway elevations).

Benefit: This project will alleviate roadway flooding and addressed problem TWU-16.

Project Number: CIP11-TWU-C03

Project Name: Culvert Replacement at Thomas Road

Cost Estimate: $196,800

Project Score: 82

Problem: Roadway flooding problems leading to flooding of private property were reported

near 34328 Thomas Road East. A property owner reported frequent flooding of the roadway and overflow of ditches, which causes runoff to wash out the road and flow into the dwelling.

Residents also reported that the drainage ditches have not been adequately maintained. Field observations noted that construction and improper sediment control could be causing sediment buildup in ditches and conveyance structures.

A tributary drainage to Tanwax Lake drains north and crosses under Thomas Road East through a 12-inch concrete culvert. Flow from the outlet of the culvert is directed into a storm drain that leads to Tanwax Lake.

Hydraulic analyses of the surrounding channels show that the channels have the capacity to convey the 25-year event. However, the 12-inch culvert does not have adequate capacity to convey the 25-year flow rate.

Solution: Maintenance should be conducted at the site to clean out sediment and debris buildup in conveyance structures. It is recommended that the 12-inch culvert be replaced with a 3-sided concrete box culvert, 6-foot wide by 5-foot high, to allow for conveyance of the 100-year flow rate and provide the necessary geometry for fish passage. The top of the box culvert is assumed to be set at the elevation of the existing roadway with no cover. Field survey and detailed hydraulic analyses should be performed before project implementation. Inlet conditions at the storm drain downstream of the culvert should be inspected to ensure proper capture of flow.

Benefit: This project addresses flooding problem TWU-24.

Ohop Creek – County Basin No. 14

Project Number: CIP14-OHL-AC01

Project Name: Ohop Creek Property Acquisition Phase 1

Cost Estimate: $617,800

Project Score: 241

Problem: Major habitat alterations have occurred in the Ohop Creek subbasin. There has been a decrease in the amount of large wood in the creek. The removal of streamside and overhanging vegetation, including standing trees, has eliminated the source of large wood and shade for the creek.

Solution: Acquire available properties along Ohop Creek. This project is Phase 1 of a three phases of property acquisition. The project was divided up into phases for budgetary purposes. Phase 1 can be completed at anytime and is not dependent on Phases 2 and 3. Properties identified for acquisition should be prioritized with the highest priority properties included in the earliest phases.

Benefit: Acquisition of high quality habitat or areas that are a priority for restoration is a primary strategy for long-term benefit to aquatic habitat. This project improves habitat for the *Ohop Cr-1* EDT reach (problem OHL-01).

Project Number: CIP14-OHL-AC02

Project Name: Ohop Creek Property Acquisition Phase 2

Cost Estimate: $618,900

Project Score: 174

Problem: Ohop Creek is the second largest Nisqually River tributary below La Grande Dam. It is an area of historic agricultural use that is being converted to rural residential use. The area has undergone many changes that have led to the decline of salmon productivity. Channel confinement modifications such as ditching and channelization have occurred. There has been a decline in the amount of key habitat and habitat diversity, including loss of large woody debris, streamside vegetation, pools, and riffle habitat. These factors have lead to reduced channel stability, increased summer stream temperatures, increased fine sediment levels, and reduction in food availability. There has also been an increase in predation by non-native fish.

Solution: A restoration plan for lower Ohop Creek was developed. The plan summarizes habitat conditions in the project reach and evaluates restoration alternatives. The most comprehensive restoration alternative in the plan has been selected and engineering designs have been developed. The project will re-elevate the 4.0 miles of severely channelized creek back into its original floodplain, recreating a 5.2-mile-long stream. The creek's original meander pattern and its connection to the adjacent floodplain and wetland areas will be restored. The project will also re-vegetate approximately 490 acres of the surrounding valley floor, which is dominated by wetlands. Several large properties in the valley are in protected status; however, almost 1 mile of Ohop Creek is unprotected. Acquiring properties along this reach will help ensure the long-term success of the Ohop Valley Restoration Project.

This project is Phase 1 of a three phases of property acquisition. The project was divided up into phases for budgetary purposes. Phase 1 can be completed at anytime and is not dependent on Phases 2 and 3. Phases 2 and 3 are intended to be completed in conjunction with the Ohop Valley Restoration Project. Properties identified for acquisition should be prioritized with the highest priority properties included in the earliest phases.

Benefit: Protection of riparian areas along Ohop Creek is critical to the long-term success for the Ohop Restoration Project. If implemented, the project will restore a critical region of the Nisqually River Basin, including the original floodplain and riparian area. This project improves habitat for the *Ohop Cr-1a* EDT reach (problem OHL-01), and would also improve important wetland habitat for other aquatic and avian wildlife such as amphibians and migratory waterfowl.

Project Number: CIP14-OHL-AC03

Project Name: Ohop Creek Property Acquisition Phase 3

Cost Estimate: $618,900

Project Score: 174

Problem: Ohop Creek is the second largest Nisqually River tributary below La Grande Dam. It is an area of historic agricultural use that is being converted to rural residential use. The area has undergone many changes that have led to the decline of salmon productivity. Channel confinement modifications such as ditching and channelization have occurred. There has been a decline in the amount of key habitat and habitat diversity, including loss of large woody debris, streamside vegetation, pools, and riffle habitat. These factors have lead to reduced channel stability, increased summer stream temperatures, increased fine sediment levels, and reduction in food availability. There has also been an increase in predation by non-native fish.

Solution: A restoration plan for lower Ohop Creek was developed. The plan summarizes habitat conditions in the project reach and evaluates restoration alternatives. The most comprehensive restoration alternative in the plan has been selected and engineering designs have been developed. The project will re-elevate the 4.0 miles of severely channelized creek back into its original floodplain, recreating a 5.2-mile-long stream. The creek's original meander pattern and its connection to the adjacent floodplain and wetland areas will be restored. The project will also re-vegetate approximately 490 acres of the surrounding valley floor, which is dominated by wetlands. Several large properties in the valley are in protected status; however, almost 1 mile of Ohop Creek is unprotected. Acquiring properties along this reach will help ensure the long-term success of the Ohop Valley Restoration Project.

This project is Phase 1 of a three phases of property acquisition. The project was divided up into phases for budgetary purposes. Phase 1 can be completed at anytime and is not dependent on Phases 2 and 3. Phases 2 and 3 are intended to be completed in conjunction with the Ohop Valley Restoration Project. Properties identified for acquisition should be prioritized with the highest priority properties included in the earliest phases.

Benefit: Protection of riparian areas along Ohop Creek is critical to the long-term success for the Ohop Restoration Project. If implemented, the project will restore a critical region of the Nisqually River Basin, including the original floodplain and riparian area. This project improves habitat for the *Ohop Cr-1a* EDT reach (problem OHL-01), and would also improve important wetland habitat for other aquatic and avian wildlife such as amphibians and migratory waterfowl.

Project Number: CIP14-OHL-AC04

Project Name: Ohop Creek Repetitive Loss Property Acquisition

Cost Estimate: $606,800

Project Score: 195

Problem: Based on new claims data, an area along lower Ohop Creek was identified as a repetitive loss area following completion of the Pierce County Repetitive Loss Plan in 2001. The current repetitive loss report as of April 30, 2006, shows one identified property in this area.

Ohop Creek is a tributary to the Nisqually River. The principal cause of flooding along this reach is surface water drainage into the creek channel, increasing stream flow above the capacity of the channel. This typically results in overbank flooding. It is estimated that there are approximately five additional properties within this reach subject to similar repetitive flooding as the identified property.

Solution: Acquire available properties identified as a repetitive loss property or properties within the repetitive loss area that could potentially sustain future flood damages.

Benefit: Buying out repetitive loss properties eliminates future property damage due to flood and reduces the risk to public safety. This project mitigates problem OHL-07.

Project Number: CIP14-OHL-RST01

Project Name: Lower Ohop Valley Restoration Phase 1 (Segments D, E, and F)

Cost Estimate: $404,595 (County share)

Project Score: 242

Problem: Ohop Creek is the second largest Nisqually River tributary below La Grande Dam. It is an area of historic agricultural use that is being converted to rural residential use. The area has undergone many changes that have led to the decline of salmon productivity. Channel confinement modifications such as ditching and channelization have occurred. There has been a decline in the amount of key habitat and habitat diversity, including loss of large woody debris, streamside vegetation, pools, and riffle habitat. These factors have led to reduced channel stability, increased summer stream temperatures, increased fine sediment levels, and reduced food availability. There has also been an increase in predation by non-native fish.

Solution: A restoration plan for lower Ohop Creek was developed. The plan summarizes habitat conditions in the project reach and evaluates restoration alternatives. The most comprehensive restoration alternative in the plan has been selected and engineering designs have been developed. The project will re-elevate the 4.0 miles of severely channelized creek back into its original floodplain, recreating a 5.2- mile-long stream. The

creek's original meander pattern and its connection to the adjacent floodplain and wetland areas will be restored. The project will also re-vegetate approximately 490 acres of the surrounding valley floor, which is dominated by wetlands. Due to the large size of the project, it is split into three phases. This first phase will restore approximately 1 mile of creek and will be the pilot project for the other phases. It focuses on the Land Trust properties by Highway 7, which are visible to the tens of thousand of travelers to Mount Rainier National Park every year.

The total project cost is estimated at $2,697,300, of which $2,100,000 is currently funded and $597,300 is needed. This project would be a partnership of the Nisqually River Tribe, Surface Water Management and possibly other entities. Surface Water Management share would be intended to meet local match obligations of State and/or Federal grants, estimated at 15 % of the total cost, or $404,595.

Benefit: This project restores a critical regional of the Nisqually River Basin, including the original floodplain and riparian area. This project improves habitat for the *Ohop Cr-1a* EDT reach (problem OHL-01). It would also improve water quality of this degraded stream and improve important wetland habitat for other aquatic and avian wildlife such as amphibians and migratory waterfowl.

Project Number: CIP14-OHL-RST02

Project Name: Lower Ohop Valley Restoration Phase 2 (Segments A, B, and C)

Cost Estimate: $606,600 (County share)

Project Score: 242

Problem: Ohop Creek is the second largest Nisqually River tributary below La Grande Dam. It is an area of historic agricultural use that is being converted to rural residential use. The area has undergone many changes that have led to the decline of salmon productivity. Channel confinement modifications such as ditching and channelization have occurred. There has been a decline in the amount of key habitat and habitat diversity, including loss of large woody debris, streamside vegetation, pools, and riffle habitat. These factors have led to reduced channel stability, increased summer stream temperatures, increased fine sediment levels, and reduced food availability. There has also been an increase in predation by non-native fish.

Solution: A restoration plan for lower Ohop Creek was developed. The plan summarizes habitat conditions in the project reach and evaluates restoration alternatives. The most comprehensive restoration alternative in the plan has been selected and engineering designs have been developed. The project will re-elevate the 4.0 miles of severely channelized creek back into its original floodplain, recreating a 5.2-mile-long stream. The creek's original meander pattern and its connection to the adjacent floodplain and wetland areas will be restored. The project will also re-vegetate approximately 490 acres of the surrounding valley floor, which is dominated by wetlands. Due to the large size of the project, it is split into three phases. This second phase will restore 2.1 miles of Ohop Creek and connect areas

restored in Phase 1 to the mouth of the creek. Together with Phase 1, this phase will restore a continuous 3.1-mile reach.

The total project cost is estimated at $4,044,000. This project would be a partnership of the Nisqually River Tribe, Surface Water Management and possibly other entities. Surface Water Management share would be intended to meet local match obligations of State and/or Federal grants, estimated at 15 % of the total cost, or $606,600.

Benefit: This project restores a critical region of the Nisqually River Basin, including the original floodplain and riparian area. This project also improves habitat for the *Ohop Cr-1a* EDT reach (problem OHL-01), water quality of this degraded stream, and important wetland habitat for other aquatic and avian wildlife such as amphibians and migratory waterfowl.

Project Number: CIP14-OHL-RST03

Project Name: Lower Ohop Valley Restoration Phase 3 (Segments G, H, I, J, K, and L)

Cost Estimate: $799,600 (County share)

Project Score: 242

Problem: Ohop Creek is the second largest Nisqually River tributary below La Grande Dam. It is an area of historic agricultural use that is being converted to rural residential use. The area has undergone many changes that have led to the decline of salmon productivity. Channel confinement modifications such as ditching and channelization have occurred. There has been a decline in the amount of key habitat and habitat diversity, including loss of large woody debris, streamside vegetation, pools, and riffle habitat. These factors have led to reduced channel stability, increased summer stream temperatures, increased fine sediment levels, and reduced food availability. There has also been an increase in predation by non-native fish.

Solution: A restoration plan for lower Ohop Creek was developed. The plan summarizes habitat conditions in the project reach and evaluates restoration alternatives. The most comprehensive restoration alternative in the plan has been selected and engineering designs have been developed. The project will re-elevate the 4.0 miles of severely channelized creek back into its original floodplain, recreating a 5.2-mile-long stream. The creek's original meander pattern and its connection to the adjacent floodplain and wetland areas will be restored. The project will also re-vegetate approximately 490 acres of the surrounding valley floor, which is dominated by wetlands. Due to the large size of the project, it is split into three phases. This third and last phase will restore an additional 2.1 miles of Ohop Creek consisting of the remaining creek sections up and downstream of the Ohop Valley Road bridge. Together with Phases 1 and 2, this phase will restore a continuous 5.2-mile reach.

The total project cost is estimated at $5,330,600. This project would be a partnership of the Nisqually River Tribe, Surface Water Management and possibly other entities. Surface Water Management share would be intended to meet local match obligations of State and/or Federal grants, estimated at 15 % of the total cost, or $799,590.

Benefit: This project restores a critical regional of the Nisqually River Basin, including the original floodplain and riparian area. This project also improves habitat for the *Ohop Cr-1a* EDT reach (problem OHL-01), water quality of this degraded stream, and important wetland habitat for other aquatic and avian wildlife such as amphibians and migratory waterfowl.

Project Number: CIP14-OHU-AC01

Project Name: Upper Ohop Shoreline Protection (Hancock-Ohop) Phase 1

Cost Estimate: $572,100

Project Score: 177

Problem: There has been a decline in key habitat and habitat diversity, including loss of large woods, streamside vegetation, pools, and riffle habitat. These factors have led to reduced channel stability, increased summer stream temperatures, increased fine sediment levels, and reduced food availability.

Solution: Acquire upper Ohop Creek shoreline in reaches accessible to anadromous fish. This project is Phase 1 of a two continual phases. The project was divided up into phases for budgetary purposes; however, phases can be combined or completed independently.

Benefit: Acquisition of high quality habitat or areas that are a priority for restoration is a primary strategy for long-term benefit to aquatic habitat. This project improves habitat for the *Twenty-five Mile Creek* and *Trib0094* EDT reaches (problems OHU-16 and OHU-17).

Project Number: CIP14-OHU-AC02

Project Name: Upper Ohop Shoreline Protection (Hancock-Ohop) Phase 2

Cost Estimate: $572,100

Project Score: 177

Problem: There has been a decline in key habitat and habitat diversity, including loss of large woods, streamside vegetation, pools, and riffle habitat. These factors have led to reduced channel stability, increased summer stream temperatures, increased fine sediment levels, and reduced food availability.

Solution: Acquire upper Ohop Creek shoreline in reaches accessible to anadromous fish. This project is Phase 2 of a two continual phases. The project was divided up into phases for budgetary purposes; however, phases can be combined or completed independently.

Benefit: Acquisition of high quality habitat or areas that are a priority for restoration is a primary strategy for long-term benefit to aquatic habitat. This project improves habitat for the *Twenty-five Mile Creek* and *Trib0094* EDT reaches (problems OHU-16 and OHU-17).

Upper Nisqually River – County Basin No. 19

Project Number: CIP19-ASH-C01

Project Name: Culvert Replacement at 278th Avenue East

Cost Estimate: $288,100

Project Score: 147

Problem: Local residents reported flooding over the roadway where an unnamed tributary crosses under 278th Avenue East. Residents also reported erosion and sediment problems for this crossing.

The crossing consists of a stream running generally from east to west along the floor of the Upper Nisqually River Valley. There are two parallel culverts under the road: one 48-inch-diameter CMP and one 24-inch CMP. The 48-inch culvert is partially filled with sediment, and both culverts are partially blocked at the inlet by rocks (see Figure 6-5). Bank erosion was noted at the upstream inlet to the culvert.

The drainage area to this culvert was delineated using USGS quadrangle maps (County topographic data is not available for this area). The stream originates in the mountains on the north side of the valley, then flows west along the valley floor joining with other streams flowing into the valley. The total area draining to these culverts is approximately 1,200 acres. Hydrologic calculations estimated the 25-year flow to be approximately 510 cfs and the 100-year flow rate to be approximately 810 cfs.

Design standards specified in the Stormwater Management Manual call for the use of a 100-year flow rate for design of new conveyance structures on natural stream channels (Pierce County, 2005). However, the 100-year discharge calculated for the crossing at 278th Avenue East would require a considerably large structure; most likely a bridge. A lower design flow was considered for several reasons:

- A proposed project in this situation is retrofitting an existing structure
- The location is on a rural roadway with what is assumed to be light traffic
- The site conditions are not conducive to a large structure due to cover limitations
- The channel leading to the culverts does not have adequate capacity to convey large flows such as the estimated 100-year flow rate

Solution: A WDFW (2003) “Stream Simulation” design approach was used to size a 3-sided, 12-foot by 5-ft concrete box culvert to be installed under 278th Avenue East. It is assumed the top of the box culvert will be flush with the existing roadway (i.e. no cover is assumed over the culvert). The culvert is proposed to have a slope of 2% and be countersunk 1.8-feet in accordance with fish passage design criteria. A hydraulic analysis of this proposed replacement culvert found the crossing could convey a flow rate of approximately 200 cfs, which would corresponds to a flow rate between the 2-year and 5-year recurrence interval.

This solution is based on field observations and existing information (e.g. 5-ft contours), therefore, a survey should be conducted prior to detailed design to confirm the assumed channel and culvert geometry (e.g. bed slope, culvert invert elevations, channel depth, and roadway elevations).

Benefit: This project alleviates flooding over the roadway and addresses problem ASH-01 and ASH-02.

Project Number: CIP19-COP-AC01

Project Name: Upper Nisqually River Property Acquisition

Cost Estimate: $748,300

Project Score: 213

Problem: Some properties adjacent to the Nisqually River, particularly areas near the Mount Rainier National Park Entrance are vulnerable to flooding and channel migration hazards. Some of these properties include riparian areas that could provide habitat if preserved. Also, some of the properties fall within a designated open space corridor. Acquisition of such properties for conservation is supported by the Upper Nisqually River Valley Community Plan and the Pierce County Conservation Plan, as well as Nisqually River Land Trust (personal communication with Kimberly Freeman, Pierce County Planning and Land Services).

Solution: Purchase property and set aside for conservation. Assumed area of 140 acres at a cost of $3,000 per acre based on the assessed value (Pierce County Assessor).

Benefit: Property is set aside for conservation, including areas of riparian habitat. Open space is preserved along the Upper Nisqually River. This project will help provide flood storage and address problem NIS-25.

Mashel River – County Basin No. 20

Project Number: CIP20-MAL-AC01

Project Name: Mashel River Property Acquisition

Cost Estimate: $663,000

Project Score: 161

Problem: Major habitat alterations have occurred in the Mashel subbasin. Encroachment on the river by development has affected the most productive section of the river through Eatonville. There has been a decrease in the number of large fallen trees in the creek. Many of the side-channels have been eliminated and overhanging vegetation has been removed, including standing trees that would have provided a source of large wood and shade. Removal of the trees has produced an excess of fine sediment inputs from increased soil erosion. Channelization of the Mashel River has also occurred in many areas. A few areas have not been affected by the encroachment and therefore need to be protected. Properties

identified for acquisition should be prioritized to determine which properties will be purchased first.

Solution: Purchase properties downstream of Eatonville (include shoreline/adjacent uplands.

Benefit: Acquisition of high quality habitat or areas that are a priority for restoration is a primary strategy for long-term benefit to aquatic habitat. Addition of these acres to the refuge would make them available for restoration. This project improves habitat for the *Lower Mashel-A_B* EDT reach (problem MAL-03).

Project Number: CIP20-MAL-AC02

Project Name: Mashel Shoreline Buffer Acquisition

Cost Estimate: $848,700

Project Score: 171

Problem: Major habitat alterations have occurred in the Mashel subbasin. Encroachment on the river by development has affected the most productive section of the river through Eatonville. There has been a decrease in the number of large fallen trees in the creek. Many of the side-channels have been eliminated and overhanging vegetation has been removed, including standing trees that would have provided a source of large wood and shade. Removal of the trees has produced an excess of fine sediment inputs from increased soil erosion. Channelization of the Mashel River has also occurred in many areas. A few areas have not been affected by the encroachment and therefore need to be protected. Properties identified for acquisition should be prioritized to determine which properties will be purchased first.

Solution: Purchase 1 mile of the Mashel River shoreline in Eatonville. Seek strategic properties for protection and restoration purposes.

Benefit: Acquisition of high quality habitat or areas that are a priority for restoration is a primary strategy for long-term benefit to aquatic habitat. The project preserves riparian function, off-channel wetlands, and instream diversity of the Mashel River near Eatonville. This project improves habitat for the *Lower Mashel-A_B* EDT reach (problem MAL-03).

Project Number: CIP20-MAL-AC03

Project Name: Mashel Small Properties Acquisition

Cost Estimate: $617,800

Project Score: 174

Problem: Major habitat alterations have occurred in the Mashel subbasin. Encroachment on the river by development has affected the most productive section of the river through Eatonville. There has been a decrease in the number of large fallen trees in the creek. Many of the side-channels have been eliminated and overhanging vegetation has been removed,

including standing trees that would have provided a source of large wood and shade. Removal of the trees has produced an excess of fine sediment inputs from increased soil erosion. Channelization of the Mashel River has also occurred in many areas. A few areas have not been affected by the encroachment and therefore need to be protected. Properties identified for acquisition should be prioritized to determine which properties will be purchased first.

Solution: Acquire available properties along the Mashel River.

Benefit: Acquisition of high quality habitat or areas that are a priority for restoration is a primary strategy for long-term benefit to aquatic habitat. This project improves habitat for the *Lower Mashel-A_A*, *Lower Mashel-A_B*, and *Lower Mashel-B* EDT reaches (problems MAL-01, MAL-03, and MAL-04).

Project Number: CIP20-MAL-RST01

Project Name: Mashel Eatonville Reach Instream Restoration Phase II

Cost Estimate: $149,215 (County share)

Project Score: 242

Problem: The Mashel River is the largest tributary to the Nisqually River downstream of La Grande Dam. Salmon productivity has been declining for years because of changes in the river basin. There has been a decline in the habitat diversity, pool habitat, and habitat suitable for spawning. This loss of habitat has been caused by unnatural channel narrowing from bank hardening and dikes. The channel narrowing has caused decreased channel stabilization and increased sediment loading from soil erosion. Summer water temperatures have also increased.

Solution: Phase I, which has already been completed, restored in-stream diversity and riparian function in approximately half of the degraded areas in this reach. Phase II would address the remaining in-stream habitat issues in this reach. This phase would include additional landowner outreach prior to completing project designs and permitting.

The total project cost is estimated at $998,100, of which $60,000 is currently funded and $938,100 is needed. This project would be a partnership of the Nisqually River Tribe, Surface Water Management and possibly other entities. Surface Water Management share would be intended to meet local match obligations of State and/or Federal grants, estimated at 15 % of the total cost, or $148,215.

Benefit: Completion of Phase I and II of this project, combined with the planned riparian revegetation work, would substantially address all major habitat issues that can be addressed. This project improves habitat for the *Lower Mashel-A_A*, *Lower Mashel-A_B*, and *Lower Mashel-B* EDT reaches (problems MAL-01, MAL-03, and MAL-04).

Project Number: CIP20-MAL-VC01

Project Name: Mashel Eatonville Reach Riparian Revegetation

Cost Estimate: $226,800 ($25,000 already funded; $201,800 additional funding needed)

Project Score: 221

Problem: There are remaining areas along the Mashel River that are devoid of vegetation and need to be planted over during the next 5 years.

Solution: Restore potential sites with native plants and shrubs.

Benefit: This project addresses the long-term needs of the river for mature conifers – for shade and to provide a large woody debris source for the river. This project improves habitat for the *Lower Mashel-A_A*, *Lower Mashel-A_B*, and *Lower Mashel-B* EDT reaches (problems MAL-01, MAL-03, and MAL-04).

9.3.3 Programmatic Projects

The Basin Plan contains 21 programmatic measures to address the flooding, water quality, and aquatic habitat problems in the Nisqually River Basin. This section presents programmatic measures grouped by countywide programmatic measures, then by basin wide measure. Each programmatic measure is listed in Table 9-6 along with the program score, estimated cost, and priority ranking. The costs for ongoing programmatic activities (such as developing and implementing an education and outreach program) are estimated over a 10-year period. Inflation is not accounted for in the cost estimates.

TABLE 9-6
Programmatic Measures, Scoring, Costs, and Priorities

Basin	Measure Number	Description of Program	Score	Estimated Cost	Priority
County-wide	PRG00-01	Implement a Low Impact Development Program	348	$116,000	High
County-wide	PRG00-02	Update Stormwater Management Manual	385	$1,000	High
County-wide	PRG00-03	Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit	398	$170,000	High
County-wide	PRG00-04	Develop and Implement a Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation	385	$7,000	High
Countywide	PRG00-05	Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality	291	$92,000	High
Countywide	PRG00-06	Develop and Implement an Education, Outreach, and Technical Assistance Program	396	$28,000	High
Countywide	PRG00-07	Develop and Implement a Surface Water Monitoring Program	239	$131,000	Medium
Countywide	PRG00-08	Develop and Implement a BMP Manual for Pierce County Surface Water Management Maintenance Activities	385	$6,000	High

TABLE 9-6
Programmatic Measures, Scoring, Costs, and Priorities

Basin	Measure Number	Description of Program	Score	Estimated Cost	Priority
Countywide	PRG00-09	Develop and Implement an Invasive Species Management Program	361	$806,000	High
Countywide	PRG00-10	Require Flood Disclosure Statements on Property Titles	123	$7,000	Low
Countywide	PRG00-11	Beaver Management Policy	217	NA	Medium
Countywide	PRG00-12	Encourage Installation of Permanent Buffer Markings and/or Signage	243	$6,000	Medium
Countywide	PRG00-13	Implement Elements of Shellfish Protection Program	310	$116,000	High
Countywide	PRG00-14	Develop and Implement a Habitat Monitoring Program	196	$6,000	Medium
Countywide	PRG00-15	Develop and Implement a Lake Water Quality Management Program	362	$2,765,000	High
Countywide	PRG00-16	Develop and Implement Countywide Vegetation Management Program	325	$136,500	High
Lower, Mid, and Upper Nisqually River	PRG11-01(b)	Revise Flood Hazard Maps Nisqually River, Wilcox Flat Reach	264	$80,000	High
Lower, Mid, and Upper Nisqually River	PRG11-02	Nutrient Enhancement using Salmon Carcasses	81	$320,000	Low
Lower, Mid, and Upper Nisqually River	PRG11-03	Enhance Nisqually River Council Capacity	332	$375,000	High
Lower, Mid, and Upper Nisqually River	PRG11-04	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems	183	$116,000	Medium
Lower and Mid Nisqually River	PRG11-05	Implement Elements of Nisqually River Bacteria TMDL Water Quality Implementation Plan	240	$58,000	Medium
		Total Estimated Cost for all Programmatic Measures		**$5,452,500**	

Programmatic Project Descriptions

Project Number: PRG00-01

Project Name: Implement a Low-Impact Development Program

Cost Estimate: $116,000 ($11,600 annually over 10 years)

Cost Assumption: Assumes 0.1 FTE per year in Nisqually River Basin.

Project Score: 348

Establish and implement a program that would work with development industry, agencies, environmental groups, and communities in the County to actively promote the use of LID in new development and redevelopment. Program activities might include developing standards for use of LID principles in public road construction and reconstruction where it makes sense, initiating and coordinating pilot projects, providing training and technical assistance in the application of LID techniques and principles, investigating regulatory and other barriers to LID and identifying solutions, and educating citizens about LID and its benefits. In the Nisqually River planning area, LID efforts should focus on lakeshore areas because: 1) much of the new and re-development is likely to be concentrated in those areas, and 2) shoreline LID would help protect and enhance lake water quality.

Project Number: PRG00-02

Project Name: Update Stormwater Management Manual

Cost Estimate: $1,000

Cost Assumption: Includes 0.25 FTE as a one-time, one-year cost. Prorated for the Nisqually River Basin share of the Countywide cost (3 %).

Project Score: 385

The Washington State Department of Ecology provided local jurisdictions, including Pierce County, with updated guidance on stormwater management standards with issuance of the 2005 Stormwater Management Manual for Western Washington. Adoption of either Ecology's manual or an equivalent manual is required for all municipalities currently covered under the NPDES Municipal Stormwater Permit. The County should apply the flow duration standard for systems that drain to small streams, which may be susceptible to channel erosion. This standard matches the existing flow duration and helps to prevent erosion in the steep, erosion-prone reaches. The flow duration standard may not be needed for systems that discharge directly to lakes or large streams (e.g., Nisqually River mainstem, Mashel River).

Project Number: PRG00-03

Project Name: Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit

Cost Estimate: $170,000

Cost Assumption: Includes 6.0 FTEs per year Countywide. The estimated costs include funding to support additional inspection staff. The 10-year life cycle cost is then prorated for the Nisqually River Basin's share of the Countywide cost (3 %).

Project Score: 398

Pierce County would increase the inspection of public and private stormwater facilities to ensure compliance with current regulations (including NPDES requirements). Both existing and new stormwater facilities would be inspected to confirm that regular maintenance is occurring and that maintenance standards and agreements are being met. When a violation is identified, inspectors would offer education and technical assistance, but enforcement actions would be taken when necessary.

Project Number: PRG00-04

Project Name: Develop and Implement a Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation

Cost Estimate: $7,000

Cost Assumption: Includes 0.5 FTE for one year to develop the inventory countywide, establish the policies and procedures for acquisition and management. Also, 0.25 FTE per year for nine years to pursue purchases and oversee property management. Prorated for the Nisqually River Basin share of the countywide cost (3 %). The estimate does not include costs to purchase the properties. Property acquisition is included in a number of the capital improvement projects recommended in this basin plan. Therefore, land acquisition costs are included in the CIP cost estimates.

Project Score: 385

Surface Water Management acquires and manages properties for floodplain, water quality, and habitat protection. The program has the following elements:

- **Standards for Property Development**. Develop standards for determining which properties or types of properties to acquire and how they should be managed for multiple uses.
- **Inventory Development**: Surface Water Management would develop and prioritize a list of desired properties and a method for tracking when they become available.

Properties identified through the Basin Planning process would help build the inventory.

- **Consultation with Stakeholders.** Develop standards for coordinating with other departments, agencies, citizen groups, or other entities (e.g., the Nisqually River Land Trust) that have a stake in property acquisition sites or the overall program.
- **Acquisition:** Pierce County will pursue acquisition of properties through outright purchase, easements, or other legal mechanisms, reviewing the current or potential habitat value of the parcels, and negotiating with sellers would be included in this element.
- **Management**: Surface Water Management manages properties after acquisition. Issues such as access, preventing vandalism and illegal dumping, restoration, maintenance, public use and liability will be addressed. Pierce County may consider working with private or non-governmental agencies, such as the Nisqually River Land Trust, on managing certain parcels where appropriate.

Project Number:	PRG00-05
Project Name:	Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality
Cost Estimate:	$92,000
Cost Assumption:	Includes 1 FTE per year to establish and run the program (costs estimated for a 10-year period). Prorated for the Nisqually River Basin share of the countywide cost (3 %). The estimate does not include cost for site restoration projects; these costs are included in the cost estimates for habitat/water quality CIP.
Project Score:	291

Build internal capacity to implement restoration and enhancement projects in riparian and wetland areas to improve ecosystem functions, where property owners have given permission and on properties owned by Pierce County Surface Water Management. Soft bank engineering techniques, such as those contained in the WDFW's Integrated Streambank Protection Guidelines should be developed and enhanced.

The primary program function would be to manage the restoration sites in the Basin Plan. Duties would include identifying potential projects, obtaining access, developing restoration plans, identifying resources to help in the restoration (recruiting volunteers where appropriate or hiring contractors, ordering supplies, and publicizing planting events or completed projects).

The County would form partnerships with volunteer groups and other organizations such as the Pierce Conservation District, Nisqually River Council, Nisqually River Indian Tribe, lake homeowners associations, and the Stream Team to restore/enhance riparian or estuarine areas.

Project Number: PRG00-06

Project Name: Develop and Implement an Education, Outreach, and Technical Assistance program

Cost Estimate: $28,000

Cost Assumption: Includes 0.25 FTE per year over a 10-year lifecycle cost. Prorated for the Nisqually River Basin share of the countywide cost (3 %).

Project Score: 396

Surface Water Management would develop a comprehensive education, outreach, and technical assistance program that includes the following elements:

- **Awareness**: Activities under this element include public notification of department activities, availability of data such as updated floodplain and groundwater information and mapping, and Basin Plan-related information as it is developed.
- **Topics:** Topics may address specific pollutants such as pathogens, metals, nutrients; or issues such as flooding, lawn and garden chemicals, native plant landscaping, lake management, all-terrain vehicle (ATV) use, coastal bluff erosion and stormwater management issues, or small farm management. Generally, increasing public awareness of best management practices that they can implement to reduce water quality, flooding, and habitat impacts in their basin will be the focus of each educational effort. Emergency information related to flooding needs to be well coordinated and easily accessible.
- **Target audiences:** Audiences would include basin residents but may also target specific stakeholders such as floodplain residents, lakeshore residents, coastal bluff residents, business owners, ATV users, real estate professionals, or homebuyers. Coordination with other education providers such as schools and non-governmental organizations would be addressed.
- **Methods:** Methods to distribute information may include a variety of techniques such as posting information on the internet, use of libraries and public bulletin boards, speakers, news releases, newsletters, utility bill inserts, targeted mailings, fair booth displays, billboards, Pierce County Speaks segments, and other options. These methods will be utilized based on the information to be distributed and the target audience.
- **Direct Technical/Financial Assistance:** In addition to basic awareness, Pierce County's education program would include an assistance program to directly aid residents in taking desired actions. This may include supporting volunteer monitoring programs, offering technical and financial assistance to floodplain residents, offering incentives for establishing buffers, and coordinating with other agencies that provide technical support such as the Pierce Conservation District and Nisqually River Council. Pierce County may offer financial support and assistance to other programs that support the goals and objectives of the basin plan. Additional incentives might come in the form

of free native plants, discounts at local stores, free workshops, tax breaks, or other methods. Pierce County may identify certain staff members to serve as outreach coordinators for specific stream reaches.

- **Coordination:** In order to efficiently communicate Surface Water Management messages, the education, outreach and other technical assistance program will include a coordination element with other agencies, groups, or jurisdictions (e.g., City of DuPont, Nisqually River Council). Coordination efforts will include other education providers but also technical staff.

Project Number:	PRG00-07
Project Name:	Develop and Implement a Surface Water Monitoring Program
Cost Estimate:	$131,000
Cost Assumption:	Includes 3.75 FTE per year countywide plus a $106,000 lifecycle cost over 10 years. Prorated for the Nisqually River Basin share of the countywide cost (3 %).
Project Score:	239

The Monitoring Program would include the following aspects:

- **Monitoring Components:** Monitoring would be performed as outlined in the Countywide Water Quality Monitoring Plan (CWQMP). This plan was developed to guide the types and location of management strategies needed for protection and enhancement of receiving water quality and beneficial uses in Pierce County. The CWQMP prescribes a long-term monitoring program that is designed to help Pierce County assess and improve its stormwater management program over time. The program includes Benthic-Index Biological Integrity (B-IBI) monitoring, in-situ bioassays, physical channel monitoring, continuous water quality monitoring, and hydrological monitoring.
- **Water bodies:** The sampling program would include key streams and lakes in the planning area, such as water bodies with pending TMDLs or TMDL implementation plans (e.g., Lynch Creek, Ohop Creek), or lakes where water quality information is needed to develop management solutions.
- **Dissemination/Mapping:** Information collected under this monitoring program would be evaluated and shared with other appropriate agencies. Where feasible, data would be recorded in GIS systems and mapped. Pierce County would have a strategy for posting updated information on the internet.
- **Adaptive Management:** As the monitoring program generates data, that information would be shared and used to assess the effectiveness of current Pierce County policies, programs, and procedures. Every five years, we would perform an in-depth analysis of available data and publish a report on the overall health of the basin and on the effectiveness of existing programs.

- **Training:** Competent personnel are needed to generate reliable data. Pierce County would continue to train existing staff, hire or consult with identified experts, work with other agency personnel with capable staff, or develop a pool of volunteers that can competently collect data.

Project Number: PRG00-08

Project Name: Develop and Implement a BMP Manual for Pierce County Surface Water Management Maintenance Activities

Cost Estimate: $6,000

Cost Assumption: Includes one-time cost for 0.5 FTE plus $87,000 for a consultant contract to develop a BMP manual and an additional 0.1 FTE per year to support on-going training sessions and updated; lifecycle costs over 10 years. Prorated for the Nisqually River Basin share of the Countywide cost (3 %).

Project Score: 385

Develop a maintenance manual containing BMPs for Pierce County's stormwater management facilities. The manual would address stormwater conveyance and treatment facility maintenance, as well as levee maintenance activities. The maintenance manual would be patterned after the Tri-County transportation facilities approach and the Pierce County Stormwater Management and Site Development Manual.

The manual would include practices and techniques that protect water quality and aquatic habitat while preserving the flood control functions of the facilities. The manual would provide standard operating procedures for work crews. It would also be designed to achieve compliance with Pierce County's NPDES permit.

Distribution of the manual would be accompanied by training sessions on its purpose and use. In the Nisqually River Basin, special attention would be paid to ditch system maintenance. BMPs would include guidance on identifying ditches with high erosion risk as well as guidance on selecting and installing appropriate controls for sediment and erosion such as check dams, vegetation, and/or geo-textile fabric.

Project Number: PRG00-09

Project Name: Develop and Implement an Invasive Species Management Program Knotweed Control Program

Cost Estimate: $806,000 ($80,600 annually over a 10-year program)

Cost Assumption: Includes one-time cost for 0.5 FTE and $9,000 for a consultant to develop the BMP document, complete the inventory and data layer, and 0.1 FTE per year for ongoing volunteer organization and implementation. Lifecycle cost over 10 years then prorated for the

Nisqually River Basin share of the countywide cost (3 %).

Additionally, in the Nisqually River Basin, 0.25 FTE biologists and a 0.75 FTE crew plus equipment and supplies.

Project Score: 361

Pierce County Surface Water Management would develop a program for addressing invasive species impacts to surface management facilities and surface water bodies within unincorporated Pierce County. A general inventory of invasive plant problems in Pierce County would be conducted and entered into Pierce County's GIS database. A Best Management Practices (BMP) manual would be developed to offer guidance in identifying problematic species, information on their preferred conditions, and options for controlling each problem species. An Integrated Pest Management approach, and a variety of methods, including hand pulling, mechanical harvesting, and herbicides, would be used as appropriate.

Surface Water Management will confer with other agencies, including the Noxious Weed Control Board, Washington State Departments of Ecology and Fish and Wildlife and the Washington State University Cooperative Extension programs in developing the guidance document. Upon completion of the guidance document, invasive species training will be provided to drainage system maintenance personnel and invasive species issues will be included in public outreach and education programs. Surface Water Management will survey their facilities and properties to identify the presence of invasive species and the extent to which they are impacting the facility. This information will be incorporated into division work plans. Implementation of this recommendation could also include organizing and orchestrating volunteer groups and working with other groups and agencies to conduct invasive species control such as hand or mechanical harvesting, native species plantings, and other techniques. This program would be applicable to County-managed storm drainage facilities and properties.

In the Nisqually River Basin, emphasis is needed on targeting knotweed. Knotweed is an invasive plant that is suffocating and killing native plants along the entire Nisqually River from its mouth up to Mt. Rainier National Park. Surface Water Management should coordinate with County Noxious Weed Board to survey planning area to identify knotweed problem areas, and then kill knotweed using state-approved herbicide. Surveys should be repeated periodically to identify and control new problems that may arise.

This project improves habitat for the Nisqually River (problems NIS-01, 02, 04, 05, 06, 07, 08, 09, 10, 12, 13, 15, 17, 18, 19, 20, 21, 22, and 23).

Project Number: PRG00-10

Project Name: Require Flood Disclosure Statements on Property Titles

Cost Estimate: $7,000

Cost Assumption: Includes 0.25 FTE per year countywide over a 10-year lifecycle cost. Prorated for the Nisqually River Basin share of the countywide cost

(3 %).

Project Score: 123

Require that a disclosure statement of flood hazard designation be placed on the titles of buildings location in Special Flood Hazard Areas (SFHAs). Some measure of protection for buyers is provided through RCW 64.06.020 (1994), a state law that requires sellers of real property to disclose to buyers if a property is within a designated floodplain or designated flood hazard zone. Disclosure is based on the seller's actual knowledge of the flood hazard when the disclosure form is completed. Response options for floodplain disclosure are "yes", "no", and "don't know", with no further explanation or documentation required. Because the basis for this disclosure is the seller's knowledge of flood hazard rather than a determination based on scientific and historical evidence, this disclosure has limited effectiveness in informing potential buys about flood hazard risk.

This measure will require the development of a policy and further coordination with the Department of Planning and Land Services.

Project Number: PRG00-11

Project Name: Beaver Management Policy

Cost Estimate: Not Applicable (NA)

Cost Assumption: Assumed to be negligible.

Project Score: 217

Flooding associated with beaver activity has been identified as a problem in the Nisqually River Basin. Instances of roadway, tributary, and lake flooding have been attributed to beaver damming behavior, and have caused damage to private property and public infrastructure. There are two general types of beaver-related flooding issues in Pierce County. The first type is beaver activity at culverts that causes flooding problems on public roads. The second type is beaver activity near private property that results in property owners requesting technical assistance or information from Pierce County regarding management strategies.

Pierce County Public Works is currently managing known beaver-related flooding problems at culverts on a case by case basis. A standard operating procedure and policy is needed to determine when to use maintenance, road design, or the installation of dam discouragement devices.

It is not recommended that Pierce County become involved in actively managing beaver activity on private property, however it would be helpful to have a consistent approach to addressing these issues.

It is expected that this standard operating procedure will be incorporated into the Surface Water Management maintenance manual and its overriding policy be established through the Division's Land Management Program.

Project Number: PRG00-12

Project Name: Encourage the Installation of Permanent Buffer Markings and/or Signage for Pierce County Surface Water Management Property

Cost Estimate: $6,000

Cost Assumption: Includes one-time cost for staff or consultants to develop the signage format and ongoing costs for installation and maintenance. Prorated for the Nisqually River Basin share of the countywide cost (3 %).

Project Score: 243

This action would include developing an attractive, visible, durable marking system for buffer boundaries. These markers could be used by both private landowners and the County for informational purposes. They should meet the legal requirements for buffer marking but could also be installed voluntarily.

Project Number: PRG00-13

Project Name: Implement Elements of Shellfish Protection Program

Cost Estimate: $116,000 ($11,600 annually over 10 years)

Cost Assumption: Assumes 0.1 FTE per year in Nisqually River Basin.

Project Score: 310

Surface Water Management would provide funds and staff or volunteers to complete elements of a Shellfish Protection Program as described in "Appendix M" of the Key Peninsula-Islands Bain Plan. The program would involve the following elements: Education and Outreach; Coordination and Information Sharing; Downgrade Prevention; Monitoring and Sampling; Source Identification; Technical Assistance; Enforcement; Data management and dissemination; Financial Assistance; Legal/Regulatory Support; and Funding. Surface Water Management would work cooperatively with the Tacoma-Pierce County Health Department and the Pierce Conservation District to implement a fully functional shellfish protection program.

Project Number: PRG00-14

Project Name: Develop and Implement a Habitat Monitoring Program

Cost Estimate: $6,000

Cost Assumption: Includes one-time cost for Professional Services to conduct study

Project Score: 196

Surface Water Management would evaluate the effectiveness of habitat improvement projects and track changes in the original habitat assessments performed for the basin plan. The program would reassess the aquatic/riparian habitat every 5 years.

Project Number: PRG00-15

Project Name: Develop and Implement a Lake Water Quality Management Program

Cost Estimate: $2,875,000 (countywide)

$86,250 (Nisqually River Basin portion)

Cost Assumption: Includes 6.0 FTE per year (estimated over a 10-year period) plus $2,215,000 per year capital costs, goods and services countywide. For the Nisqually River Basin, at 3% annual revenues, this is $86,250 per annum, basin specific.

Project Score: 362

Surface Water Management would provide funds and staff to complete elements of a Lake Management Program as described in "Appendix I." Implementing the Surface Water Management portion of the Lake Management Program at a County-wide level would require 6.0 FTE and $2,215,000 in additional supporting budget annually, for a total program budget within Surface Water Management of approximately $287,500 per year. Surface Water Management would work cooperatively with the Tacoma-Pierce County Health Department and the Pierce Conservation District to implement a fully functional lake management program. Costs for the Tacoma-Pierce County Health Department are estimated at an additional 2.0 FTE, costs for the Pierce Conservation District are estimated at 1.0 FTE, plus $15,000. Both of these needs are to be funded under those agency fund sources.

To support the phased implementation of the lake management program in the Nisqually River Basin, it is recommended that 1.5 FTE and $25,000 in annual supporting funding be allocated to implement components of the Lake Management Program including monitoring and source identification, volunteer monitoring, education and outreach, and community technical assistance.

Additional capital funding will be required to implement specific lake projects such as detailed lake studies, in-lake management activities, watershed strategies for improving lake water quality, and private projects such as septic system retrofits. It is recommended that an additional $1,000,000 of the capital project budget for the Nisqually River Basin Plan be used to provide funding for implementing specific lake projects and studies.

Cost Assumption: See "Appendix I".

Project Number: PRG00-16

Project Name: Develop and Implement Countywide Vegetation Management Program

Cost Estimate: $136,500 (Nisqually River Basin share at 3 %; $4,550,000 countywide)

Cost Assumption: 1 FTE biologist and a 3 FTE crew plus equipment and supplies.

Project Score: 325

A healthy riparian plant community is important to aquatic habitat and water quality. Numerous riparian areas in the Nisqually River Basin have been planted with native vegetation to restore and protect aquatic habitat and water quality. Additional riparian areas will be re-planted as part of future habitat restoration projects. To ensure the long-term success of these efforts, re-vegetated areas should be periodically inspected and re-planted as needed to ensure establishment of a healthy riparian plant community. Some areas may require removal of invasive weeds to ensure the survival of the appropriate native vegetation.

An assessment of the riparian vegetation in the Nisqually River watershed was completed in 2004. There is a need to ground-truth the assessment, identify priority revegetation areas, and organize and implement projects. A plan, that prioritizes risks and outlines control measures, needs to be developed and implemented.

This program would support a biologist to develop and implement a watershed vegetation management plan and a crew of three technicians to inspect and maintain the riparian re-vegetation sites in the basin. Maintenance would largely consist of replacement plantings to achieve desired densities and invasive weed control if needed. Knotweed control efforts would be coordinated with PRG11-01.

Restores and manages riparian vegetation in the Nisqually River watershed. This project will ensure the success of vegetation projects. This project improves habitat and water quality for the Nisqually River (problems NIS-01, 02, 04, 05, 06, 07, 08, 09, 10, 12, 13, 15, 17, 18, 19, 20, 21, 22, and 23).

Project Number: PRG11-01

Project Name: Lower Nisqually River Flood Mitigation Program

Cost Estimate: $80,000

Cost Assumption: Total cost is the sum of estimated contract costs for consultants

Project Score: 264

Flooding along the lower Nisqually River mainstem has caused damage to private property and numerous residential structures, particularly in areas such as the community of McKenna and the Wilcox Flats area. Existing flood studies and flood maps are outdated and insufficient for developing a complete analysis of flood mitigation alternatives. This program consists of a series of studies to develop flood mitigation activities for McKenna, Wilcox Flats, and the lower Nisqually River mainstem in general.

REVISE FLOOD HAZARD MAPS – NISQUALLY RIVER, WILCOX FLATS REACH

A ground survey should be conducted to obtain cross-sections within the main channel of the Nisqually River along the length of the reach (5,000 feet from Horn Creek confluence to

Tanwax Creek confluence) to be studied (including points along the channel bottom below the water surface). In addition, the locations and elevations of key hydraulic features (e.g., diversion dam, bank revetments) should be surveyed. These data can be combined with LiDAR data covering the floodplain to create a single terrain model representing the existing channel and floodplain geometry. Integration and processing of the topographic data can be performed using geographic information systems (GIS).

Additional data for bridges or other structures that may affect river hydraulics need to be collected to estimate the dimensions of those structures. This information can be obtained from design drawings or as-built drawings from the owner of the structure. For example, the Washington Department of Transportation should have as-built drawings for the State Route 507 bridge in McKenna. In the absence of detailed data for a particular structure, field observations can be made to approximate relevant dimensions. In addition, a site visit should be conducted to observe channel and floodplain roughness, hydraulic structures, and historical high-water marks.

A hydraulic model of the Nisqually River study reach should be developed using a software package such as the HEC-RAS program developed by the Army Corps of Engineers. Once the geometric input data have been developed, calibration can be performed based on historical water surface observations. For example, high water marks were observed during the flooding that occurred in the 1996 flood event. The estimated peak discharge from the 1996 event can be input into the model and the roughness parameters can be adjusted to achieve a water surface elevation approximately equal to the observed elevation.

After the model is calibrated, flood flow frequency data can be input as peak discharges for use in a series of steady-state hydraulic simulations. The results will provide hydraulic profiles along the study reach, including flow velocities, depths, and water surface elevations. These results can be exported to GIS, overlaid onto the terrain model, and used to delineate inundation areas for the study reach. The updated delineation for the base (100-year) flood can be used, along with depth and velocity data to map new flood hazard zones.

Modeling should be conducted in accordance with FEMA standards for flood hazard mapping. The analyses should then be used to apply for a Letter of Map Revision (LOMR), which is required to change the effective FIRM maps used by FEMA to determine flood insurance rates. A LOMR application for the Nisqually River will require a cooperative effort between the floodplain coordinators at Pierce County and Thurston County.

Cost estimate for Part B: $80,000

Project Number: PRG11-02

Project Name: Nutrient Enhancement using Salmon Carcasses

Cost Estimate: $320,000 ($32,000 annually over 10 years)

Cost Assumption: 0.3 FTE, plus equipment and transportation costs.

Project Score: 81

Without the proper nutrients juvenile salmon cannot survive. Juvenile salmon receive nutrients from the carcasses of spawning salmon. However, in stream reaches with few spawning salmon, the juvenile salmon may not be able to obtain all of the nutrients they require.

Continue an ongoing program to "jump-start" the nutrient food web in key salmon streams, including but not limited to the mainstem Nisqually River and the Mashel River.

This enhancement project is an annual program to be continued for 15 years or until wild salmon stocks have rebounded enough to a point of self-sustaining carcass supply.

This project improves habitat for various Nisqually River EDT Reaches (problems NIS-01, 02, 04, 05, 06, 07, 08, 09, 10, 12, 13, 15, 17, 18, 19, 20, 21, 22, and 23). This project also improves habitat for other aquatic wildlife.

Project Number: PRG11-03

Project Name: Enhance Nisqually River Council Capacity

Cost Estimate: $375,000 ($37,500 annually over 10 years)

Cost Assumption: 0.5 FTE stewardship coordinator.

Project Score: 332

PART A. NISQUALLY RIVER LAND TRUST STEWARDSHIP COORDINATOR TO PRESERVE WATERFRONT LAND

The Nisqually River Land Trust owns over 1,600 acres in the Nisqually River Watershed, for habitat and flood protection, along over 8 miles of river and streams.

Without on-going stewardship these lands will succumb to a variety of problems such as dumping, illegal forest products harvesting, illegal trespassing, ATV trail making, invasive species infestations, and others that will diminish the quality and function of the property.

In addition, some of the lands purchased need restoration to predevelopment conditions since the developments harm the ecological and flood relief function these lands provided.

The Nisqually River Land Trust has been working for 18 years to preserve waterfront land in the watershed, focusing on the mainstem Nisqually River.

Funding to assist a stewardship coordinator for these lands will enable the Land Trust to fulfill its mission and combat illegal activities on these lands and mitigating damage.

Once properly stewarded, these lands will assist in maintaining good water quality, protecting aquatic habitat and promoting flood relief along the mainstem Nisqually River and its major tributaries.

Cost estimate for Part A: $500,000 ($50,000 annually over 10 years)

PART B. IMPLEMENT NPS CONTROL, HABITAT PRESERVATION & RECOVERY

Coordination of activities within the watershed is critical to the overall success of habitat and water quality restoration efforts. Without a coordinating council, prioritization of projects becomes haphazard, and cooperative efforts are more difficult. Coordinating councils require consistent staffing and steady financial support to be effective.

The Nisqually River Council (NRC) has been working for 20 years to coordinate recovery and preservation activities in the watershed. Funding to continue this effort is paramount to enabling the NRC to build on the efforts started with the 1987 Nisqually River Management Plan and expanded through the 2005 Nisqually River Watershed Stewardship Plan.

Coordination and implementation of the Nisqually River Management Plan and Nisqually River Watershed Stewardship Plan will benefit fish and wildlife habitat and water quality throughout the Nisqually River basin planning area. This program would provide financial and technical support for the NRC's habitat and water quality protection and restoration efforts.

Surface Water Management would provide the NRC with educational material and technical information on non-point source controls applicable to the known or suspected sources in the basin, including hobby farms, dairies, land clearing, logging, septic systems, construction sites, ATV use, solid waste dumping, and runoff from developed areas.

Cost estimate for Part B: $500,000 ($50,000 annually over 10 years)

PART C. NISQUALLY RIVER EDUCATION PROJECT – STUDENT IMPLEMENTED ACTIVITIES

Non-point source pollution continues to be a major contributor to the decline of our waterways. A lack of understanding of the watershed, its mechanics and problems, undermines the effort to ensure adequate supply of clean water for people and fish.

Continue an ongoing program to involve over 800 students in the Nisqually River Education Project, which connects them to their local watershed and creates a sense of stewardship for their environment and empowerment to make a difference in their community.

The program includes:

- Bi-annual water quality monitoring along the Nisqually River and its tributaries with a teacher training event;
- Benthic macroinvertebrate monitoring with a teacher/student training event;
- A Student Congress workshop, to analyze the water quality data, create action projects and learn new watershed stewardship skills;
- An annual Summer Teachers Institute to revitalize committed teachers with the latest environmental education opportunities and curriculum;
- Revegetation and invasive species removal events; and
- Coordinating school groups for salmon carcass tossing events.

Coordination and implementation of the Nisqually River Education Project will benefit fish

and wildlife throughout the Nisqually River basin by educating and empowering the future stewards of the land and water.

Cost estimate for Part C: $500,000 ($50,000 annually over 10 years)

The total project cost is estimated to be $1,500,000 or $150,000 annually for 10 years. This project would be implemented in partnership with the Nisqually Tribe, Thurston County, the State of Washington, the federal government, and possibly other entities. Pierce County's share is estimated to be 25%, or $375,000 ($37,500 annually for 10 years).

Project Number: PRG11-04

Project Name: Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems

Cost Estimate: $116,000 ($11,600 annually over 10 years)

Cost Assumption: Includes 0.1 FTE per year in Nisqually River Basin.

Project Score: 183

Failures of on-site sweater treatment systems have occurred in the Basin. Failing septic systems, especially in shoreline areas, could contribute bacteria and nutrients to lakes and streams. County staff should notify the Tacoma-Pierce County Health department of reported septic systems problems in the basin planning area, so that TPCHD can take appropriate action (i.e. focused education, technical assistance).

Project Number: PRG11-05

Project Name: Implement Elements of Nisqually River Bacteria TMDL Water Quality Implementation Plan

Cost Estimate: $58,000

Cost Assumption: Includes 0.1 FTE per year for a 5-year period.

Project Score: 240

The state Department of Ecology issued a TMDL for fecal coliform bacteria Lynch Creek, Ohop Creek, and Red Salmon Creek. Ecology completed the TMDL Water Quality Implementation in 2007. Surface Water Management participated in the development of the Water Quality Implementation Plan and has agreed to help implement it. To that end, Surface Water Management will perform the following activities:

- Provide pet owner education materials to the Town of Eatonville
- Monitor Ohop and Lynch Creeks
- Investigate bacteria sources affecting Lynch Creek
- Continue implementation of stormwater BMPs
- Complete the Nisqually River Basin Plan

9.3.4 Recommendations for Additional Studies

The Basin Plan contains 18 studies to provide information needed to address current Basin issues that cannot be resolved without additional data collection and analysis. Study results will assist in the next update of the Basin Plan and implementation of recommended projects with an improved understanding of basin characteristics.

This section presents the recommended studies grouped by County subbasins. Each study is listed in Table 9-7 along with the program score and estimated cost. Studies were not ranked, because the County's ranking criteria do not apply to studies.

TABLE 9-7
Studies and Costs

Study Number	Name	Estimated Cost
ST11-BRI-ST01	Brighton Creek Barrier Removal Assessment (62nd Ave. S.)	$5,500
ST11-HRN-ST01	Horn Creek Barrier Removal Assessment (368th St. S.)	$5,500
ST11-HRN-ST01	Harts Creek / Harts Lake Habitat Assessment	$75,000
ST11-MUR-ST01	Lower Murray Restoration Assessment	$85,000
ST11-MUR-ST02	Murray, Brighton and Horn Creek Wetlands Restoration Assessment	$275,000
ST11-MUR-ST03	Murray Creek Barrier Removal Assessment (48th Ave. S., RM 6.2)	$5,500
ST11-MUR-ST04	Murray Creek Barrier Removal Assessment (pipeline crossing, RM 7.2)	$5,500
ST11-MUR-ST05	Murray Creek Hydrologic Study and Flood Hazard Mapping	$95,000
ST11-NIS-ST01	Mainstem Nisqually River LWD Assessment and Restoration Plan	$125,000
ST11-TWL-ST01	Cranberry and Rapjohn Lakes Assessment	$75,000
ST11-TWL-ST02	Lower Tanwax Sediment Reduction Assessment	$50,000
ST11-TWU-ST01	Tanwax Valley Restoration Assessment	$275,000
ST11-TWU-ST02	Eatonville Cutoff Road Culvert Replacement Assessment (Mud Creek)	$5,500
ST11-TWU-ST03	Eatonville Cutoff Road Culvert Replacement Assessment (Tanwax Creek)	$5,500
ST11-TWU-ST04	Trout Creek at 352nd Street East Culvert Replacement Assessment	$5,500
ST14-OHU-ST01	Clay City Sediment Reduction Assessment	$70,000
ST19-NIS-ST03	Analysis of Flooding at State Route 7 in Community of Elbe	$150,000
ST20-LMR-ST01	Lower Mashel Restoration Assessment	$50,000
	Total Estimated Cost	**$1,363,500**

Notes: Costs are for studies only and do not cover costs of projects that may result from the study.

Project Number: ST11-BRI-ST01

Project Name: Brighton Creek Barrier Removal Assessment (62nd Ave. S.)

Cost Estimate: $5,500

Problem: A 30-foot long culvert located at river mile 0.9 is only 67% passable according to a Level A (less detailed) analysis.

Existing data are insufficient to determine whether the culvert is truly a barrier and to support the design of an appropriate solution.

Recommendation: Visit culvert location to collect information for a Level B (more detailed) analysis. Perform a Level B analysis.

If results indicate culvert is a barrier, remove and replace the existing 49-inch by 33-inch pipe arch, corrugated steel culvert.

Downstream barrier (CIP11-BRI-FP01) should be improved first.

Benefit: Assessment could result in a project that allows for fish passage, natural flow patterns, and improves habitat for the *Brighton Cr-1_d* EDT Reach (problems *BRI-06* and *BRI-07*).

Project Number: ST11-HRN-ST01

Project Name: Horn Creek Barrier Removal Assessment (368th St. S.)

Cost Estimate: $5,500

Problem: A 31-foot long culvert on 368th St. S., near river mile 2.5, is a total barrier due to steep slope and that the culvert is broken, according to a Level A analysis.

Existing data are insufficient to determine whether the culvert is truly a barrier and to support the design of an appropriate solution.

Recommendation: Visit culvert location to collect information for a Level B analysis. Perform a Level B analysis.

If results indicate culvert is a barrier, remove and replace the existing 36-inch concrete culvert. Downstream barriers (CIP11-HRN-FP01 and CIP11-HRN-FP02) should be improved first.

Benefit: Assessment could result in a project that allows for natural flow, opens available spawning and rearing habitat, and improves habitat for the *Horn Cr-2_b* EDT Reach (problem *HRN-05*).

Project Number: ST11-HRT-ST01

Project Name: Harts Creek / Harts Lake Habitat Assessment

Cost Estimate: $75,000

Problem: Harts Lake borders Wilcox farm near the City of Roy, and drains to the Nisqually River through "Harts Lake outlet" or "Harts Creek."

The channel was created artificially and the lake, most likely, originally connected to the river through a series of wetlands rather than a defined creek.

The creek currently provides low habitat value, except for the lower end where wetlands still dominate. In the areas above the wetlands, the channel is very incised, invaded by reed canary grass, exhibits no gravel substrate, has very shallow flows and limited to no riparian buffer.

Water diversion structures in the creek may pose passage problems and affect flow, especially during summer low flows. The riparian buffer is limited by an access road as well as invasive plants such as blackberry.

The creek's water quality is impaired due to its proximity to various nutrient sources from farm operations, connection to a developed lake, low flow and lack of riparian shade.

Recommendation: Evaluate habitat potential. All of "Harts Creek" and Harts Lake are within the Nisqually River channel migration zone and could provide extensive floodplain habitat.

Although restoring "Harts Lake outlet" to its original condition of a large wetland would provide more benefit to fish than its current creek alignment, this would render large areas of agricultural land unusable and hence is not feasible.

Creating a healthy riparian buffer along the channel would be the second best restoration opportunity, possibly in conjunction with wetland enhancement, i.e. removal of invasive plants and planting of native wetland species near the confluence with Horn Creek.

Benefit: Assessment could result in a project that improves habitat for the *Harts Creek-1_a, Harts Creek-1_b, Harts Creek-1_c,* and *Harts Creek-1_d* EDT Reaches (problems *HRT-01, HRT-02, HRT-03, HRT-06,* and *HRT-08*).

Project Number: ST11-MUR-ST01

Project Name: Lower Murray Restoration Assessment

Cost Estimate: $85,000

Problem: The reach of Murray Creek between the unnamed lake near the Denman Marsh and Highway 507 is extensively utilized by chum salmon in years with high chum returns and plentiful flow. This reach has been affected by unrestricted livestock access, which appears to have eroded the banks and promoted invasive grasses. Additional impacts include loss of riparian canopy and large woody debris. The sparse riparian canopy has likely led to higher summer water temperatures and more suitable conditions for non-native vegetation. The sparse woody debris means the creek has fewer opportunities for fish concealment and less food for aquatic organisms.

Recommendation: This project would assess the habitat and extent of alteration and develop a recommended project. A recommended project would include, but not be limited

to: enhancement of the riparian areas by fencing off livestock and planting native vegetation, restoration of degraded instream habitat by recreating stream components that have been severely impacted, and restoration of the channel by re-shaping banks, bars and pools and adding habitat-forming large woody debris. The study should identify land ownership and access needs for initial construction and ongoing maintenance.

Benefit: Assessment could result in a project that restores historic conditions. Restoring historic conditions, after fish passage is regained (projects ST11-MUR-ST03, -04 and other locations), would greatly benefit local salmonids.

Restoring conditions would also improve downstream habitat by storing water over the winter and slowly releasing it over the summer, keeping the water cool and free of excessive nutrients and sediment.

This project could improve habitat for the *Murray Cr-1, Murray Cr-2_a, Murray Cr-2_b_A, Murray Cr-2_b_B, Murray Cr-3_a*, and *Murray Cr-3_b* EDT Reaches (problems *MUR-01*, *MUR-02*, *MUR-06*, *MUR-14*, *MUR-19*, and *MUR-21*).

Project Number: ST11-MUR-ST02

Project Name: Murray, Brighton and Horn Creek Wetlands Restoration Assessment

Cost Estimate: $275,000

Problem: Many wetlands in the upper Horn, upper Murray and upper Brighton Creek reaches have been altered, mostly by the surrounding agriculture.

Although many of the wetlands historically have not had much salmon usage, their moderating effects on downstream flow, water quality and sedimentation have always benefited salmon stocks. Many of these beneficial effects have been eliminated by wetland ditching, diking, filling and flooding, as well as, removal of riparian buffers and wetland forests.

These changes and an increase in the amount of bed scour have also led to a decline in channel stability in most sections of the creeks. Poor channel stability reduces the survival of incubating eggs, and of fry and juveniles that rear in the creek. The disconnection of the channel from its floodplain and lack of large wood in the stream channel have also resulted in fewer habitats for rearing juveniles to hold in during summer low flows.

The wetlands at the mouths of Brighton Creek and Horn Creek are refuge areas for juvenile salmonids (both salmonids that were hatched in the creek and salmonids hatched in other places in the Nisqually River that migrate in from the river) and should be the highest priority for restoration and protection in these subbasins.

The Lower Brighton Reach (below Harts Lake Loop Road) is primarily good habitat, although it has some minor problems with loss of streamside vegetation, reduced availability of large instream wood, and reduced numbers of salmon carcasses to provide nutrients compared to historic conditions.

In addition, there is extensive invasive reed canary grass which dominates the emergent

wetland and the riparian vegetation.

Recommendation: This project would begin to assess the habitat and extent of alteration and develop recommended projects.

Recommended projects include, but are not limited to: enhancement of the riparian areas, restoration of degraded instream habitat, restoration of the wetland functions and removal of invasive species.

The study should identify land ownership and access needs for initial construction and ongoing maintenance.

Benefit: Assessment could result in a project that restores wetlands, vegetation and other historic conditions.

Restoring wetlands in the upper Horn, upper Brighton, and upper Murray Creek reaches to their historic conditions would greatly benefit local salmonids. It could help increase summer flows and reduce sedimentation issues.

Restoring conditions would also improve downstream habitat by storing water over the winter and slowly releasing it over the summer, keeping the water cool and free of excessive nutrients and sediment.

This project could improve habitat for the *Horn Cr-2_a* and *Horn Cr-2_b* EDT Reaches (problem *HRN-10*), *Murray Cr-1, Murray Cr-2_a, Murray Cr-2_b_A, Murray Cr-2_b_B, Murray Cr-3_a*, and *Murray Cr-3_b* EDT reaches (problems *MUR-01*, *MUR-02*, *MUR-06*, *MUR-14*, *MUR-19*, and *MUR-21*) and *Brighton Cr-1_d* EDT each (problem *BRI-13*).

Restoration of the vegetation along the stream channel and removal of reed canary grass in the lower Brighton Creek and Horn Creek wetlands would significantly benefit juvenile salmon by providing refuge areas.

This project could improve habitat for the *Brighton Cr-1_a* EDT Reach (problems *BRI-01* and *BRI-03*), *Horn Cr-1* and *Nisqually River-McKenna* EDT Reaches (problems *HRN-01* and *NIS-13*).

Project Number: ST11-MUR-ST03

Project Name: Murray Creek Barrier Removal Assessment (48th Ave. S., RM 6.2)

Cost Estimate: $5,500

Problem: A 62-foot long culvert at 48th Ave S. near river mile 6.2 is not passable until maintenance is performed to remove gravel.

The gravel causes the bed elevation to change and the steep bed slope causes the impassability. After the gravel is removed, the culvert is only 33% passable according to the Level A analysis.

Existing data are insufficient to determine whether the culvert is truly a barrier and to support the design of an appropriate solution.

Recommendation: Visit culvert location to collect information for a Level B analysis. Perform a Level B analysis.

If results indicate culvert is a barrier, remove and replace the existing 56-inch round, cast-in-place culvert.

Benefit: Assessment could result in a culvert replacement project that would open available spawning and rearing habitat for salmon and trout improving habitat for the *Murray Cr-3_a* EDT Reach (problem MUR-20).

Project Number: ST11-MUR-ST04

Project Name: Murray Creek Barrier Removal Assessment (pipeline crossing, RM 7.2)

Cost Estimate: $5,500

Problem: A 20-foot long culvert at a pipeline crossing located near river mile 7.2, which is only 33% passable according to a Level A analysis, due to steep slopes.

The culvert is also damaged at its upstream end. Existing data are insufficient to determine whether the culvert is truly a barrier and to support the design of an appropriate solution.

Recommendation: Visit culvert location to collect information for a Level B analysis. Perform a Level B analysis.

If results indicate culvert is a barrier, remove and replace the existing 57 by 38-inch pipe arch, corrugated steel culvert. If is not a barrier, fix damaged end.

Downstream barrier (ST11-MUR-ST03) should be improved first.

Benefit: Assessment could result in a culvert replacement project that would open available spawning and rearing habitat for salmon and trout improving habitat for the *Murray Cr-3_b* EDT Reach (problem MUR-22).

Project Number: ST11-MUR-ST05

Project Name: Murray Creek Hydrologic Study and Flood Hazard Mapping

Cost Estimate: $95,000

Problem: Development pressures in the Murray Creek subbasin increase the need for accurate delineation of flood hazard zones to prevent future flood damages and to protect the public.

In addition, several flooding problems were identified along Murray Creek and tributary drainages including roadway flooding along:

- 336th Street South between 48th Ave South and 40th Ave South
- Hinkleman Road
- Lyons Drive South
- Tisch Road.

The 100-year floodplain mapped for Murray Creek was developed for the FEMA Flood Insurance Study (FIS) using approximate hydrologic and hydraulic methods.

This mapping could be improved with a detailed flood study.

Recommendation: A detailed hydrologic and hydraulic model should be developed for Murray Creek and relevant tributaries.

A detailed flood study along Murray Creek should be completed to re-map the floodplain, develop Base Flood Elevations, and to map the floodway.

A Letter of Map Revision should be completed for submittal to FEMA.

Benefit: This project helps assess flooding problems MUR-10, MUR-12, MUR-26, MUR-27, and MUR-28.

Project Number: ST11-NIS-ST01

Project Name: Mainstem Nisqually River LWD Assessment and Restoration Plan

Cost Estimate: $125,000

Problem: In the watershed analyses and in other assessments of the mainstem Nisqually River, it has been noted that certain sections of the Nisqually River mainstem are lacking wood, especially in the reaches immediately downstream of the Alder/La Grande Hydro Project.

Recommendation: This project will assess the large woody debris loading in many of mainstem reaches, identify wood loading deficiencies, and evaluate data on wood recruitment to develop a wood recruitment project to a 30% engineering design level.

Benefit: Assessment could result in a restoration project that improves habitat for the Nisqually River (problems NIS-01, 02, 04, 05, 06, 07, 08, 09, 10, 12, 13, 15, 17, 18, 19, 20, 21, 22, and 23).

Project Number: ST11-TWL-ST01

Project Name: Cranberry and Rapjohn Lakes Assessment

Cost Estimate: $75,000

Problem: The rearing potential of Cranberry and Rapjohn Lakes needs to be assessed.

These two lakes have the least lakeside development of all the tributary lakes in the subbasin, and therefore have higher restoration potential than other lakes. Elimination of non-native species would be beneficial.

Restoration and habitat potential of lakes other than Rapjohn and Cranberry (and their outlet tributaries) should be assessed.

Recommendation: Assess salmon habitat rearing potential.

Benefit: Assessment could result in lake restoration projects that provide refuge and rearing habitat for fish, improving habitat for the *Cranberry Reach* EDT Reach (problem *TWL-03*).

Project Number: ST11-TWL-ST02

Project Name: Lower Tanwax Sediment Reduction Assessment

Cost Estimate: $50,000

Problem: Fine sediments are detrimental to the survival of juvenile fish.

The extensive former logging road network in the Lower and Middle Tanwax Reaches (i.e. below the Rapjohn Creek confluence) is a potential source of excessive fine sediment input to the creek.

Historically drainage ditches from logging roads were typically routed directly to the stream network, delivering sediment from surface erosion to the creek.

Recommendation: Water bars can be built to redirect water and sediment onto the hillslope rather than into the stream preventing excess fine sediment inputs to the creek.

It may also be possible to abandon unneeded roads.

Benefit: Assessment could result in a project that would reduce the amount of fine sediment inputs to the creek improving aquatic habitat for the *Tanwax Cr-1* and *Tanwax Cr-2* EDT Reaches (problems *TWL-01* and *TWL-02*).

Project Number: ST11-TWU-ST01

Project Name: Tanwax Valley Restoration Assessment

Cost Estimate: $275,000

Problem: In an estimated 1.0-mile long section of Tanwax Creek valley, below and above the

Eatonville Cutoff Road, the creek has been ditched and the wetlands drained for agricultural purposes.

This has potentially harmful effects on fish and aquatic habitat in this section, but the extent of the damage and area requiring restoration are not known.

Recommendation: This project would begin to assess the habitat and extent of alteration and develop a recommended project.

Benefit: Assessment could result in a project that improves habitat for *Tanwax Cr-3_a* and *Tanwax Cr-3_b* EDT Reaches (problems *TWU-01* and *TWU-07*).

Project Number: ST11-TWU-ST02

Project Name: Eatonville Cutoff Road Culvert Replacement Assessment (Mud Creek)

Cost Estimate: $5,500

Problem: A 41-foot long culvert at Eatonville Cutoff Road (Mud Creek river mile 1.3) is a partial barrier (67 % passable) to fish passage according to a Level A analysis.

The limited passability is due to steep slope.

Existing data are insufficient to determine whether the culvert is truly a barrier and to support the design of an appropriate solution.

Recommendation: Visit culvert location to collect information for a Level B analysis. Perform a Level B analysis.

If results indicate culvert is a barrier, remove and replace the existing 8-foot (span) by 6-foot (rise) concrete box culvert.

Benefit: Assessment could result in a project that opens a culvert for fish passage providing access to habitat on the *Mud* EDT Reach (problems *TWU-03* and *TWU-10*).

Project Number: ST11-TWU-ST03

Project Name: Eatonville Cutoff Road Culvert Replacement Assessment (Tanwax Cr.)

Cost Estimate: $5,500

Problem: A 62-foot long culvert at Eatonville Cutoff Road (Tanwax Creek river mile 7.8) is a partial barrier (50% passable) to fish passage according to a Level A analysis.

This limited passability is due to velocity. Existing data are insufficient to determine whether the culvert is truly a barrier and to support the design of an appropriate solution.

Recommendation: Visit culvert location to collect information for a Level B analysis. Perform a Level B analysis.

If results indicate culvert is a barrier, remove and replace the existing 8-foot (span) by 6-foot (rise) concrete box culvert.

Downstream barrier (ST11-TWU-ST02) should be improved first.

Benefit: Assessment could result in a project that opens a culvert for fish passage and provides access to habitat on the *Tanwax Cr-3_b, Tanwax Lake, and Upper Tributaries* EDT Reaches (problems *TWU-06, TWU-07, TWU-22,* and *TWU-29*).

Project Number: ST11-TWU-ST04

Project Name: Trout Creek at 352nd Street East Culvert Replacement Assessment

Cost Estimate: $5,500

Problem: An 89-foot long culvert at 352nd Street East (Trout Creek river mile 0.2) is a total barrier to fish passage due to steep slope and outfall drop height according to a Level A analysis.

Existing data are insufficient to determine whether the culvert is truly a barrier and to support the design of an appropriate solution.

Recommendation: Visit culvert location to collect information for a Level B analysis. Perform a Level B analysis.

If results indicate culvert is a barrier, remove and replace the existing 2-foot diameter, round, concrete culvert.

Downstream barriers (ST11-TWU-ST02 and -ST03) should be improved first.

Benefit: Assessment could result in a project that opens culvert for fish passage and provides access to habitat on Trout Creek (no EDT Reach has been analyzed above this barrier) (problem *TWU-13*).

Project Number: ST14-OHU-ST01

Project Name: Clay City Sediment Reduction Assessment

Cost Estimate: $70,000

Problem: Exposed sediment at the abandoned brick factories and clay mines in the "Clay City" area contribute to fine sediment problems in the Twenty-Five Mile Creek subbasin.

The extent of the problem and possible solutions are currently unknown.

Recommendation: An assessment should inventory the extent of the exposed sediment, the potential hazard to local salmonids, and identify a variety of methods to reclaim these areas and address the various sediment sources.

Benefit: Assessment could result in a project that reduces sediment inputs, benefiting important coho spawning areas in the subbasin, and improving habitat for the *Twentyfive*

Mile Cr EDT Reach (problem *OHU-16*).

Project Number: ST19-NIS-ST03

Project Name: Analysis of Flooding at State Route 7 in Community of Elbe

Cost Estimate: $150,000

Problem: State Route 7 in the community of Elbe floods. Backwater from roadway flooding causes flooding of local buildings, such as the U.S. Post Office. Preliminary field investigations by SWM staff indicate that the drainage problem is due to inadequate capacity of the drainage system in the right-of-way for State Route 7.

Recommendation: Conduct additional investigations to confirm the cause of the problem. Perform hydrologic and hydraulic analyses to assess drainage system capacity and identify project alternatives to mitigate the problem. Projects associated with these mitigation alternatives will likely fall within the jurisdiction of the Washington State Department of Transportation (WSDOT); however, Pierce County will work with WSDOT to help facilitate the project and resolve the problem.

Benefit: This study will provide information necessary to identify a preferred mitigation alternative to address flooding problem ALD-03.

Project Number: ST20-LMR-ST01

Project Name: Lower Mashel Restoration Assessment

Cost Estimate: $50,000

Problem: The lower section of the Little Mashel River is impacted by degradation of riparian areas by adjacent land owners.

Recommendation: This project would begin to assess the habitat and extent of alteration and develop a recommended project.

A recommended project would include, but not be limited to enhancement of the riparian areas by planting native vegetation and restoration of degraded instream habitat by recreating stream components that have been severely impacted.

The study should identify land ownership and access needs for initial construction and ongoing maintenance.

Benefit: Assessment could result in a project that restores historic conditions, benefiting local salmonids, and improving habitat for the *Little Mashel R* EDT Reach (problem *LMR-01*).

9.4 IMPLEMENTATION

9.4.1 Capital Facilities Element of Pierce County Comprehensive Plan

The annually updated Capital Facilities Element of the *Comprehensive Plan for Pierce County, Washington* (Pierce County Code 19E) is the capital improvement program for Pierce County Surface Water Management.

It describes the capital projects over $100,000 that Surface Water Management intends to construct in a six-year period. It also presents the non-capital (non-structural) alternatives that can be used with capital projects to help meet the level of service standard for storm drainage and surface water management facilities.

Surface Water Management has two entries in the Capital Facilities Plan: 19E.50.130, River Improvement Facilities; and 19E.50.170, Surface Water Management. The Capital Facilities Plan sets the stage for Surface Water Management annual budget.

9.4.2 Annual Budget for Pierce County Surface Water Management

The Pierce County budget each year authorizes the activities of Surface Water Management. Programmatic measures, studies, and capital improvement projects appear in the detailed annual budget.

Capital improvement projects in the annual budget generally come from the Capital Facilities Element of the County's Comprehensive Plan described in Section 9.4.1 or in response to an unexpected problem.

9.4.3 Order of Implementation

Implementation of the recommended actions will generally follow the prioritization groupings of High-Priority, Medium-Priority, and Low-Priority in a logical order of sequencing.

To realize the full benefits of projects, implementation will not follow the exact progression of the first project to the last project in the High category, followed by the first action in the Medium category, and so forth.

Several factors contribute to implementation of actions in an order different than that depicted in Table 9-2, High-Priority Recommended Projects; Table 9-3, Medium-Priority Recommended Projects; and Table 9-4, Low-Priority Recommended Projects.

Influencing factors include the following:

- Availability of funds
- The completion of other projects or activities on which a project relies

- Available staff and professional services
- Cooperation from private landowners
- Identification of a implementing agency other than Pierce County Public Works and Utilities
- New information, regulations, or emerging issues

9.4.4 Economic Development Criteria

Implementing projects and programs recommended in the Basin Plan is expected to reduce flood hazards, and preserve or protect water quality and floodplain habitat. Collectively and individually, these projects are aimed at protecting Pierce County's quality of life.

Projects and programs in the Basin Plan will:

- Afford resource protection as the community develops
- Preserve, enhance or protect natural floodplain functions
- Balance structural and non-structural approaches
- Reduce potential County environmental liabilities
- Help achieve environmental compliance and long term sustainability

Collectively, these attributes help make Pierce County a livable community where quality of life issues will provide indirect, passive economic development benefits to businesses and individuals looking to locate or stay in Pierce County.

In addition, Surface Water Management will consider the following criteria in developing its annual proposed capital facilities plan updates:

- Is the project located in an employment center zone (or handle flow from those zones)?
- Is the project located in another type of commercial zone (or handle flow from those zones)?
- Will the project reduce permitting timelines for industrial/commercial projects?
- Will the project assure access to an employment center via road and /or rail?
- Will the project increase the supply of developable property?
- Will the project reduce overall development costs?
- Are there partners willing to contribute to the development costs of the project?
- Does the project allow / provide for land development?

In light of these and other factors, following action on the Basin Plan, Pierce County will develop an implementation strategy designed to sequence, schedule and assign resources for the various recommended actions.

This implementation strategy will be developed in collaboration and coordination with other potential implementers and in consideration with available financial and staff resources. The implementation strategy will include performance measurements and provide for periodic evaluation of progress.

9.4.5 Voluntary Actions by Other Interested Parties

Broad, multi-stakeholder groups such as the Nisqually River Council can be instrumental in implementation of the Basin Plan.

Representatives of environmental interest groups, tribes, business, economic development, and individual citizens provide valuable suggestions about specific activities. Their support of specific activities and the ongoing progress of Basin Plan implementation will be an essential component of successful implementation. For example, these groups can be instrumental in carrying out effective public education.

Businesses in the Basin can be involved in implementation of the Basin Plan recommendations. The private sector will need to comply with regulations to protect the water resources and habitat of the Nisqually River Basin. Additionally, businesses can be partners in developing creek and natural resource protection strategies, and may also offer funding assistance for individual and/or ongoing watershed activities.

Farmers and other large landowners with extensive property along the creeks can play a critical role in addressing the temperature and sedimentation problems.

The establishment and revegetation of riparian buffers is the single most important measure for improving water quality within the Basin.

9.5 PROBLEMS AND CIP SOLUTIONS CROSS-REFERENCE

TABLE 9-8
Problems and CIP Solutions Cross-Reference

RECOMMENDED ACTION		PROBLEMS ADDRESSED
HIGH-PRIORITY		
CIP08-RED-RST01	Red Salmon Slough Estuary Restoration Phase III	NIS-02 (habitat)
CIP11-TWU-AC01	Tanwax Creek Wetland Protection Phase 1	TWL-01, TWL-02, TWU-06, TWU-22, TWU-29 (all habitat)
CIP11-TWU-AC02	Tanwax Creek Wetland Protection Phase 2	TWL-01, TWL-02, TWU-06, TWU-22, TWU-29 (all habitat)

TABLE 9-8
Problems and CIP Solutions Cross-Reference

RECOMMENDED ACTION		PROBLEMS ADDRESSED
MEDIUM-PRIORITY		
CIP19-ASH-C01	Culvert Replacement at 278th Avenue East	ASH-02 (flooding)
CIP20-MAL-VC01	Mashel Eatonville Reach Riparian Revegetation	MAL-01 (habitat), MAL-03 (habitat), MAL-04 (habitat)
CIP11-BRI-C01	Upper Brighton Creek Culvert Replacements	BRI-18 (flooding), BRI-19 (flooding), BRI-21 (flooding)
CIP11-NIS-RST01	Nisqually River Wilcox Side-Channel	NIS-13 (habitat), NIS-15 (habitat)
CIP14-OHL-AC04	Ohop Creek Repetitive Loss Property Acquisition	OHL-07 (flooding)
CIP14-OHL-AC01	Ohop Creek Property Acquisition Phase 1	OHL-01 (habitat)
CIP14-OHL-AC02	Ohop Creek Property Acquisition Phase 2	OHL-01 (habitat)
CIP14-OHL-AC03	Ohop Creek Property Acquisition Phase 3	OHL-01 (habitat)
CIP20-MAL-AC03	Mashel Small Properties Acquisition	MAL-01 (habitat), MAL-03 (habitat), MAL-04 (habitat)
CIP20-MAL-AC01	Mashel River Property Acquisition	MAL-03 (habitat)
CIP19-COP-AC01	Upper Nisqually River Property Acquisition	NIS-25 (flooding)
CIP11-NIS-RST03	Mainstem Off-Channel Restoration	NIS-01, 02, 04, 05, 06, 07, 08, 09, 10, 12, 13, 15, 17, 18, 19, 20, 21, 22, 23 (all habitat)
CIP20-MAL-AC02	Mashel Shoreline Buffer Acquisition	MAL-03 (habitat)
CIP11-KRG-C01	Silver Lake Culvert Replacement	KRG-09 (flooding)
CIP11-NIS-AC04	Wilcox Flats Repetitive Loss Acquisition	NIS-16 (flooding)
CIP20-MAL-RST01	Mashel Eatonville Reach Instream Restoration Phase II	MAL-01 (habitat), MAL-03 (habitat), MAL-04 (habitat)
CIP14-OHU-AC01	Upper Ohop Shoreline Protection (Hancock-Ohop) Phase 1	OHU-16 (habitat), OHU-17 (habitat)
CIP14-OHU-AC02	Upper Ohop Shoreline Protection (Hancock-Ohop) Phase 2	OHU-16 (habitat), OHU-17 (habitat)
CIP14-OHL-AC01	Ohop Creek Acquisition	OHL-01 (habitat)
CIP14-OHL-RST01	Lower Ohop Valley Restoration Phase 1 (Segments D, E and F)	OHL-01 (habitat)
CIP11-NIS-AC02 (renumbered to AC01)	Nisqually River Mainstem Acquisition Phase 2	NIS-01, 02, 04, 05, 06, 07, 08, 09, 10, 12, 13, 15, 17, 18, 19, 20, 21, 22, 23 (all habitat)
CIP11-NIS-AC03 (renumbered to AC02)	Nisqually River Mainstem Acquisition Phase 3	NIS-01, 02, 04, 05, 06, 07, 08, 09, 10, 12, 13, 15, 17, 18, 19, 20, 21, 22, 23 (all habitat)
CIP14-OHL-RST02	Lower Ohop Valley Restoration Phase 2 (Segments A, B and C)	OHL-01 (habitat)
CIP14-OHL-RST03	Lower Ohop Valley Restoration Phase 3 (Segments G, H, I, J, K and L)	OHL-01 (habitat)

TABLE 9-8
Problems and CIP Solutions Cross-Reference

RECOMMENDED ACTION		PROBLEMS ADDRESSED
LOW-PRIORITY		
CIP11-TWU-C03	Culvert Replacement at Thomas Road	TWU-24 (flooding)
CIP11-TWU-C02	Webster Road Culvert Replacement	TWU-16 (flooding)
CIP11-MUR-C01	Tisch Road South Culvert Replacement	MUR-18 (flooding)
CIP11-TWL-C01	Culvert Replacement at 365th Street East	TWL-06 (flooding)
CIP11-HRN-C01	364th Street East Culvert Replacement	HRN-09 (flooding)
CIP11-HRT-C01	Hart's Lake Loop Road Culvert Replacement	HRT-10 (flooding)
CIP11-CLR-C01	West Clear Lake Road Culvert	CLR-01 (flooding)
CIP11-TWU-C01	Benbow Drive Culvert Replacement	TWU-34 (flooding), TWU-35 (flooding)
CIP11-HRN-FP01	Horn Creek Barrier Removal (waterfall at RM1.0)	HRN-04 (habitat)
CIP11-HRN-FP02	Horn Creek Barrier Removal (Hart Lake Loop Rd.)	HRN-04 (habitat)
CIP11-KRG-C02	Dean Kreger Road Culvert Replacement and Slope Stabilization	There is no problem number. This problem was identified after the Basin Characterization Report was completed.
CIP11-NIS-RST02	Wilcox Flats Off-Channel Restoration	NIS-15 (habitat), NIS-17 (habitat), NIS-18 (habitat)
CIP11-TWL-RST01	Lower Tanwax Riparian Enhancement	TWL-01 (habitat), TWL-02 (habitat)
CIP11-BRI-FP01	Brighton Creek Culvert Replacement (Harts Lake Loop Rd.)	BRI-02 (habitat)

NISQUALLY RIVER BASIN PLAN

FINAL

SUPPLEMENTAL ENVIRONMENTAL

IMPACT STATEMENT

Pierce County
Department of Planning and Land Services

CHUCK KLEEBERG
Director

2401 South 35th Street
Tacoma, Washington 98409-7460
(253) 798-7210 • FAX (253) 798-7425

August 20, 2008

Dear Interested Party:

Attached is the ***Final Supplemental Environmental Impact Statement (Final SEIS)*** for the ***Proposed Nisqually River Basin Plan (Basin Plan)*** issued on August 20, 2008. The Final SEIS revises the Draft Supplemental Environmental Impact Statement (Draft SEIS) in response to comments received during the 30-day comment period. A new section called "Responses to Comments" has been added.
The Pierce County Department of Public Works and Utilities, Surface Water Management, proposes to update the *1991 Pierce County Storm Drainage and Surface Water Management Plan* (1991 Plan) by adopting a basin-specific plan for unincorporated, non-federal areas of Pierce County draining to the Nisqually River, excluding the Muck Creek drainage basin. The Proposed Basin Plan evaluates flooding, water quality, habitat, and other storm drainage problems and recommends capital improvement projects and nonstructural measures to solve the problems.

This Final SEIS is prepared as a non-project environmental impact statement per Washington Administrative Code, Chapter 197-11-442. The non-project Final SEIS provides a general discussion of the probable significant adverse environmental impacts of implementing the Proposed Basin Plan and the No-Action Alternative. Many proposed actions covered in the Final SEIS will be subject to project-specific environmental review prior to construction or implementation.

There is no comment period for this Final SEIS. An appeal of the adequacy of the Final SEIS may be filed at the Pierce County Development Center, Pierce County Public Services Building (Annex), 2401 South 35th Street, Tacoma, WA 98409 by filing a notice of appeal together with an appeal fee of $1323.00 by 4:30 p.m. on September 3, 2008. More information on the appeal of a Final SEIS may be obtained at the Development Center.

The Proposed Basin Plan and Final SEIS (Chapter 10 of the Plan) are posted on the County's website at http://www.piercecountywa.org/pc/services/home/environ/water/ps/basinplans. Printed copies of the Proposed Basin Plan and Final SEIS may be purchased for the cost of printing at Pierce County Public Works and Utilities, 2702 South 42nd Street, Tacoma, Washington, or at the Pierce County Planning and Land Services Department at 2401 South 35th Street, Suite 175, Tacoma, Washington. Copies of the FSEIS and Proposed Basin Plan can also be reviewed at the following libraries: Pierce County Library–DuPont Branch, Pierce County Library–Eatonville Branch, and Pierce County Library–Graham Branch.

For more information about the Final SEIS, call Adonais Clark at (253) 798-7165. For questions regarding the Proposed Nisqually River Basin Plan, contact Roy Huberd, (253) 798-6793 or Randy Brake, at (253) 798-4651, Pierce County Public Works and Utilities, Surface Water Management.

Sincerely,

CHARLES F. KLEEBURG
Director

Adonais Clark

By: Adonais Clark
Environmental Designee

Printed on recycled paper

CHAPTER TEN
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

FACT SHEET

Final Supplemental Environmental Impact Statement (FSEIS)

Title and Description of "Proposed Action"

Final Nisqually River Basin Plan. Pierce County proposes to update its *1991 Storm Drainage and Surface Water Management Plan* (1991 Plan) by adopting and implementing a basin-specific update for the Nisqually River Basin. The 1991 Plan has guided the identification, design, construction, and operation of surface water management facilities and the implementation of Surface Water Management throughout unincorporated Pierce County. The proposed Nisqually River Basin Plan (Basin Plan) would include basin-specific capital improvement projects and programmatic measures (activities) to solve flooding, water quality, habitat, and other storm drainage problems within the unincorporated portion of the Nisqually Basin.

This *Final Supplemental Environmental Impact Statement* (FSEIS) evaluates two alternatives. The "Proposed Action" is the adoption and implementation of the Nisqually River Basin Plan. The "Proposed Action" would achieve the County's goals and objectives to reduce flood hazards, improve water quality, improve fish habitat, demonstrate responsible use of public resources, and influence methods for new development. The "No Action" Alternative is the continued implementation of the 1991 Plan and other current Pierce County surface water management activities.

This Nisqually River Basin Plan FSEIS adds information to the "Environmental Impact Statement" for the 1991 Plan. New and additional information since 1991 includes changes to regulations and policies, constructed stormwater facilities, revised existing conditions, new growth and development patterns in Pierce County, and updated information on water quality, flooding problems, and habitat problems in the Nisqually River Basin.

Location of Proposal

The planning area is the unincorporated Pierce County portion of the Nisqually River Basin. The planning area excludes the Muck Creek Basin and areas within other jurisdictions, such as incorporated towns and cities, most commercial timber lands, and federal lands.

Proponent	Proponent and Lead Agency: Pierce County Department of Public Works and Utilities, Surface Water Management
Proponent Contact	Roy Huberd, Planner Pierce County Public Works and Utilities, Surface Water Management 9850 64th Street West University Place, WA 98467-1078 (253) 798-6793
Lead Agency	Pierce County Department of Public Works and Utilities, Surface Water Management
Responsible Official	Charles F. Kleeburg, Director, Pierce County Planning and Land Services
Lead Agency Contact	Adonais Clark Environmental Designee Pierce County Planning and Land Services 2401 South 35th Street Tacoma WA 98409-7490 (253) 798-7165
List of Permits & Approvals Required	Pierce County Storm Drainage and Surface Water Management Advisory Board review, and Pierce County Planning Commission review and recommendation. County Council approval of an ordinance adopting the Nisqually River Basin Plan as an update of the *1991 Storm Drainage and Surface Water Management Plan*. After approval and adoption of the Basin Plan, capital projects affecting water resources and other environmentally sensitive areas may require the appropriate federal, state, or local permits and approvals at the time the future projects are proposed and designed. Potential permits and approvals could include Hydraulic Project Approvals, Shoreline Substantial Development Permits, Section 404 Permits, Critical Areas Approvals, SEPA review, and/or other approvals.

Authors & Principal Contributors	Roy Huberd, Randy Brake, Dan Wrye, and Ann Rees Pierce County Public Works and Utilities Department, Surface Water Management Mike Milne, Nathan Foged, Ada Hamilton, Robin Lee, Tim Krause, and Colleen Doten of Brown and Caldwell, Inc. Jeanette Dorner and Florian Leischnerof the Nisqually Indian Tribe
Date of DSEIS Issuance	June 9, 2008
End of DSEIS Comment Period	July 11, 2008
Public Meeting(s)	Two public meetings on the Draft Basin Plan and DSEIS have been held: June 18th, 2008, 6:30 to 8:30 P.M. Weyerhauser Elementary School Gymnasium 6105 365th Street East, Eatonville June 19th, 2008, 6:30 to 8:30 P.M. Eatonville Community Center 305 Center Street West, Eatonville Prior to Basin Plan adoption, the Pierce County Planning Commission and the Pierce County Council will schedule public hearings.
Date of FSEIS Issuance	August 20, 2008
Date of Final Action	Action by the Pierce County Council is anticipated in November 2008.
Subsequent Environmental Review	Project-specific environmental review for future capital projects and programmatic actions will be performed when site and implementation alternatives are identified and designed. Individual environmental review will precede issuance of applicable development permits or construction.

Location of proposed Nisqually River Basin Plan and FSEIS, and the Original EIS for the 1991 Plan

Pierce County Public Works and Utilities
Environmental Services Building
9850 64th Street West
University Place, WA 98467-1078
253-798-2725

Pierce County Planning and Land Services
2401 South 35th Street, Suite 175
Tacoma, Washington 98409

Reference copies are available for review at the following libraries:

- Pierce County Library-DuPont Branch
- Pierce County Library-Eatonville Branch
- Pierce County Library-Graham Branch

The FSEIS, Basin Plan, and other information regarding the Nisqually River Basin Plan also are available at the following internet address:

http://www.piercecountywa.org/pc/services/home/environ/water/ps/basinplans

Cost of FSEIS

The Final Basin Plan and FSEIS may be purchased for the cost of printing at:

Pierce County Public Works and Utilities
Environmental Services Building
9850 64th Street West
University Place, WA 98467-1078
253-798-2725

Pierce County Planning and Land Services
2401 South 35th Street, Suite 175
Tacoma, Washington 98409

10.1 SUMMARY

The Pierce County Public Works and Utilities, Surface Water Management (Surface Water Management), proposes the adoption and implementation of the Nisqually River Basin Plan (Basin Plan or Plan). The Basin Plan would meet the goals and objectives for basin planning in Pierce County, and would be consistent with the recent laws and policies regarding water quality, stormwater management, and natural habitat. If adopted, the Basin Plan would amend the County's *1991 Storm Drainage and Surface Water Management Plan* for the Nisqually River Basin within unincorporated Pierce County.

Pierce County has prepared this Final Supplemental EIS (FSEIS) for the proposed Basin Plan. This FSEIS has been issued to comply with the requirements of the *Washington State Environmental Policy Act* (SEPA).

10.1.1 Background

In 1991, Pierce County adopted the original *1991 Stormwater Drainage and Surface Water Management Plan* (1991 Plan). The 1991 Plan was intended to provide a comprehensive, County-wide program for surface water management of non-federal land in unincorporated Pierce County. Pierce County has been using the 1991 Plan as the basis for its Capital Improvement Program (CIP), although other stormwater projects have been developed to respond to more recent information and drainage problems. The 1991 Plan addressed 26 drainage basins in Pierce County, and the Nisqually Basin was studied as a rural basin. The 1991 Plan identified stormwater and surface water management measures in response to the legal requirements and flooding problems existing at that time.

Since the 1991 Plan was prepared, surface water management has increased in complexity. New legal requirements include the *Stormwater National Pollutant Discharge Elimination System* (NPDES) permit, provisions of the *Clean Water Act*, *Endangered Species Act* (ESA) listings, and *Growth Management Act* (GMA) mandates. The 1991 Plan emphasized flood protection. Water quality, aquatic habitat, protection of critical areas, endangered species, and support for community design and multiuse preferences have become important concerns. Since 1991, growth in Pierce County has made development impacts on storm drainage systems and associated surface water more widespread and apparent.

To maintain consistency with these new requirements since 1991, Pierce County has updated the 1991 Plan through a series of basin plans. This Nisqually River Basin Plan is one of the series of new basin plans. This Basin Plan identifies specific flooding, water quality, and habitat problems in the Nisqually Basin, and recommends capital improvement projects and programmatic measures to address the problems. The proposed Basin Plan also addresses changes in stormwater policies and planning to meet the requirements of the *NPDES*, *Clean Water Act*, the *Endangered Species Act*, and the *Growth Management Act*.

10.1.2 Objectives

Under SEPA, the objectives are the intended goals that a proposal would address. The goals and objectives for the Nisqually River Basin Plan form the basic criteria for the selection and prioritization of the actions recommended in the Basin Plan. The goals and objectives are described in detail in Chapter 1, and are listed below.

- Reduce flood hazards
- Improve fish passage
- Improve water quality
- Demonstrate coordinated and responsible use of public resources
- Influence location and methods for new development

The goals and objectives for the Basin Plan listed above are based on guidance prepared by Pierce County Surface Water Management. These goals and objectives reflect the new legal and policy requirements for Pierce County stormwater planning, which have developed since the 1991 Plan was issued.

10.1.3 Alternatives

The Nisqually Basin SEIS evaluates two alternatives. The "Proposed Action" is the adoption and implementation of the Nisqually River Basin Plan for drainage and surface water management of the Nisqually Basin within unincorporated Pierce County. The "No Action" Alternative is the continued implementation of the 1991 Plan and other current County surface water management activities.

The "Proposed Action" covers the entire length of the Nisqually River within unincorporated Pierce County. The Basin Plan, however, excludes incorporated towns and cities, most commercial timber lands, and federal lands. It also excludes the Muck Creek basin, which has been addressed in a separate basin plan.

The Basin Plan includes recommendations for site-specific projects and basin-wide programmatic measures to remedy existing problems and to prevent future water resource and habitat problems. The components of the Basin Plan would achieve the County's goals and objective for basin planning, and would be consistent with recent laws and regulations regarding stormwater.

The Basin Plan would append and update the 1991 Plan. The Basin Plan would provide guidance for Pierce County's future capital projects, non-capital expenditures, water resource protection policies, and public education programs in the Nisqually Basin.

The proposed Nisqually River Basin Plan is a set of recommended solutions in the form of capital improvement projects (CIP) and programmatic measures that would address identified flooding, water quality, and habitat problems. Most of these proposed CIP improvements are site-specific in nature, and are designed to deal with existing site-specific flooding, water

quality, or habitat issues. Programmatic measures are basin-specific or County-wide activities such as inspection, maintenance, monitoring, and educational programs.

The Basin Plan proposes 42 CIP projects and 21 programmatic measures for the Nisqually Basin. The types of projects and programs are summarized below:

- 9 habitat restoration projects
- 3 fish passage projects
- 16 property acquisition projects
- 12 culvert replacement projects
- 1 revegetation project
- Programs to reduce stormwater runoff from future development, by promoting Low Impact Development (LID) techniques and adopting updated stormwater management standards.
- Programs for education, outreach, and technical and financial assistance with landowners, students, government agencies, and community groups in the Nisqually Basin.
- Programs to increase inspection and/or maintenance activities for culverts, ditches, stormwater facilities, levees, and septic tanks.
- Programs for long-term monitoring of surface water and for fish and wildlife habitat.
- Programs to restore and enhance floodplains and riparian, wetland, and estuarine habitats.
- Programs to control invasive species and to restore native vegetation.
- Program for acquisition and management of properties for floodplain, water quality, and habitat protection.
- Programs to protect and enhance shellfish, fisheries, and other aquatic resources.
- Programs for coordination and financial support with the Nisqually River Land Trust and Nisqually River Council.
- Program to implement elements of total maximum daily load (TMDL) for fecal coliform bacteria in Nisqually tributaries, where required, to improve water quality.
- A study to analyze sediment and aggradation effects on the floodplain along the upper Nisqually River.

The “No Action” Alternative means that the proposed Basin Plan would not be adopted. Under the “No Action” Alternative, stormwater would continue to be managed under the previous

1991 Plan and other current County programs. The 1991 Plan does not contain any remaining CIP projects to be constructed in the Nisqually Basin. The County would increasingly rely on more opportunistic means of identifying and prioritizing capital projects, such as citizen complaints and judgment of County staff. Few, if any, capital projects likely would be proposed in the Nisqually Basin.

The "No Action" Alternative would not address most of the specific flooding, water quality, and habitat problems identified in the Basin Plan. "No Action" would not achieve many of the County's updated goals and objectives for basin planning. The "No Action" Alternative also would not be consistent with many of the new legal and policy requirements for Pierce County stormwater planning, which have developed since the 1991 Plan was issued.

10.1.4 SEPA Process and Public Involvement

The *Washington State Environmental Policy Act* (SEPA), Chapter 43.21C RCW, requires that an environmental impact statement (EIS) be prepared for proposed "actions" that could result in probable significant adverse environmental impacts. "Actions" include adoption of new or revised plans by Pierce County. Under SEPA, decisions on plans, policies, and programs are "nonproject actions." Both the original 1991 Plan and the proposed Basin Plan are nonproject actions under SEPA.

Pierce County prepared a nonproject EIS for the 1991 Plan that compared the potential adverse impacts of the 1991 Plan with "No Action". Since then, some of the information and legal requirements evaluated in the original 1991 EIS have changed. Updated information exists on flooding, water quality, and habitat problems in the Nisqually Basin. New or additional information also includes development and growth patterns in Pierce County that have occurred since 1991. The legal requirements and Pierce County goals and objectives for stormwater planning have substantially changed since 1991.

Because of the new information since the 1991 Plan, Pierce County has prepared this Final Supplemental EIS (FSEIS) for the proposed Basin Plan. A supplemental EIS under SEPA has been prepared to determine whether any new information or substantial changes in County programs since 1991 could result in probable significant adverse environmental impacts (WAC 197-11-405(4)).

This FSEIS compares the implementation of the "Proposed Action" (Nisqually River Basin Plan) with the "No Action" Alternative. This Nisqually Plan FSEIS is based in part on information provided in the previous 1991 EIS. This FSEIS identifies new information on stormwater-related problems and legal requirements in the Nisqually Basin, which are discussed in detail in the accompanying Basin Plan.

Pierce County has prepared this FSEIS under the nonproject and phased review provisions of SEPA (WAC 197-11-704 and WAC 197-11-774) and the Pierce County SEPA Ordinance (PCC, Title 18D). A nonproject (or programmatic) analysis under SEPA provides a general discussion of potential environmental impacts, and considers other existing regulations and plans. Phased review under SEPA covers general matters in a broader environmental document, with

subsequent narrower documents that concentrate on the issues relating to specific projects (Section WAC 197-11-776 WAC).

Implementation of the Basin Plan would be phased. Pierce County would not implement a particular recommendation until it is included in a Capital Improvement Program (CIP) or other approved program.

Projects and programs to implement the Basin Plan may require future environmental review under SEPA. Individual projects may require project-level federal, state, and local government approvals and permits, including SEPA review. Individual projects also could require review under the *National Environmental Policy Act* (NEPA) if a project involves federal permits and approvals. Proposed projects would complete environmental review under SEPA/NEPA and obtain required permits and approvals when individual projects are proposed and prior to construction. The location, design, construction, and operation of individual projects would comply with all applicable federal, state, and Pierce County regulations and policies.

Public involvement has been an integral part of the County's basin planning and SEPA processes. Key stakeholders have included basin residents and landowners, citizen and environmental groups, the Nisqually Tribe, and federal, state, and local agencies. Their concerns regarding habitat, water quality, and flooding in the Nisqually Basin have been evaluated within the Basin Plan. Pierce County prepared a citizen questionnaire, conducted a mail survey, held public meetings, and contacted a variety of organizations and agencies. Stakeholder involvement and agency coordination are described in detail in Chapter 3 of the Basin Plan, and specific details are provided in Appendix B.

During the basin characterization phase, Pierce County held two public meetings to present draft findings and to solicit public input. The first meeting was held on June 1, 2005, toward the beginning of the characterization phase, at Weyerhaeuser Elementary School near Eatonville. This meeting was intended to inform residents of the planning process and to solicit information regarding drainage/flooding, water quality, and/or fish habitat problems in the basin. A second public meeting was held on September 6th, 2006, at Weyerhaeuser Elementary School, to present the draft findings of the Nisqually Basin characterization and obtain citizen input of identified problems.

During environmental review under SEPA, two public meetings were held on the DSEIS. The public meetings were held on June 18th, 2008, at the Weyerhaeuser Elementary School near Eatonville, and on June 19th, 2008, at the Eatonville Community Center. During the 30-day comment period on the DSEIS, the public and agencies had opportunities to provide written comments and testimony at the two public meetings. Responses to the comments on the DSEIS are provided in the back of this FSEIS.

10.1.5 Comparison of Alternatives

Table 10-1 summarizes and compares potential environmental impacts under the alternatives. The identification of potential environmental impacts assumes that future implementation of

any proposed projects would be conducted in accordance with applicable land use, development, and environmental regulations.

TABLE 10-1
Comparison of Alternatives

Element	"Proposed Action" Basin Plan	Probable Significant Adverse Environmental Impact?	"No Action" Alternative	Probable Significant Adverse Environmental Impact?
Water Resources and Water Quality	A series of CIP projects and programmatic measures would address specific water quality and flooding problems in the Nisqually River, its tributaries, and area lakes. The proposed Basin Plan would improve water quality and reduce flooding problems, at a higher level than the "No Action" Alternative. CIP projects to replace culverts would reduce localized flooding of roadways and adjacent properties. Acquisition and restoration projects that preserve and enhance riparian areas and floodplains would provide natural storage to reduce flooding, and would improve water quality. Low impact development (LID) techniques and updated stormwater standards would reduce stormwater impacts from existing and future development. Programmatic measures would increase inspection and maintenance activities, develop an acquisition and management plan, establish a monitoring program, and implement public education and outreach on water resource problems and solutions. Potential for short-term impacts during construction of individual projects on or near	No	Most of the water resource and water quality problems identified in the Nisqually Basin would not be addressed. Degradation of water quality may continue. Few projects and programs to improve water resource conditions, if any, would be proposed for the Nisqually Basin. Any improvements to flooding and water quality would occur a lower level compared to the "Proposed Action". Potential for short-term impacts during construction of any individual projects. Construction would include mitigation measures similar to "Proposed Action".	"No Action" would not meet County's updated goals and objectives for basin planning. The "No Action" Alternative also would not be consistent with many of the new legal and policy requirements for water quality and flood hazards.

TABLE 10-1
Comparison of Alternatives

Element	"Proposed Action" Basin Plan	Probable Significant Adverse Environmental Impact?	"No Action" Alternative	Probable Significant Adverse Environmental Impact?
	water, by temporarily increasing erosion and sedimentation. All projects would include "Best Management Practices" (BMPs) to reduce erosion, comply with all applicable regulations, and obtain necessary permits and approvals.			
Fishery Resources	The proposed CIP projects and programmatic measures would address identified fishery and habitat problems in the Nisqually Basin planning area. The Basin Plan would protect and restore the overall fishery resources and aquatic habitat, at a higher level than the "No Action" Alternative. CIP projects to improve fish passage will increase upstream habitat anadromous fish. CIP restoration projects would improve fish access, native vegetation, the channel migration zone, the original floodplain, estuarine habitat, and riparian areas. CIP projects to acquire property would protect aquatic and riparian habitats, preserve channel migration zones, reduce future degradation of water quality, and make areas available for future habitat restoration Programmatic measures to benefit fisheries would provide nutrients to juvenile salmon with salmon carcasses, and would monitor the effectiveness of habitat	No	Most of the fishery and habitat problems identified in the Nisqually Basin would not be addressed. "No Action" may result in continued degradation of habitat. Few future projects and programs, if any, would be proposed. Any improvements to fish habitat would occur a lower level compared to the "Proposed Action". Potential for short-term impacts during construction of individual projects, if any. Construction would include mitigation measures similar to "Proposed Action".	"No Action" would not meet County's updated goals and objectives for basin planning. The "No Action" Alternative also would not be consistent with many of the new legal and policy requirements for habitat protection.

TABLE 10-1
Comparison of Alternatives

Element	"Proposed Action" Basin Plan	Probable Significant Adverse Environmental Impact?	"No Action" Alternative	Probable Significant Adverse Environmental Impact?
	improvement projects. Other programmatic measures would enhance riparian habitat and improve water quality, which would indirectly benefit fisheries resources. Potential for short-term impacts during construction of individual projects, by temporarily increasing erosion and sedimentation. Construction would include BMPs and mitigation measures to reduce erosion.			
Plants and Animals	The proposed CIP projects and programmatic measures would address identified habitat problems, which would generally benefit plant and animal resources in the Nisqually Basin. The projects and programs would restore and protect plant and animal habitat, at a higher level than the "No Action" Alternative CIP projects would restore riparian habitat, native vegetation, wetlands, and the original floodplain. Acquisition of property would protect riparian and wetland habitats, preserve the floodplain, reduce future degradation of water quality, and make areas available for future habitat restoration. Programmatic measures would enhance riparian, wetland, and in-shore habitats, and would improve water quality. Removal of invasive plants	No	Few projects and programs to improve fish habitat, if any, would be proposed for the Nisqually Basin. Any improvements to plant and animal habitat would occur a lower level compared to the "Proposed Action". The "No Action" Alternative would not address many of the habitat problems identified in the Nisqually Basin. "No Action" may result in continued degradation of plant-and-animal habitat in the watershed. Individual projects, if any, could result in site-specific impacts, although future impacts would be relatively small. Similar to the "Proposed Action", any	"No Action" would not meet County's updated goals and objectives for basin planning. The "No Action" Alternative also would not be consistent with many of the new legal and policy requirements for habitat protection.

TABLE 10-1
Comparison of Alternatives

Element	"Proposed Action" Basin Plan	Probable Significant Adverse Environmental Impact?	"No Action" Alternative	Probable Significant Adverse Environmental Impact?
	would restore native vegetation and improve wildlife habitat in the long term. Construction activities could temporarily alter vegetation and displace wildlife. Future projects would include required BMPs, and would restore disturbed vegetation and habitat after construction.		future project would include BMPs and revegetation.	
Soil and Geology	Projects and programs to restore riparian areas, stabilize stream channels, and control stormwater would reduce erosion and sedimentation in streams. Future projects could require limited excavation, grading/filling, and impervious surfaces. All projects would comply with applicable regulations for grading and filling activities and critical areas, would obtain any necessary permits, and may include site-specific mitigation. Construction activities could result in temporary erosion. All construction activities would include required erosion control measures and "Best Management Practices" (BMPs), and stream banks would be stabilized and revegetated.	No	Limited erosion control would occur at a lower level than "Proposed Action". Future projects, if any, could result in excavation, grading, and filling. Similar to "Proposed Action", future projects would comply with applicable regulations, would obtain any necessary permits and critical areas review, and may include site-specific mitigation Temporary construction impacts and mitigation of individual projects, similar to "Proposed Action".	No
Land Use	Projects and programs would address identified flooding of land uses in the Nisqually Basin. The Basin Plan would not induce new growth or development, and changes to existing and planned land uses	No	Few projects, if any, would address flooding of land uses. Future projects and programs, if any, would not change existing and planned land uses and	The "No Action" Alternative would not be consistent with many of the new legal and policy

TABLE 10-1
Comparison of Alternatives

Element	"Proposed Action" Basin Plan	Probable Significant Adverse Environmental Impact?	"No Action" Alternative	Probable Significant Adverse Environmental Impact?
	are not anticipated. By better accommodating planned growth and providing required stormwater facilities, the "Proposed Action" would reduce development-related stormwater impacts. Projects and programs to acquire property in the Nisqually Basin would not result in displacement of residences or businesses. Any future land acquisition would purchase property from willing sellers. Future projects would be consistent with site-specific land use and shoreline policies and regulations, and would obtain all required land use permits and approvals. Basin Plan would be consistent with the *County Comprehensive Plan* and its land use and stormwater policies.		not induce growth. Development-related stormwater impacts from planned growth would be addressed by existing regulations, but at lower level than the "Proposed Action". The few projects likely would not displace residences, demolish structures, or inundate property. Future projects would be consistent with land and shoreline regulations and policies, and would obtain all applicable permits. The "No Action" Alternative may be inconsistent with the *County Comprehensive Plan.*	requirements for land use.
Historic and Cultural Resources	Individual projects could have the potential to encounter cultural, archaeological, or historic resources. Future projects would be located and designed to avoid any identified resources. Pierce County would conduct site surveys, evaluate potential impacts and mitigation, and coordinate with appropriate tribes and agencies. Projects and programmatic measures to control stormwater, reduce erosion, and restore stream channels would be a benefit to streamside historic and cultural	No	Individual projects, if any, could encounter historic or cultural resources. The location and design of future projects would be coordinated with appropriate officials, similar to "Proposed Action". Limited erosion control and fishery restoration, which would provide a lower level of cultural benefits than the "Proposed Action". If any cultural resources	No

TABLE 10-1
Comparison of Alternatives

Element	"Proposed Action" Basin Plan	Probable Significant Adverse Environmental Impact?	"No Action" Alternative	Probable Significant Adverse Environmental Impact?
	resources. Water quality and habitat projects and programs would protect and restore fishery resources that are an important cultural resource for the Nisqually Tribe. If any cultural resources were encountered during construction of individual projects, the County would immediately consult with appropriate officials regarding appropriate measures.		were discovered during construction activities, the County would immediately consult with appropriate officials regarding appropriate measures.	
Public Services and Utilities	Projects and programs would not substantially increase the demand for public services and utilities. Implementation of the Basin Plan would affect the services provided by Pierce County Surface Water Management, which provides drainage utility services. Proposed projects and programs would reduce flooding of roadways and properties, which would improve public safety and reduce demand for public services and utilities. The projects and programs to improve water quality, habitat, and fisheries also would benefit recreational areas. Construction of individual CIP projects may temporarily affect roadways and disrupt local services and utilities. Pierce County would coordinate mitigation measures with local service providers and utilities to	No	Future projects, if any, would not require new utilities or services. Few projects, if any, would address identified roadway and property flooding problems. Potential for temporary disruptions during construction of individual projects. Construction would include mitigation measures similar to "Proposed Action".	No

TABLE 10-1
Comparison of Alternatives

Element	"Proposed Action" Basin Plan	Probable Significant Adverse Environmental Impact?	"No Action" Alternative	Probable Significant Adverse Environmental Impact?
	maintain access and services during construction			

10.2 ALTERNATIVES, INCLUDING THE "PROPOSED ACTION"

This section describes the FSEIS alternatives to achieve the goals and objectives for basin planning in Pierce County. The alternatives evaluated are the **"Proposed Action"**, which is the adoption of the Nisqually River Basin Plan (Basin Plan), and the **"No Action" Alternative**, which is the continued use of the previous *1991 Stormwater Drainage and Surface Water Management Plan* (1991 Plan) and other current County surface water management activities. This section of the FSEIS also provides background on the original 1991 Plan, and identifies the subsequent changes in regulatory and planning requirements. It concludes with a summary comparison of the FSEIS alternatives.

The alternatives have been developed by the Pierce County Public Works and Utilities Surface Water Management (Surface Water Management). Surface Water Management is responsible for surface water management in unincorporated Pierce County. Surface Water Management builds and maintains storm drainage and surface water management facilities, and it identifies non-structural solutions to surface water problems. Surface Water Management prepares basin plans to identify and prioritize capital improvement projects and other Surface Water Management activities in individual drainage basins. Basin plans comprehensively address the flooding, water quality, and fish habitat aspects of surface water management in the major stream systems of the non-federal lands within unincorporated Pierce County. The basin plans will be implemented primarily through Surface Water Management activities.

10.2.1 Introduction and Background

Pierce County Storm Drainage and Surface Water Management Plan (1991 Plan)

The Pierce County Council established the County's Surface Water Management Utility in March 1988 by Ordinance 87-205. In 1991, the County adopted the original *Stormwater Drainage and Surface Water Management Plan* (1991 Plan). The 1991 Plan was intended to provide a comprehensive program for surface water management operations, for non-federal lands within unincorporated Pierce County. The 1991 Plan also was prepared to satisfy Washington State Department of Ecology (Ecology) requirements for a *Comprehensive Flood Control Management Plan* (WAC 173-145).

The 1991 Plan addressed 26 of the drainage basins in Pierce County, to varying degrees. The 1991 Plan studied in detail eight urban and urbanizing basins: Gig Harbor, Hylebos Creek, Clear/Clarks Creek, Clover/Steilacoom Creek, Chambers Bay, Tacoma West/Browns-Dash Point, Muck Creek, and American Lake. The rural study areas were comprised of small groups of basins: 1) Key Peninsula, Burley/Minter Creek, and Islands; 2) South Prairie Creek, Upper Carbon River, and Lower Carbon River; 3) Lower White River, Upper White River, and Mud Mountain; 4) Upper Puyallup River and Mid Puyallup River; 5) Ohop Creek, Mashel River, and Upper Nisqually River; and 6) Lower Nisqually River and Mid-Nisqually River. Surface water management objectives were developed for each basin and for the County.

The 1991 Plan included recommendations for both capital projects (structural) and programmatic measures (non-structural activities) of accomplishing its goals and objectives. The programmatic recommendations tended to be broad and countywide rather than basin or study-area specific. The 1991 Plan focused primarily on capital projects aimed at addressing flooding problems that existed in 1991. The 1991 Plan recommended specific flooding projects for a Capital Improvement Program (CIP).

Four short-term and six long-term goals were developed as part of the 1991 Plan. The short-term goals were to have been implemented within two years of Plan development. They included: 1) adoption of the 1991 Plan; 2) establishment of a permanent Storm Drainage and Surface Water Management Utility; 3) provision of a funding mechanism to implement the entire plan; and 4) implementation of all the non-structural recommendations. A fifth goal, listed separately, was to adopt a drainage manual. To date, all the short-term goals have been implemented, at least in part.

The six long-term goals of the 1991 Plan are listed below:

- Prevent the loss of life, the creation of public health or safety problems, and the loss or damage of public and private property.
- Establish and adopt a systematic and comprehensive approach.
- Minimize expenditure of public funds.
- Maintain the varied uses of the existing natural drainage system within the County.
- Prevent the degradation of the quality of both surface water and the water entering the region's aquifers.
- Coordinate with public and private sectors.

Pierce County has continued the pursuit of these goals since the 1991 Plan was issued. Most of the goals were related to the planning, construction, operation, and maintenance of storm drainage facilities. Many of the objectives in the 1991 Plan have been met.

Use of the 1991 Plan As Principal Focus of CIP Has Evolved

Pierce County has been using the 1991 Plan as the basis for its Capital Improvement Program (CIP) proposals since 1991. Projects have been selected every year and adopted by the County Council as part of the County's six-year Capital Facilities Plan. Other projects not in the 1991 Plan also have been developed to respond to more recent information and drainage problems. Many of the projects proposed as part of the 1991 Plan have been constructed, while others could not be constructed because development patterns made acquisition of construction sites prohibitively expensive.

The 1991 Plan identified stormwater and surface water management measures in response to the legal requirements and flooding problems existing at that time. Since 1991, development and flooding conditions in Pierce County have changed, and stormwater requirements are more complex. While the 1991 Plan emphasized flood protection, newer laws and policies consider water quality, habitat, protection of critical areas, and community concerns. The programs,

policies, and regulations that currently affect stormwater and surface water management in Pierce County are described in Chapter 2 of the Basin Plan.

The 1991 Plan was developed before adoption of the *Pierce County Comprehensive Plan* (*County Comprehensive Plan*), which was adopted in 1995 pursuant to the Growth Management Act (GMA). Zoning and other land use regulations have changed development patterns in some areas of the County, and the future growth estimates used to develop the 1991 CIP list are no longer valid.

The GMA requires the establishment of "critical areas", such as flood hazard areas, fish and wildlife habitat, and wetlands. It also requires their protection. GMA directed a revision of the *County Comprehensive Plan* to meet statewide growth management objectives. The GMA requires the internal consistency of the various elements of the *County Comprehensive Plan*, and consistency of implementing plans and budget decisions with the policies of the *County Comprehensive Plan*. The *County Comprehensive Plan* designated urban growth areas (UGAs) and rural areas; and it set out policy on environmental protection, economic development, public facilities and services, and land uses. The *County Comprehensive Plan* became effective in 1995.

In 1995, jurisdictions with populations over 100,000, including Pierce County, were required by the Washington State Department of Ecology (Ecology) to create stormwater management programs under the federal Clean Water Act's National Pollutant Discharge Elimination System (NPDES) program.

In the late 1990's, the federal government listed Chinook salmon and bull trout under the Endangered Species Act (ESA). The National Marine Fisheries Service in May 2007 listed the Puget Sound steelhead as threatened under the ESA. The Nisqually Basin planning area includes Chinook salmon and steelhead, and has the potential for bull trout.

The requirement to maintain consistency with these laws and policies has led Surface Water Management to initiate an update of the 1991 Plan through a series of basin plans. The basin plans identify and address the flooding, water quality, and habitat problems in more detail than was possible in 1991. The basin plans also address the relevant laws, regulations, and policies enacted since the 1991 Plan, including the Growth Management Act, CRS, NPDES, total maximum daily load (TMDL) requirements of the federal Clean Water Act, and the fish listings under the federal Endangered Species Act (ESA).

The proposed Nisqually River Basin Plan is one of 10 basin plans developed by Surface Water Management. Basin plans describe existing conditions that affect storm drainage and surface water, forecast future hydrological conditions, identify existing and potential problems, and evaluate alternative solutions based on technical, environmental, and cost considerations. The basin plans are used to develop Surface Water Management' capital improvement, maintenance, repair, property acquisition, and program schedules and budgets.

10.2.2 Objectives

Under SEPA, the objectives are the intended goals that a proposal would address. The objectives for stormwater planning in Pierce County have changed since the 1991 Plan was issued, because of the new legal and policy requirements identified in the previous section. The development of the goals and objectives for Pierce County basin planning is described in Chapter 1.

The goals and objectives for the Nisqually River Basin Plan are provided in Table 10-2. These goals and objectives in Table 10-2 form the basic criteria for the selection and prioritization of the actions recommended in the Basin Plan.

TABLE 10-2
Goals and Objectives of the Nisqually River Basin Plan

Goal	Objectives
Reduce flood hazards	Property loss and repetitive damage are reduced. Streams will not be adversely impacted by flood events. Pierce County standing under the Federal Emergency Management Agency's Community Rating System is improved. New development is located outside of flood-prone areas.
Improve fish habitat	Number of stream miles available for wild, native fish populations is increased. Population numbers of species listed as endangered or threatened under the ESA are maintained or increased. Quality and quantity of available wetlands and riparian habitat is improved.
Improve water quality	State Surface Water Quality Standards (WAC 173-201a) are met. Number of impaired (303d listed) water bodes is reduced. Pierce County complies with its NPDES permit for stormwater by meeting permit terms and condition to the maximum extent practicable. Risk of groundwater contamination is reduced. Rates of erosion are reduced.
Demonstrate coordinated and responsible use of public resources	Cost of maintaining stormwater facilities are reduced. Project value is favorable when measured in terms of costs and benefits. Polls demonstrate that public awareness of flooding, fish habitat, and water quality issues has increased. Monitoring and enforcement programs demonstrate an increase in services per dollar spent. Basin plan implementation addresses elements of other Pierce County plans. Other agencies and jurisdictions use basin plan to support their surface water management activities.
Influence location and methods for new development	Low Impact Development techniques are widely used. Effective BMPs are identified and widely used.

Source: *Guidance for Basin Planning, Pierce County Surface Water Management*., Pierce County Public Works & Utilities, Surface Water Management; Pierce County Storm Drainage and Surface Water Management Advisory Board, June 2005.

10.2.3 "Proposed Action" – Nisqually River Basin Plan

The "Proposed Action" is the adoption of the Nisqually River Basin Plan for drainage and surface water management of the Nisqually Basin within unincorporated Pierce County. The "Proposed Action" includes recommendations in the Basin Plan for capital projects and programmatic measures to remedy existing problems and to prevent future water resource degradation. The projects and programs in the Basin Plan would achieve the County's updated goals and objectives for basin planning in Table 10-2.

The Basin Plan would append and update the 1991 Plan. The proposed projects in the Basin Plan would supplement and update the 1991 Plan and the County's Capital Improvement Plan. Programmatic recommendations would augment and/or replace the nonstructural recommendations contained in the 1991 Plan. The proposed Basin Plan would provide guidance for Pierce County's future Capital Improvement Projects, non-capital expenditures, water resource protection policies, and public education programs in the Nisqually Basin.

The Basin Plan has been prepared in accordance with the *Guidance for Basin Planning,* by Pierce County Surface Water Management. This guidance document lists the tasks for the preparation of a basin plan and the directions for completing the tasks.

The Basin Plan provides more detailed analyses of existing and future flooding, drainage, water quality, and habitat problems in the Basin than were possible for the 1991 Plan. Citizens in the Nisqually Basin provided information about the basin, and they commented on problems and solutions at public meetings and other public outreach efforts. Their concerns regarding flooding, drainage, habitat, and water quality issues were evaluated within the Basin Plan.

The Nisqually Basin planning area includes the unincorporated Pierce County portion of Water Resource Inventory Area (WRIA) 11, exclusive of the Muck Creek basin. Moreover, the Basin Plan does not cover areas of the Basin that lie within other jurisdictions, such as incorporated towns and cities, commercial timber lands regulated by the state Department of Natural Resources, Thurston and Lewis counties, and federal lands, except where activities in these areas may contribute to surface water management problems in unincorporated Pierce County. The Nisqually Basin planning area is shown in Figure 1-1 of the Basin Plan.

The proposed Nisqually River Basin Plan is a set of recommended solutions in the form of capital improvement projects (CIP) and programmatic measures that would address identified flooding, water quality, and habitat problems. The proposed recommendations in the Basin Plan are described in detail in Chapter 9.

The Basin Plan contains site-specific capital improvement projects (CIPs), which are described in Table 9-6 and shown in Figures 9-1 through 9-8 of the Basin Plan. Most of these proposed CIP improvements are site-specific in nature, and are designed to deal with identified flooding or habitat issues within the Nisqually Basin. The proposed CIPs would include the following types of projects:

- 9 habitat restoration projects

- 3 fish passage projects
- 16 property acquisition projects
- 12 culvert replacement projects
- 1 revegetation project

The proposed Basin Plan also includes programmatic or non-structural measures. Programmatic measures include programs that would be specific to the Nisqually Basin, and other programs that would be County-wide but would benefit the Nisqually Basin. The proposed programmatic measures are described in Table 9-7 of the Basin Plan. The Basin Plan includes the following programs:

- Programs to reduce stormwater runoff from future development, by promoting Low Impact Development (LID) techniques and adopting updated stormwater management standards.
- Programs for education, outreach, and technical and financial assistance with landowners, students, government agencies, and community groups in the Nisqually Basin.
- Programs to increase inspection and/or maintenance activities for culverts, ditches, stormwater facilities, levees, and septic tanks.
- Programs for long-term monitoring of surface water and for fish and wildlife habitat.
- Programs to restore and enhance floodplains and riparian, wetland, and estuarine habitats.
- Programs to control invasive species and to restore native vegetation.
- Program for acquisition and management of properties for floodplain, water quality, and habitat protection.
- Programs to protect and enhance shellfish, fisheries, and other aquatic resources.
- Programs for coordination with the Nisqually River Land Trust and Nisqually River Council.
- Program to implement a total maximum daily load (TMDL) for fecal coliform bacteria in Nisqually tributaries, where required, to improve water quality.
- Studies to assess aquatic habitat for restoration.
- Studies to assess culverts for fish passage.
- Studies to analyze flooding and channel migration hazards on the upper and lower Nisqually River.

10.2.4 "No Action" Alternative

The "No Action" Alternative means that the proposed Basin Plan would not be adopted. Pierce County would continue to use the 1991 Plan as its guide for managing drainage and surface water activities. The 1991 Plan does not contain any remaining CIP projects to be constructed in the Nisqually Basin. The "No Action" Alternative would continue Surface Water Management' activities as they currently exist. Capital projects would be selected based on the identification of problems as they arise. The County would increasingly rely on more opportunistic means of identifying and prioritizing capital projects, such as citizen complaints and judgment of County staff. Few, if any, site-specific projects and basin-wide programs likely would be proposed in the Nisqually Basin.

The "No Action" Alternative would not address most of the specific flooding, water quality, and habitat problems identified in the Basin Plan. "No Action" also would not achieve many of the County's updated goals and objectives for basin planning in Table 10-2. The "No Action" Alternative would not be consistent with many of the new legal and policy requirements for Pierce County stormwater planning, which have developed since the 1991 Plan was issued.

10.2.5 Comparison of Alternatives

Table 10-3 summarizes the major characteristics of the "Proposed Action" and the "No Action" Alternative.

TABLE 10-3
Comparison of the Alternatives

Feature	"Proposed Action" (Basin Plan)	"No Action" Alternative
Comprehensive stormwater planning within Basin	X	
Comprehensive stormwater planning County-wide		X
Focus on identified flooding, water quality, and habitat problems within Basin	X	
Basin-specific flooding projects	X	
Basin-specific water quality projects	X	
Basin-specific habitat projects	X	
Annual Capital Facilities Element	X	X
County-wide programmatic or non-structural solutions	X	X
Basin-specific programmatic or non-structural solutions	X	
Meet updated goals and objectives for Pierce County basin planning	X	
Consistent with new legal and policy requirements for stormwater	X	
Basin-wide public education, outreach, and technical assistance	X	

10.3 AFFECTED ENVIRONMENT, SIGNIFICANT IMPACTS, AND MITIGATION MEASURES

The planning area for the Nisqually River Basin Plan includes the unincorporated Pierce County portion of Water Resource Inventory Area (WRIA) 11. The planning area excludes the Muck Creek Basin, which has been addressed in a separate Pierce County basin plan. The planning area also does not cover areas within other jurisdictions, such as incorporated towns and cities, commercial timber lands regulated by the state Department of Natural Resources, Thurston and Lewis counties, and federal lands; except where activities in these areas may contribute to surface water management problems in unincorporated Pierce County. The Nisqually Basin planning area encompasses approximately 240 square miles within the 760-square mile Nisqually River Watershed. The Nisqually Basin planning area is shown in Figure1-1 of the Basin Plan.

10.3.1 Water Resources and Water Quality

This section describes the affected environment of the Nisqually Basin and potential impacts on water resources and water quality. The laws, regulations, plans, and policies concerning water resources and water quality are evaluated separately in Section 10.3.8, Plans and Policies.

Affected Environment

The Nisqually River originates on Mount Rainier and flows approximately 78 miles before discharging into Puget Sound. The LaGrande Canyon at river mile 42 divides the Watershed into two distinct physiographic areas. In the eastern portion of the Basin above the Canyon, volcanic rock and steeper mountainous terrain dominate the area. Subbasins in the east are covered primarily by designated forest lands. In the western portion below the Canyon, the Watershed consists of low hills and prairie plains of glacial outwash. Western drainage areas are characterized by mixed forest, rural residential, and agricultural uses.

The three largest tributaries in the planning area are the Mashel River, Ohop Creek, and. Tanwax Creek. Other major streams include Red Salmon Creek, Murray Creek, Brighton Creek, Horn Creek, Kreger Creek, Lynch Creek, the Little Mashel River, and Elbe Creek. To allow for more detailed characterization, the Nisqually Basin planning area has been subdivided into 23 subbasins based on existing topographic and hydrographic data. The 23 subbasins are shown in Figure 4-8 and are described in detail in Chapter 4.

Development in the Nisqually Basin planning area is relatively limited. The few small communities in the upper Basin are Elbe, Ashford, and Park Entrance (just outside Mount Rainier Nation Park). In the lower Basin are agricultural and rural residential uses in the Wilcox Flats area and in communities of McKenna and Whitewater Estates. Figure 4-9 shows areas of development and other important features such as levees and dams.

Several hydroelectric projects are located on the Nisqually mainstem. The hydroelectric dams are the Alder Dam and LaGrande Dam, which comprise the Nisqually River Project owned and

operated by Tacoma Power. The Centralia Diversion Dam is a run-of-the-river project, which is owned and operated by City of Centralia Light Department as the Yelm Hydroelectric Project. These hydroelectric projects are regulated by the Federal Energy Regulatory Commission (FERC), and their operation is outside the scope of Pierce County basin planning.

Drainage and Flooding

Major floods in the Nisqually Basin occurred in 1933, 1965, 1974, 1975, 1977, 1996, 1997, and 2006. Major floods typically occur between October and March as a result of rainstorms, which are sometimes augmented by melting snow. Existing and future flooding problems in the Nisqually Basin planning area are described in Chapter 6.

In the mainstem of the Nisqually River, the most substantial flooding problem area is located near the community of McKenna. Other locations along the Nisqually mainstem that have incurred flood damages include the Wilcox Flats area and some areas upstream of Lake Alder. Flows in the lower reaches of the Nisqually mainstem are regulated by the Nisqually hydroelectric project, but the small storage capacity of Lake Alder is inadequate to prevent downstream flooding.

In the Nisqually tributaries, flood hazard areas exist in the low-elevation areas west of Eatonville. Subbasins such as Murray Creek, Brighton Creek, Horn Creek, Tanwax Creek, Kreger Creek, and Ohop Creek have extensive flood hazard areas in low-lying regions and around lakes, in addition to riverine flooding along the major tributaries. Beavers are a common cause of minor flooding, by blocking outlets to lakes and roadway culverts. Insufficient culvert design and maintenance have flooded local roadways, which has closed roads and flooded adjacent properties.

The Nisqually Basin planning area is primarily rural and does not have many constructed drainage facilities aside from ditches and culverts associated with roads. Culverts and bridges have been constructed throughout the Basin at driveway, road, and highway crossings. The Nisqually mainstem contains several levee systems, near the Mount Rainier National Park entrance, near Elbe, and in the Nisqually National Wildlife Refuge.

New mainstem flooding problems could arise due to (1) filling within the floodplain without providing compensatory volume or (2) building below the maximum flood elevation. Overtopping or failure of the existing County-maintained levee on the Upper Nisqually River near the National Park entrance could expose nearby structures to flood damage. Climate change could lead to lower freezing elevations during the late fall and winter, resulting in more winter rain (instead of snow). This could increase the risk of flooding due to late fall/early winter rain or rain-on-snow events. Channel migration could also lead to future flooding problems on the mainstem.

Although most of the basin will remain rural, current zoning and community plans allow for small areas of more intense development in vicinity of Roy, Eatonville, and the Upper Nisqually communities of Elbe, Ashford, and Park Entrance. Localized flooding and stream channel erosion could occur in these areas. . However, new development would be subject to County site development and critical areas regulations. These regulations are intended to minimize the risk of flooding and stream channel erosion.

Other potential causes of future stormwater and tributary flooding problems include:

- Beavers dams blocking culverts and channels.
- Invasive weeds reducing ditch and stream channel capacities.
- Debris accumulations in roadside ditches, culverts, and lake outlet channels.

Water Quality

In the Nisqually Basin planning area, the most common water quality problems are bacterial pollution, which is indicated by high fecal coliform levels, and high nutrient (particularly phosphorus) levels in lakes. Turbidity is reportedly a problem in a number of lakes as well as in the Lower Nisqually River. The water quality problems in the Nisqually Basin planning area are described in Chapter 7.

High fecal coliform levels may indicate a health risk to people who ingest it or contact contaminated water through recreational uses (swimming and boating). High levels of phosphorus can lead to algal blooms and accelerated eutrophication of a lake system. High levels of suspended sediments can harm aquatic organisms, transport pollution, decrease drainage capacity, and increase water turbidity.

Sources of bacteria and phosphorus include failing septic systems, dairies, hobby farms, and stormwater runoff. Septic-system failures are a common problem in the Nisqually Basin planning area. Stormwater runoff may contribute to water quality problems from developed areas at Eatonville, growth anticipated in the Upper Nisqually Valley, and development around lakes. Sources of suspended sediments include shoreline construction, logging (and logging roads), and off-road vehicle use.

Ecology has prepared a list of water bodies that have not met state water quality standards, in response to the federal Clean Water Act. The listed water bodies within the Nisqually Basin planning area include the Mashel River, Nisqually River (lower reaches), Ohop Creek, Red Salmon Creek, Clear Lake, Harts Lake, and Ohop Lake (see Table 4-20*)*. Ecology must develop a total maximum daily load (TMDL) for each “listed” water body that can’t meet the water quality standards through technology-based controls.. The TMDL is the maximum amount of the pollutant that can be discharged into the water body without violating the standard. TMDLs are implemented through NPDES permits and “Best Management Practices”. Ecology recently established TMDLs for fecal coliform bacteria in Ohop Creek, Lynch Creek (a tributary to Ohop Creek), and Red Salmon Creek.

The Upper Nisqually River mainstem appears to be in good condition and meets water quality standards. In the marine waters near the mouth of the Nisqually River (Nisqually Reach), the Washington State Department of Health previously had closed the Nisqually Reach adjacent to the mouth of the Nisqually River and McAllister Creek to harvesting of shellfish because of high fecal coliform levels.

Significant Impacts and Mitigation Measures

"Proposed Action" (Basin Plan)

The "Proposed Action" recommends a series of CIP projects and programmatic measures to address specific water resource problems identified in the Nisqually River, its tributaries, and area lakes. The proposed Basin Plan would improve water quality and reduce flooding problems in the Nisqually Basin planning area, at a higher level than the "No Action" Alternative. Improved water quality and floodplain restoration also would result in positive benefits for fishery resources, plant and animal habitat, scenery, and recreation.

The Basin Plan includes twelve culvert replacement projects and that would address flooding and drainage problems. Replacing culverts would reduce localized flooding of roadways and adjacent properties. Most of these proposed CIP improvements are site-specific in nature, and are designed to deal with existing localized flooding issues. Some of the culvert replacement projects also would improve fish passage, as discussed under Fisheries Resources below.

The Basin Plan also includes sixteen property acquisition projects and nine habitat restoration projects. In addition, the Basin Plan prescribes several studies that would improve understanding of flood frequencies and flood hazard areas near McKenna and Wilcox Flats along the Nisqually mainstem and improve emergency response in those areas. The study results are intended to support development of more accurate floodplain maps and flood hazard mitigation measures, such as buy-outs or elevating flood-prone structures.

The acquisition and restoration projects would preserve and enhance riparian areas and floodplains that provide natural storage of floodwaters. Maintaining and enhancing natural storage of floodwaters would reduce flooding, and would not require new man-made, flood-control structures.

CIP projects to preserve and restore riparian areas would improve water quality because healthy riparian vegetation can moderate stream temperatures, control erosion, and filter runoff. Acquiring property may reduce future degradation of water quality. Most of the acquisition and restoration projects also would protect and enhance habitat for fish, plants, and animals, as described in the sections on Fisheries and Plants and Animals below.

In addition to the CIP projects, the Basin Plan includes programmatic measures to address stormwater runoff from future residential development, which could increase flooding and water quality problems. Implementation of a Low Impact Development (LID) Program would promote the use of LID in new development and redevelopment. The LID Program would focus on lakeshore areas where much of the new development is likely to be concentrated. In addition, potential stormwater impacts from future development would be addressed by adopting updated stormwater management standards.

Several programmatic measures would provide education, outreach, and technical and financial assistance with landowners, students, government agencies, and community groups in the Nisqually Basin. These programs would increase public awareness of water resource issues in the Basin, and would persuade the public to voluntarily implement water quality and habitat improvements. Public education and outreach programs likely would result in a net benefit on

surface water quality and habitat, depending upon the success of various education programs (Ecology, 2003).

Other programs would increase inspection and maintenance activities related to water resources. One program would prioritize the inspection of septic systems, which would reduce failures of septic tanks that are a source of fecal coliform bacteria in Basin receiving waters. Another program would increase the inspection of existing and future stormwater facilities, to confirm regular maintenance and compliance with current regulations. Development of a BMP Manual for Pierce County maintenance activities would include practices and techniques that protect water quality and aquatic habitat while preserving the flood control functions of stormwater facilities. To maintain culverts, Pierce County would cooperate with the Washington State Department of Fish and Wildlife (WDFW) to clear culverts and other blockages caused by beaver activity.

The Basin Plan includes several programmatic measures to improve the overall management of water resources in the Nisqually Basin. Pierce County would develop and implement a program for land acquisition and management for floodplain, water quality, and habitat protection. One program would enhance degraded riparian habitat and water quality, and would form partnerships with volunteer groups and other organizations such as the Pierce Conservation District, Nisqually River Council, Nisqually Indian Tribe, lake homeowners associations, and Pierce Stream Team. A program to implement elements of a total maximum daily load (TMDL) for fecal coliform bacteria in Nisqually tributaries could result in a more rapid improvement in water quality. Water quality issues at the various lakes in the basin would be addressed by a lake management program. Monitoring programs for surface water and for fish and wildlife habitat would assess the conditions and monitor the effectiveness of various Pierce County projects and programs.

Although the Basin Plan would improve the overall water resources in the Nisqually Basin, individual projects have the potential for site-specific impacts, particularly those constructed within or adjacent to the streams, lakes, or wetlands. Site preparation and construction activities could result in short-term impacts from erosion, temporarily reducing water quality. Measures to minimize construction-related impacts for individual projects would include temporary erosion and sediment control (TESC) measures and related “Best Management Practices” (BMPs) to reduce erosion and sedimentation. Standard erosion control measures such as silt fencing, coverage of exposed earth, and permanent seeding of disturbed areas following construction, would further reduce temporary sediment and water quality impacts. Construction work adjacent to or within streams would be limited to low-flow periods, typically the summertime. The standard requirements for control of erosion and other construction-related pollutants, such as fuels and lubricants, would assure that the construction impacts on water resources would be short term and not significant. Impacts on water quality during construction would be minor if appropriate erosion-control BMPs would be properly implemented.

The design and construction of each project would be required to meet Pierce County construction and erosion control requirements, as well as applicable state and federal requirements. Potential reviews, approvals, and permits for individual projects could include

environmental review (SEPA, NEPA), Shoreline Management Act compliance, Critical Areas compliance, ESA assessment, NPDES compliance, water quality (Army Corps of Engineers 404 Permit and Ecology 401 Certification), and Hydraulic Project Approval (HPA).

Overall, the projects and programs under the proposed Nisqually River Basin Plan are expected to cumulatively result in long-term benefits to the flooding, drainage, erosion, and water quality conditions within the Nisqually Basin. The types of projects under the Basin Plan would require minimal construction and minor structures, and would not result in long-term adverse impacts. All projects would include site-specific mitigation, comply with all applicable regulations, and obtain necessary permits and approvals. No significant adverse environmental impacts on water resources would occur under the "Proposed Action".

The Basin Plan would meet the County's updated goals and objectives for basin planning in Table 10-2. The Basin Plan would meet the goals to reduce flood hazards, improve water quality, and influence methods for new development. The Basin Plan also would be consistent with the new legal and policy requirements for Pierce County stormwater planning (see Section 10.3.8, Plans and Policies). The Basin Plan includes multiple projects and programmatic measures that would be consistent with the current requirements of the NPDES stormwater permit. The Basin Plan includes programmatic measures to implement a TMDL program in the Nisqually Basin. The projects and programs under the Basin Plan would reduce overall flood hazards, which would possibly improve the County's flood ratings and make the area eligible for reduced flood insurance.

"No Action" Alternative

Under the "No Action" Alternative, water resources and water quality would continue to be managed under the previous 1991 Plan and other current County programs. The 1991 Plan does not contain any remaining CIP projects to be constructed in the Nisqually Basin. County efforts would continue to focus on serious drainage complaints rather than assuming a more proactive, comprehensive approach for the Nisqually Basin. Few future site-specific projects and basin-wide programs to improve water resource conditions, if any, would likely be proposed for the Nisqually Basin. Any improvements to flooding and water quality would occur a lower level compared to the "Proposed Action". Periodic maintenance of ditches, culverts, and other County drainage facilities by County crews would continue. During construction of any individual projects, if any, the short-term impacts and mitigation measures would be similar to those discussed under the "Proposed Action".

The "No Action" Alternative would not address most of the specific flooding and water quality problems identified in the Nisqually Basin. Many identified water quality and flooding problems in the Nisqually planning area would continue. As further development occurs, water resource problems are expected to intensify. "No Action" may continue to result in degradation of water quality. "No Action" also would not achieve many of the County's updated goals and objectives for basin planning in Table 10-2. The "No Action" Alternative would not be consistent with many of the new laws, regulations, programs, and policy requirements for stormwater planning in Pierce County, which have developed since the 1991 Plan was issued (see Section 10.3.8, Plans and Policies).

10.3.2 Fishery Resources

This section summarizes the existing fisheries resources of the Nisqually Basin and evaluates potential impacts on fishery resources and aquatic habitat. The laws, regulations, plans, and policies concerning fishery resources and habitat are evaluated separately in Section 10.3.8, Plans and Policies.

Affected Environment

The salmonid species present in the Nisqually River Watershed are Chinook salmon, coho salmon, chum salmon, pink salmon, cutthroat trout, and steelhead trout. Bull trout are no longer present in the freshwater portion of the Nisqually River Watershed; however, the Nisqually Estuary is believed to be a potential foraging, migration, and overwintering area for Puyallup River bull trout and bull trout from other core areas (USFWS, 2004). Non-native species such as bass and pumpkinseed are present in the Nisqually mainstem, and other non-natives such as bluegill, brook trout, catfish, kokanee, and yellow perch are present in lakes of tributaries or above LaGrande Dam, and are likely present in the mainstem Nisqually River. The fish species, stream conditions, and aquatic habitat in the Nisqually mainstem and tributaries are described in detail in Chapter 4. Known fish distributions within the Nisqually River Basin planning area are shown on Figures 4-17 through 4-23.

In Pierce County waters, the National Oceanographic and Atmospheric Administration, National Marine Fisheries Service (NOAA Fisheries) has listed the Puget Sound Evolutionary Significant Unit (ESU) Chinook salmon and Puget Sound Distinct Population Segment (DPS) steelhead as threatened, and the United States Fish and Wildlife Service (USFWS) has listed the Coastal-Puget Sound DPS bull trout as threatened under the Endangered Species Act (ESA). A species categorized as “endangered” is in danger of extinction. One listed as “threatened” is likely to become endangered within the foreseeable future.

NOAA Fisheries also has designated the marine nearshore of Puget Sound, portions of the mainstem Nisqually River, and portions of several tributaries including McAllister Creek, Lynch Creek, Powell Creek, Tanwax Creek, Twentyfive Mile Creek, Yelm Creek, Horn Creek, Ohop Creek, three unnamed tributaries, and the Mashel and Little Mashel Rivers, as designated Critical Habitat (70 Federal Register 170) for the Puget Sound ESU Chinook salmon. The USFWS has designated Critical Habitat for bull trout along the eastern nearshore areas of Puget Sound, which includes the areas around the mouth of the Nisqually River (70 Federal Register 185). Critical habitat has not yet been designated for steelhead at this time.

The Nisqually River mainstem is utilized extensively by multiple salmon species for spawning, rearing, and as a migration corridor. Much of the Nisqually mainstem is still in good condition, especially when compared to most other lowland Puget Sound rivers in urbanizing areas. Although the mainstem and its tributaries provide productive habitat, some aquatic habitat has been lost or impaired because of alterations that have occurred over the last century.

Major aquatic habitat alterations include loss of instream woody cover, channel modifications, loss of estuary habitat, reduced riparian (streamside) vegetation, fish passage barriers, impaired water quality, elevated stream temperatures, and altered peak and base flows in several

tributaries. The major aquatic habitat problems and specific locations of habitat degradation are described in Chapter 8.

Anadromous fish travel great distances during juvenile outmigration to estuarine and ocean feeding grounds and, as adults, during their return trip to their breeding grounds to spawn. Access to upstream salmonid habitat in several tributaries has been blocked completely or partially by culverts, irrigation diversions, and beaver dams. The Pierce Conservation District (PCD) in 2002 completed an inventory of culverts and identified a number of culverts that appeared to block or impede fish passage. These "problem" culverts and other obstructions to fish passage are described in Chapter 5. These activities have impaired or eliminated access by anadromous fish to habitat that historically has been occupied by such fish.

Forest practices, agriculture, and rural residential development have altered the Nisqually River channel and banks, drained wetlands, and removed riparian vegetation. Development also has adversely affected water quality and flows as the result of stormwater runoff and erosion. Drainage projects have modified channels, hardened banks, and removed riparian vegetation. Degraded water quality, altered flows, and loss of riparian vegetation have adversely affect aquatic habitat and fishery resources. In addition, conversion of much of the Nisqually Estuary to diked agricultural land has altered salmon habitat. Although considered largely undisturbed, the Nisqually River Estuary has been reduced in size by approximately 30 percent as a result of modification by dikes (Glass and Salminen, 2002).

Significant Impacts and Mitigation Measures

"Proposed Action" (Basin Plan)

The "Proposed Action" includes a series of proposed CIP projects and programmatic measures that would address fishery problems identified in the Nisqually River Basin planning area. The proposed Basin Plan would protect and restore fishery resources and aquatic habitat, at a higher level than the "No Action" Alternative. Fishery restoration and protection also would benefit riparian vegetation, wetlands, and wildlife.

The Basin Plan includes three CIP projects that would address existing fish passage problems in the Nisqually River Basin. The Basin Plan also includes twelve CIP projects that would replace culverts, some of which would improve fish passage. Improving passage would increase upstream habitat for anadromous fish and restore the habitat that had been historically occupied by such fish. Spawning, rearing, and migration areas would increase, although the magnitude would depend on the quality of the habitat available upstream. Fish passage restoration in combination with other stream improvement projects would likely result in a positive cumulative impact on fishery resources, provided that non-native fish species are not introduced into upstream populations (Ecology, 2003). All culverts replaced must meet the fish passage criteria as required by WDFW.

The Basin Plan includes nine habitat restoration projects that would improve fish habitat. Depending on location, these CIP projects would restore fish access, native vegetation, and the channel migration zone or original floodplain and riparian areas. Another project would remove the last remaining dikes on Nisqually Tribe's estuary property, which would restore the Red Salmon Slough of the Nisqually Estuary.

In general, restoring streamside vegetation and floodplains tends to improve both aquatic and terrestrial habitat. Streamside vegetation provides riparian habitat for wildlife, shade for streams, bank stabilization, run-off filtration, and is a source of large-woody debris recruitment in streams. The restoration of natural stream channels tends to improve the abundance of pools and the sorting of spawning gravels.

Preservation and restoration values in the Nisqually mainstem are relatively high. Restoration would be expected to lead to substantial improvements, especially in salmon and trout abundance but also in the productivity and diversity of the populations. In addition, several tributaries (Ohop Creek and Mashel River) have the potential to sustain much larger salmon populations.

The Basin Plan would include sixteen CIP projects to acquire property in the Nisqually River Basin. Acquisition of property would protect aquatic and riparian habitats, preserve channel migration zones, reduce future degradation of water quality, and make areas available for future habitat restoration. Acquisition of property also would protect plant and animal habitat, open space, and scenic and recreational resources.

Although the CIP projects likely would result in an overall positive benefit on fishery resources, the construction of individual projects has the potential for short-term, adverse impacts, primarily from temporary erosion and sedimentation. Measures to minimize construction-related impacts for individual projects would include temporary erosion and sediment control (TESC) measures and related BMPs to reduce erosion and sedimentation. Impacts on fisheries during construction would be minor if appropriate erosion-control BMPs would be properly implemented. As discussed previously under Water Resources, the construction and design of each project would be required to meet Pierce County and state erosion control requirements, and all projects would be required to obtain any applicable federal, state, and local permits and approvals.

The proposed Basin Plan includes programmatic measures to enhance fisheries resources in the Nisqually River Basin. A program for “Salmon Carcass Nutrient Enhancement” would provide nutrients to juvenile salmon in key salmon streams, including but not limited to the mainstem Nisqually and Mashel River. Another program to “Develop and Implement a Fish and Wildlife Habitat Monitoring Program” would evaluate the effectiveness of aquatic and riparian habitat improvement projects in cooperation and coordination with other entities, such as the Nisqually Tribe.

Other programmatic measures would enhance riparian habitat and provide improvements to water quality, which would benefit fisheries resources. The water quality could be improved by programs that promote low-impact development (LID) techniques in future development projects, monitor surface water quality, manage water quality in lakes, update stormwater management standards, increase inspection and maintenance of stormwater facilities, and implement TMDL measures. Riparian habitat could be benefited by programs for land acquisition, riparian habitat enhancement, invasive species control, and vegetation management. Public education, outreach, and technical assistance programs likely would benefit surface water quality and habitat. Some programs would protect and enhance wetland and estuarine habitats.

Overall, the implementation of the multiple projects and programs in the Basin Plan would cumulatively result in long-term benefits for the fishery resources and aquatic habitat within the Nisqually River Basin. The types of projects under the Basin Plan would require minimal construction, minor disturbance of habitat, and minor structures, and would not result in long-term adverse impacts. All projects would include site-specific mitigation, comply with all applicable regulations, and obtain necessary federal, state, and local permits and approvals prior to construction. No significant adverse environmental impacts on fishery resources would occur under the "Proposed Action".

Endangered Species Act

The Nisqually River Basin planning area supports populations of Chinook salmon and steelhead, and has the potential to support populations of bull trout. All three of these salmonid species are listed as threatened under the Endangered Species Act (ESA). The proposed Basin Plan includes a number of projects and programmatic measures that are designed to protect or restore habitat and to improve water quality for listed and non-listed salmonids alike. Construction of individual CIP projects, however, could affect threatened salmonids in the short term. Implementing the Basin Plan in combination with other habitat improvement efforts would likely have positive, cumulative impacts on the listed salmonid species in the Nisqually River Basin. The consistency of the Basin Plan with the Endangered Species Act is evaluated in Section 10.3.8, Plans and Policies.

"No Action" Alternative

Under the "No Action" Alternative, stormwater would continue to be managed under the 1991 Plan and other current County surface water management activities. Few site-specific projects and basin-wide programs to improve fish habitat, if any, would likely be proposed for the Nisqually River Basin. Any improvements to fish habitat would occur at a lower level compared to the "Proposed Action". If any projects were to occur, short-term impacts and mitigation measures associated during construction would be similar to those discussed under the "Proposed Action".

The "No Action" Alternative would not address most of the specific fish habitat problems identified in the Nisqually River Basin. Problems associated with habitat and water quality would continue. "No Action" may result in continuing degradation to water quality and fish habitat, which would adversely affect fish and other aquatic species. "No Action" also would not achieve many of the County's updated goals and objectives for fish habitat in Table 10-2. The "No Action" Alternative would not be consistent with many of the new laws, regulations, programs, and policy requirements for fisheries in Pierce County, which have developed since the 1991 Plan was issued (Section 10.3.8, Plans and Policies).

10.3.3 Plants and Animals

Affected Environment

Habitat

The Nisqually River Basin has a mix of plant-and-animal habitats. The major habitats include wetlands, riparian, upland, near-shore, and forest lands. The streams and lakes provide habitat for a variety of fish, birds, shellfish, aquatic vegetation, and mammals. The habitats in most of the Nisqually River Basin planning area are undeveloped. Portions of the natural habitats have been altered in areas of logging and residential and agricultural development, particularly in the lower watershed. Habitat related to fish is discussed in the previous section.

Wetlands

Wetlands generally include swamps, marshes, bogs, and similar areas. Many of the freshwater wetlands are associated with ponds, lakes, rivers, and shorelines; while others can be "isolated" wetlands that are not directly connected to other surface water bodies. Wetlands are capable of performing a number of functions, including groundwater recharge and discharge, stormwater and floodwater detention, water quality improvement, erosion control, food chain support, and wildlife habitat and corridors (Ecology, 2003).

In the Nisqually River Basin planning area, most wetlands are located in the northwestern half of the Basin, in areas where lakes exist. Other wetlands are associated with the Nisqually River or its tributaries. Figure 4-26 shows the wetlands in the Nisqually River Basin, and Table 4-17 summarizes the wetland areas by subbasin.

Many wetlands have been altered by residential and agricultural development and by previous flood-control structures. In the Lower Nisqually River Watershed, wetlands have been drained and ditched to convert land to agriculture. Residential development has cleared some wetlands and encroached on wetland buffers. Stream channel and bank modifications have adversely affected wetlands, such as at the mouths of the creeks in the Nisqually River floodplain. Wetland alteration has directly and indirectly affected water quality, wildlife, and fishery resources. Chapter 4 discusses the wetland alterations that have occurred within each Nisqually subbasin.

Riparian Habitat

Riparian habitat occurs in areas adjacent to rivers, streams, seeps, and springs. Riparian habitat is an important transitional zone between aquatic and upland habitats. Suitable riparian habitat is essential for fish and aquatic wildlife, by providing shade and cooler water temperatures, stabilizing stream banks and reducing erosion, filtering sediments and pollutants, reducing peak flood flows, contributing food and nutrients, providing instream habitat through recruitment of large woody debris (LWD), and supplying overhanging cover. Riparian habitat also is important for land animals, by providing shelter, foraging habitat, nesting cavities, food for insect-eating birds, and shade for large animals such as deer and elk (Ecology, 2003).

Riparian habitat has been altered along the Nisqually River and in its floodplain. Many riparian forests have been cleared and are now either converted to non-forest areas or are in a recovery state dominated by younger hardwood stands. The clearing of streamside vegetation has

directly affected riparian plant communities and associated wildlife, and affected water quality and fishery resources. The conditions of the riparian habitats within each Nisqually subbasin are described in Chapter 4.

Upland Habitat

Upland habitat in the Nisqually River Basin includes primarily coniferous and deciduous forestland, grassland (prairie), and landscaped areas associated with rural residential development. Development has disturbed many of the uplands in the lower Basin, leaving fragmented patches of forest land and grassland. Most of the conifer and deciduous forest in the lower Basin has been changed from its pre-European settlement condition by two to three timber harvests, and over the last century by conversion to agriculture and residential land uses.

Forest Land

Much of the Upper Nisqually River Watershed is forest land. Forest land provides habitat for wildlife and plays an important role in the hydrological cycle. Forest lands in some areas of the Nisqually River Basin planning area have been developed into rural residential parcels, particularly in the lower subbasins. Development of forestland has removed valuable plant and animal habitat and has adversely affected water quality. The estimated decreases in forested area within each Nisqually River subbasin are shown in Table 4-14.

Most commercial forest activities are regulated by the Washington State Department of Natural Resources (DNR), and are outside the scope of Pierce County Basin Plans. Conversion of forest land to residential or agricultural uses, however, is subject to Pierce County's SEPA review and development regulations (see Chapter 2). Past and foreseeable conversions of timberland have been identified and evaluated under the Basin Plan.

Near-Shore Habitat

The Nisqually Reach is the near-shore area where the Nisqually River flows into Puget Sound. The Reach provides habitat for shellfish, including clams, oysters, geoducks, and mussels. Much of the Nisqually Estuary has been diked and converted to agricultural land. The Washington State Department of Health previously had closed the Nisqually Reach adjacent to the mouth of the Nisqually River and McAllister Creek to harvesting of shellfish, because of high fecal coliform bacteria levels. The Nisqually Reach shellfish harvesting areas are located primarily within Thurston County. The near-shore areas are important rearing areas for juvenile salmonids as they transition out of fresh water into salt water. Near-shore areas also provide holding/resting areas for adult salmonids prior to their upstream spawning migrations.

Vegetation

The Nisqually River Basin supports several plant communities that include conifer, deciduous, and mixed conifer-deciduous forests, grassland (agriculture), and shrub land. Generally, the western portion contains a mix of pasture, farmfields, clear cuts, meadows, and mixed deciduous/coniferous forest, while the eastern portion contains a mix of forest types and ages (Pierce County, 1999). Overall, the Nisqually River Basin planning area is relatively undeveloped, and most of the native vegetation remains.

In areas developed for residential and commercial uses, vegetation includes non-native trees, shrubs, and grasses. Non-native and invasive plants have established themselves in the Nisqually River Basin as the result of land clearing for agriculture and development. Ground disturbance and sedimentation of streamside areas, especially in wetlands and lowland pastures, have led to an explosion of invasive plant species, including reed canarygrass, Scots broom, and Himalayan blackberry.

Wildlife

Wildlife found in the Nisqually River Basin consists of native wildlife associated with the wetland, riparian, upland, near-shore, and forest habitats, and with the area's streams and lakes. Much of the Upper Nisqually River Watershed is relatively undeveloped and supports a greater diversity of native animals. In areas of residential and agricultural development, wildlife includes species that can tolerate or benefit from close association with humans and habitat fragmentation.

The Nisqually River Basin contains a variety of wildlife, including large and small mammals, amphibians, reptiles, bird species, and invertebrates. Much of the Upper Nisqually is undeveloped and supports the habitat required for large mammal species such as cougar, bobcat, bear, elk, and deer. The large tracts of land used for forestry, single-family residential, or left vacant contribute to a continuous habitat for species with a large home range (Pierce County, 1999). River otter, muskrat, and beaver can be found along the Nisqually River, and other animals such as shrews, voles, frogs, snakes, and birds can be found throughout the Basin. Fish, amphibians, waterfowl, birds of prey, and mammals, such as beaver and muskrat, depend on various types of wetlands for food, forage, nesting, and cover.

The Nisqually River Basin planning area contains documented raptor habitat and active nests, including bald eagle nesting areas. Lower portions of the Basin contain nesting and feeding habitat for seabirds and marine mammals. Riparian areas and wetlands provide nesting, migratory, and wintering areas for migratory bird species.

The Nisqually River Basin planning area includes several plant and animal species considered threatened or endangered by federal and state agencies. Besides the Chinook salmon, bull trout, and steelhead trout discussed under Fisheries, other species of concern include the bald eagle, spotted owl, water howellia, marbled murrelet, blue heron, pileated woodpecker, peregrine falcon, and western pond turtle. The state and federal endangered species and habitats are discussed in Section 10.3.8, Plans and Policies.

Significant Impacts and Mitigation Measures

"Proposed Action" (Basin Plan)

The Basin Plan includes proposed CIP projects and programmatic measures to address habitat and water quality problems identified in the Nisqually River Basin, which would generally benefit plant and animal resources in the Nisqually River Basin. Several of the projects and programs would restore and protect plant and animal habitat, at a higher level than the "No Action" Alternative. Many of the habitat restoration projects and programs also would benefit fishery, scenic, and recreational resources.

The Basin Plan includes nine stream restoration projects, one vegetation control projects, and one revegetation project that would improve overall plant and animal habitat. Depending on location, these CIP projects would restore riparian habitat, native vegetation, wetlands, or the original floodplain. One project would remove the last remaining dikes on Nisqually Tribe's estuary property, which would restore the Red Salmon Slough of the Nisqually Estuary. The overall long-term impacts on plants and animals are likely to be positive for the Nisqually River Basin.

In general, restoring riparian areas tends to improve aquatic, wetland, and terrestrial habitat. Restoration projects that revegetate stream banks would directly benefit riparian habitat for plants and animals. Floodplain enhancement would provide improved or additional wetlands, riparian, and upland habitats. Riparian and upland plant communities are likely to benefit through increased native plant presence and diversity. The development of expanded riparian corridors also may provide migration corridors for terrestrial species (Ecology, 2003). In addition, projects to improve water quality also would benefit plant and animal species and diversity. Restoring riparian, estuaries, and wetland areas would benefit raptors, seabirds, and migratory waterfowl.

The Basin Plan would include sixteen CIP projects to acquire property in the Nisqually River Basin. Acquisition of property would protect riparian and wetland habitats, preserve the floodplain, reduce future degradation of water quality, and make areas available for future habitat restoration. Acquisition of property also would preserve fishery habitat, open space, and scenic and recreational resources.

The Basin Plan includes several programmatic measures to restore and enhance riparian, wetland, and estuarine habitat in the Nisqually River Basin. One measure would be to develop and implement a program to enhance degraded riparian habitat and water quality. Another measure would develop and implement a watershed vegetation management plan, which would restore and manage riparian vegetation in the Nisqually River Watershed. A shellfish protection program would protect shellfish resources, prevent degradation of shellfish growing areas, and protect and improve water quality. A fish and wildlife habitat monitoring program would evaluate the effectiveness of habitat improvement projects in the Nisqually River Basin. Other programmatic measures would enhance fishery habitat and improve water quality, which would benefit plant and animal resources.

The Basin Plan also would include programs to control invasive species. The potential programs could inventory the invasive plant problem, develop a guidance manual, and coordinate efforts with other agencies and volunteers. Removal of invasive plant species and restoration of native vegetation would provide a positive benefit for improved plant-species diversity and wildlife. Control of invasive species would enhance riparian, wetland, and upland habitats.

Although the overall impacts on plants and animals are likely to be positive for the Nisqually River Basin, construction of individual projects could alter vegetation and displace wildlife in the short term. Individual projects would undergo future environmental review, which could include an evaluation of plants and animals in the project area, determination of the amount of vegetation and wildlife habitat to be removed or altered, review under the Pierce County Critical Areas Ordinance, and recommendation of project-specific mitigation where required.

Construction of individual projects would include BMPs, and may require minimizing the area of disturbance, restoring and revegetating disturbed areas with native plant species to the extent possible, and maintaining the areas replanted with native species until those species are well-established. As discussed previously under Water Resources, all projects would be required to obtain any applicable federal, state, and local permits and approvals. Construction work would avoid sensitive nesting and rearing periods, where possible, which would be determined during individual permitting.

Taken together, the various projects and programs under the Basin Plan would cumulatively result in long-term benefits to plant and animal habitat within the Nisqually River Basin. The Basin Plan would be consistent with the County goals and objectives for stormwater planning (Table 10-2) and with the new laws and policies related to habitat protection (Section 10.3.8, Plans and Policies, below). Individual projects would be relatively small and would not permanently convert large areas of natural habitat to developed areas. Potential short-term impacts during construction would be relatively minor, and would be mitigated with BMPs, revegetation, and other site-specific mitigation. All projects would located, designed, and operated to comply with applicable regulations, and would obtain required permits prior to construction. No significant adverse environmental impacts on plants and animals would occur under the "Proposed Action".

"No Action" Alternative

Under the "No Action" Alternative, stormwater would continue to be managed under the 1991 Plan and other current County surface water management activities. Few site-specific projects and basin-wide programs to improve plant and animal habitat, if any, would be proposed for the Nisqually River Basin. Any improvements to plant and animal habitat would occur a lower level compared to the "Proposed Action". If any projects were to occur, construction impacts and mitigation measures would be similar to those discussed under the "Proposed Action".

The "No Action" Alternative would not address most of the habitat problems identified in the Nisqually River Basin. Problems associated with habitat and water quality would continue. If projects or programs are not proposed in the Nisqually River Basin and the identified habitat problems remain, taking "No Action" may result in continued degradation of plant-and-animal habitat in the Watershed. "No Action" also would not achieve many of the County's updated goals and objectives for habitat in Table 10-2. The "No Action" Alternative would not be consistent with many of the new laws, regulations, programs, and policy requirements for habitat protection in Pierce County, which have developed since the 1991 Plan was issued (Section 10.3.8, Plans and Policies).

10.3.4 Soils and Geology

Affected Environment

Elevations in the Nisqually River Basin range from sea level to over 14,000 feet, although most of the Basin lies below 1,000 feet. Slopes range from relatively level in the valley floors to extremely steep in the eastern mountainous areas. The varied topographical landforms in the Nisqually River Basin are the product of volcanic activity, tectonic uplifting, glacial advances and

retreats, and erosion by rivers and streams. The surficial geology of the Nisqually River Basin planning area is shown in Figure 4-5.

Glaciation has modified the landscape of the western portion of the Nisqually River Basin. Ice from the most recent episode of glaciation, known as the Vashon stage, retreated about 12,500 years ago. Glacial deposits resulting from the Vashon glaciation include advance outwash, glacial till, and recessional outwash. Continental glacial ice did not cover large areas of the eastern Basin, where surface geology generally consists of sedimentary and volcanic formations (bedrock).

Pierce County has designated volcanic, landslide, seismic, and erosion hazard areas under its Critical Areas Ordinance (Title 18E). The Nisqually River Basin planning area includes landslide and erosion hazard areas, which often occur in areas with steep slopes. The planning area also has seismic hazards, which typically include alluvial or recessional outwash surficial geologic units. Volcanic hazards in the planning area occur along the river valleys leading from Mount Rainier.

Soil permeability influences the movement of water through and within the soil layers. Soils in the western portion of the Watershed are generally more permeable than those in the eastern portion. Because most of the planning area is undeveloped, the native soils have not been altered extensively. Table 4-1 describes the four classes of hydrologic soil groups and Figure 4-6 shows the hydrologic soil groups in the Nisqually River planning area.

Significant Impacts and Mitigation Measures

"Proposed Action" (Basin Plan)

The Basin Plan includes projects and programmatic measures to address flooding and water quality problems. Several of these projects and programs also would reduce soil erosion and sedimentation in the Nisqually River Basin. The overall projects and programs under the Basin Plan would address erosion problems at a higher level than the "No Action" Alternative.

CIP projects to preserve and restore riparian areas would control erosion. Revegetation and channel stabilization projects also would reduce erosion and sedimentation in streams. Several programmatic measures would address soil erosion, by enhancing riparian habitat, promoting low-impact development (LID) techniques, updating stormwater management standards, increasing inspection and maintenance of stormwater facilities, and providing public education.

Some individual projects could require limited excavation, filling, and/or grading activity. In general, the amounts of filling or grading would be relatively small, if any. Projects also could result in a relatively minor amount of additional impervious surfaces. The Basin Plan would rely on natural systems for stormwater control rather than new structures, which would minimize grading/filling activities and new impervious surfaces. In addition, some projects could be located in geological hazards regulated under the Pierce County Critical Areas Ordinance. Specific information on grading/filling, impervious surfaces, and geological hazards would be determined during project-level design and environmental review. All projects would comply with applicable regulations for grading and filling activities and critical areas, would obtain any

necessary permits, and may include site-specific mitigation. The future projects are not anticipated to result in significant, adverse impacts on soil and geology in the long term.

In the short term, construction of individual projects would have the potential for temporary adverse impacts from erosion. Activities such as land clearing, excavation, grading, and filling could increase soil erosion, if uncontrolled, by removing protective vegetation, disaggregating the soil, and modifying slopes and drainage patterns. The magnitude of potential construction impacts would depend on the type and scale of the construction activities, the site-specific soils and any geological hazards, and the season during which the construction would occur (Ecology, 2003). Potential construction impacts and site-specific mitigation would be determined during environmental review and permitting of individual projects.

As mitigation measures during construction of individual projects, standard erosion control measures and "Best Management Practices" (BMPs) would be implemented to avoid serious erosion and sedimentation problems. Examples of typical BMPs could include installing filter fabric fences or hay bales, covering exposed soils, using temporary soil covers such as mulch, diverting stormwater with temporary berms, and using settling ponds or grass-lined swales to prevent sediment from moving into receiving waters. After construction, vegetation would be restored and stream banks would be stabilized. As discussed previously under Water Resources, the construction and design of each project would be required to meet Pierce County and state erosion control requirements, and all projects would be required to obtain any applicable federal, state, and local permits and approvals.

"No Action" Alternative

Under the "No Action" Alternative, stormwater would continue to be managed under the previous 1991 Plan and other current County programs. Limited erosion control would continue in the Nisqually River Basin, but at a lower level compared to the "Proposed Action". Few site-specific projects and basin-wide programs, if any, would likely be proposed for the Nisqually River Basin. If any projects were proposed, short-term impacts and mitigation measures associated during construction would be similar to those discussed under the "Proposed Action".

10.3.5 Land and Shoreline Use

Land and shoreline use in the Nisqually River Basin is guided primarily by Washington's Growth Management Act (GMA), the Washington Shoreline Management Act (SMA), and the *Comprehensive Plan for Pierce County, Washington* (*County Comprehensive Plan*). The GMA, SMA, and *County Comprehensive Plan* are described in Chapter 2 of the Basin Plan. Applicable land use regulations, plans, and policies are evaluated in Section 10.3.8, Plans and Policies, of this FSEIS.

Affected Environment

Land use and population density can affect surface water drainage/flooding, water quality, and fish and wildlife habitat. Undeveloped forested land allows for maximum infiltration of rainwater, has the least potential for causing water pollution, and provides natural habitat for

native species. Highly developed areas (characterized by large areas of impervious surfaces) increase the surface runoff of stormwater that carries pollutants from the manmade surfaces. Poor agricultural practices, such as improperly applied irrigation methods and feeding or watering livestock too close to a stream, can contribute to water quality and fishery problems.

Pierce County has experienced substantial population growth in previous years and is expected to support more growth over the next 30 years. The estimated 2000 population in the Nisqually River Basin planning area was 12,881, which is 1.8 percent of the County's total population. Assuming that the planning area will continue to capture at least 2 percent of the County's growth, the population residing in the planning area will be approximately 16,300 in 2010 and 18,000 in 2020. Figure 4-3 shows a distribution of the population in the Nisqually River Basin planning area.

The Nisqually River Basin planning area is mostly undeveloped, while any developed areas are generally at rural densities. Urban development occurs at the Cities of Roy and Eatonville. Rural communities include Graham, Elk Plain, Kaposin, Thrift, Rocky Ridge, Alder, Elbe, Ashford, and Park Entrance (just outside Mount Rainier Nation Park). The major land uses are single-family residential, agriculture, forestry, open space, and recreation. The land uses in the planning area are described in Chapter 4 and are shown in Figure 4-1.

The primary type of residential land use is single-family residential. Most residential development is located in the western half of the planning area (west of Eatonville), and along SR-706 approaching Mount Rainier National Park. The single-family developments range from houses on large lots (five+ acres) to cabins on small lots in recreational subdivisions. Many houses are owned by individuals who live outside the area and use them for summer and weekend recreation. Many of the existing small lot subdivisions throughout the valley will slowly transform from seasonal recreational properties to year-round residences (Pierce County, 1999).

Most of the western portion of the planning area is zoned for rural residential development. Rural residential zoning allows a base density of one dwelling per 5, 10, or 20 acres. The R10 and R20 zoning designations are intended to maintain rural character and open space, while allowing resource-based industries such as agriculture and forestry. Figure 4-2 maps the zoning of the Nisqually River Basin planning area.

The eastern portion of the planning area is predominantly zoned as "Designated Forest Land," which mostly is privately owned land used for commercial timber activities. Designated forest lands can only have one dwelling unit per 80 acres. Forest lands owned by the State of Washington and U.S. Forest Service are managed for timber harvest and recreational use, and are not available for development.

Agricultural lands are scattered throughout the planning area, although most are located in the western portion. Agricultural uses operate as farms or ranches, or grassland pastures. In response to GMA requirements, Pierce County created a new designation for Agricultural Resource Lands, and applied it to prime farmlands in the County.

Pierce County has designated Urban Growth Areas (UGAs). UGAs are areas in which urban growth is encouraged, and where adequate public facilities exist or can be efficiently provided.

The majority of the Nisqually River Basin planning area is located outside the UGAs. The limited UGAs are located around the cities of Roy and Eatonville.

The western portion of the Nisqually River Basin planning area (west of Eatonville) has experienced increasing development pressure. Large tracts also are being converted from commercial timber to rural residential, 20-acre parcels, such as between Ohop and Harts Lakes. Areas that were once forested will have reduced trees and native vegetation, more impervious areas, and may have pets, livestock, septic systems, and increased traffic–all possible pollutant sources. Some of these properties have direct access to lakes and wetlands. As the land is developed and forest cover is converted to impervious surface, stormwater drainage systems will be affected by the runoff and potential increased pollutant loading.

To evaluate the development-related stormwater impacts, future stormwater runoff has been modeled on adopted land uses in the *County Comprehensive Plan*. The modeling of hydrological conditions has been based on the future County land use and zoning designations and on anticipated growth. The hydrological modeling has been used to determine the type, size, and location of proposed stormwater facilities needed to support planned growth.

As a basin becomes developed, hydrologic characteristics are altered because of impervious surfaces and structures. Impervious surface area is often used as an indicator of the potential for drainage and water quality problems associated with stormwater runoff. One of the primary physical attributes used for a hydrologic model is the Effective Impervious Area (EIA). The existing and future EIAs for the Nisqually River Basin planning area have been computed based on land use and zoning designations. The existing EIA percentages are relatively low in the Nisqually River Basin planning area. Only five of the 23 subbasins are projected to experience EIA increases of more than 1%. Table 4-12 shows the existing and future EIAs for each subbasin.

Significant Impacts and Mitigation Measures

"Proposed Action" (Basin Plan)

The proposed Basin Plan would address many of the identified flooding, drainage, and water quality problems in the Nisqually River Basin, which would result in long-term benefits on associated land and shoreline uses. The Basin Plan would reduce flooding of land uses and destruction of property and structures. The improvements to flooding, drainage, and water quality problems are evaluated in Section 10.3.1, Water Resources and Water Quality, above.

The proposed projects and programs are not anticipated to result in changes to existing and planned land uses in the Nisqually River Basin planning area. The Basin Plan would not encourage any new growth or development in addition to planned uses in the *County Comprehensive Plan*. The Basin Plan also would not substantially affect farming or timber operations that could induce conversion of agricultural or resource lands to other land uses.

Rather than encouraging new growth, the Basin Plan would support existing and planned land uses by providing stormwater facilities and services. By better accommodating planned growth under the *County Comprehensive Plan*, the Basin Plan would result in a greater reduction in development-related stormwater impacts than the "No Action" Alternative. The Basin Plan has

used planned land use/zoning to model future hydrological conditions. The Basin Plan would be internally consistent with the *County Comprehensive Plan*, as required under the GMA (see Section 10.3.8, Plans and Policies).

The Basin Plan includes projects and programmatic measure to acquire property in the Nisqually River Basin. The identified projects would not result in displacement of residences or businesses. Few individual projects, if any, would require demolition of existing structures. Any future land acquisition program would purchase property from willing sellers. Potential mitigation measures would include soliciting public input to the planning process from landowners, and providing sufficient advance notice to potentially affected property owners. Property owners would be compensated at fair market value for any property that may need to be acquired.

Because the Basin Plan does not proposed major new stormwater or flood storage structures, existing land uses would not be inundated by water. Instead, the Basin Plan would rely on natural systems that would minimize impacts on land uses. Adjacent land uses would not be substantially affected by the operation of proposed stormwater projects.

The location, design, construction, and operation of future projects would be consistent with the site-specific land use, zoning, and development regulations and policies. Projects located within a regulated shoreline also would be consistent with the policies and regulations of the County's Shoreline Master Program. Individual CIP projects could require future land use permits and approvals, and site-specific mitigation measures. Shoreline, zoning, and other land use reviews would occur when individual projects are proposed.

During construction, adjacent land uses could be temporarily affected by dust, runoff, noise, disruption of services, and construction equipment. Future projects would include site-specific mitigation to minimize potential construction impacts on adjacent land uses, which would be determined during environmental and zoning review of individual projects.

No unavoidable significant adverse impacts or cumulative impacts on land and shoreline uses are expected under the projects and programs of the Basin Plan. The Basin Plan would be consistent with the *County Comprehensive Plan* and its land use and stormwater policies. The consistency with applicable plans and policies is evaluated in detail in Section 10.3.8, Plans and Policies.

"No Action" Alternative

The "No Action" Alternative has been developed from the 1991 Plan and is a continuation of the existing County programs. The "No Action" Alternative would not address most of the identified problems concerning flooding and destruction of property. Many identified drainage and flooding problems in the Nisqually River Basin would continue. Development-related stormwater impacts from planned growth would be addressed by existing regulations, which would not adequately address future development-related stormwater impacts from planned land uses. The "No Action" Alternative may be inconsistent with the *County Comprehensive Plan*, as evaluated in Section 10.3.8, Plans and Policies. Future projects, if any, would comply with site-specific land and shoreline regulations, and would obtain all applicable permits.

10.3.6 Public Services and Utilities

Affected Environment

The Nisqually River Basin planning area has public services and utilities typical of a rural area. Depending on location, existing services and utilities include fire and police protection, schools, libraries, healthcare, electricity, refuse service, telephone, cable, and water and sewer (either on-site or community). The urban areas in the Nisqually River Basin planning area generally have more available services than rural areas. Water is supplied mostly by individual on-site wells and smaller community water systems. Eatonville draws its drinking water from the Mashel River.

The western portion of the Nisqually River Basin planning area is connected to the Pierce County sanitary sewer system, and is within the Tacoma Treatment Plant Sewer Service Planning Area. The eastern portion is largely unsewered, however, and the septic systems contribute to water quality concerns (see Section 10.3.1, Water Resources and Water Quality).

Septic system failures are a common problem in the Nisqually River Basin planning area because many of the rural houses were originally built as part-time residences. In recent years, many residences have been converted to full-time residences. In particular, septic systems serving shoreline houses may provide inadequate treatment if the water table is high or if they are too close to the surface water body. Lack of maintenance can also lead to inadequate treatment.

The Nisqually River Basin planning area is primarily rural and has few constructed drainage facilities. Stormwater facilities are constructed and maintained by Pierce County Surface Water Management. Culverts and ditches within County road rights-of-way are maintained by the Transportation Services Division of Public Works and Utilities.

Roadways are frequently flooded because of flooding and drainage problems. Flooding has closed roads, which can reduce access for emergency vehicles and disrupt services and utilities. A total of 60 roadway flooding problems have been identified in the planning area (see Chapters 4 and 5). Most of these are located in the Murray Creek, upper Tanwax Creek, Brighton Creek, Horn Creek, upper Ohop, and Kreger Creek subbasins. Beavers are frequently a cause of roadway flooding because they often build inside culverts to create blockages.

Numerous parks and recreational areas are within the Nisqually River Basin. Most of these facilities are built to attract visitors on a regional, state, or national basis. The major recreational areas are Alder Lake Park, Elbe Hills and Tahoma State Forests, Mount Tahoma Ski Trails, Mt. Baker Snoqualmie National Forest, and Mt. Rainier National Park. The Nisqually River itself is an important recreational area for fishing, boating, swimming, sightseeing, and other water-orientated activities. Other recreational areas are the numerous lakes in the planning area.

Significant Impacts and Mitigation Measures

"Proposed Action" (Basin Plan)

The projects and programs of the Basin Plan would not result in a significant increase in the long-term need for public services and utilities. Implementation of the Basin Plan would affect the services provided by Pierce County Surface Water Management, which provides drainage utility services. The Basin Plan would have no adverse impacts upon solid waste collection, schools, libraries, landfills, electrical power, natural gas, or telecommunications facilities. Significant adverse impacts on public services and utilities are not expected in the long term under the "Proposed Action".

The "Proposed Action" recommends a series of CIP projects and programmatic measures to reduce flooding and property destruction, which generally would improve public safety and reduce the need for public services and utilities. Replacing culverts would reduce localized flooding of roadways and adjacent properties. The acquisition and restoration projects would reduce specific flooding problems, and would preserve and enhance floodplains that provide natural storage of floodwaters.

Programmatic measures would increase inspection and maintenance activities of stormwater facilities such as culverts and ditches. One program would prioritize the inspection of septic systems, which would reduce failures of septic tanks that are a source of fecal coliform bacteria in Basin receiving waters.

The projects and programs to improve water quality, habitat, and fisheries also would increase recreational opportunities in the Nisqually River Basin.

Construction of some of the CIP projects could have short-term impacts upon public safety and utilities. Construction activities may temporarily affect roadways, delay emergency vehicles, and disrupt local services and utilities. Replacement or repair of culverts under roadways could disrupt traffic and access. Potential impacts during construction would be short term and site specific, and would be determined when individual projects are proposed. Pierce County would coordinate site-specific mitigation measures with local service providers and utilities to avoid or reduce disruptions during construction. Access for emergency vehicles would be maintained at all times during construction. Potential construction impacts and mitigation would be evaluated during future environmental review of individual projects.

"No Action" Alternative

Under the "No Action" Alternative, stormwater and flooding would continue to be managed under the previous 1991 Plan and other current County programs. Few, if any, projects would be proposed in the Nisqually River Basin planning area under "No Action". Limited improvements under "No Action" could reduce some of the existing flooding of roadways and properties. Many of identified roadway flooding problems in the Nisqually River Basin planning area would continue. The "No Action" Alternative would provide a lower level of stormwater-related benefits to public services and utilities, compared to the "Proposed Action".

Similar to the "Proposed Action", potential projects would not result in a substantial increase in the long-term need for public services and utilities, but could result in temporary construction

impacts. Any projects would undergo future environmental review and include site-specific mitigation, and would be designed, constructed, and operated to avoid or reduce potential impacts on services and utilities.

10.3.7 Historic and Cultural Resources

Affected Environment

Historic and cultural resources can include archaeological, historic, and traditional cultural places such as buildings, structures, sites, districts, objects, and landscapes. Several historic and cultural resources exist in the Nisqually River Basin planning area. The Nisqually River Basin includes properties that are listed on, or proposed for, national, state, and local preservation registers.

The Nisqually River Basin planning area also has potential for Native American artifacts. More site-specific information on the potential to encounter historic, cultural, or archaeological resources would be assessed when individual projects are proposed and undergo future SEPA and environmental review.

Several state and local data bases identify historic properties and cultural resources. The Washington State Department of Archaeology and Historic Preservation (DAHP) provides an on-line database of the historic and archaeological sites that are listed on the state and national registers. The DAHP has identified resources within the Nisqually River Basin planning area that are listed on the National Register of Historic Places and the Washington Heritage Register (DAHP, 2008). The Pierce County Register of Historic Places and the Pierce County Cultural Resources Inventory also identified resources within the Nisqually River Basin planning area.

In addition, the Nisqually River and its tributaries are an important cultural resource for the Nisqually Tribe. The salmon of the Nisqually River have been the mainstay of their diet, and are the foundation of their culture as well.

Significant Impacts and Mitigation Measures

"Proposed Action" (Basin Plan)

The Basin Plan is not anticipated to result in any significant, long-term adverse impacts on historic and cultural resources. Individual CIP projects could have the potential to encounter historic or cultural resources, if present. Prior to construction of individual projects, the County would assess the potential for disturbance of cultural, archaeological, or historic sites. Future CIP projects would be located and designed, where possible, to avoid any identified historic or cultural resources. If a project were to potentially affect a historic or cultural resource, Pierce County would evaluate potential impacts and coordinate the project design and mitigation measures with the appropriate local, state, and tribal officials when the individual project is proposed. Pierce County would conduct site surveys, evaluate potential impacts and mitigation, and coordinate with appropriate tribes and agencies during future environmental review of individual projects.

Archaeological resources, particularly those located along streams, can be affected by erosion, channel migration, and extreme flow variations. The "Proposed Action" includes projects and

programmatic measures to control stormwater, reduce erosion, and restore stream channels and floodplains, at a higher level than the "No Action" Alternative. Reduced erosion and restoration generally would be a benefit to historic and cultural resources.

The Basin Plan also would protect and restore fishery resources that are an important cultural resource for the Nisqually Tribe. The potential impacts and benefits on fisheries of the Basin Plan are evaluated in Section 10.3.2, Fishery Resources.

The potential exists to encounter archaeological or cultural resources during construction of individual projects. If any cultural resources were discovered during excavation, Pierce County would immediately consult with the state and local historic preservation offices and with affected tribes regarding site-specific mitigation. Potential mitigation measures could include redesigning the project, data recovery, and site monitoring. Potential construction impacts would be evaluated during future environmental review of individual projects, and are not anticipated to be significant.

"No Action" Alternative

Under the "No Action" Alternative, stormwater would continue to be managed in the Nisqually River Basin planning area as it is today. Limited erosion control and fishery restoration, if any, would continue under "No Action", but at a lower level of cultural benefits than the "Proposed Action". Few, if any, projects would be proposed in the Nisqually River Basin planning area under "No Action". If future projects were proposed, projects would be located and designed to avoid identified historic or cultural resources, and any potential impacts and mitigation would be coordinated with the appropriate local, state, and tribal officials.

10.3.8 Plans and Policies

Numerous federal, state, and local regulations, laws, plans, policies, and programs may affect stormwater, water quality, and habitat in unincorporated Pierce County. Under SEPA, the review of a nonproject proposal should include a consideration of existing regulations, plans, and policies. This section evaluates the various laws and policies that are related to stormwater planning in the Nisqually River Basin planning area. This evaluation represents the requirements applicable to stormwater planning, and is not intended to be an exhaustive list.

The major federal, state, and Pierce County requirements pertinent to the Nisqually River Basin Plan are described in Chapter 2. It should be noted that laws, regulations, and programs are subject to change over time. The evaluations in this section are based on those in effect at the publication of this Basin Plan and SEIS.

The original *1991 Stormwater Drainage and Surface Water Management Plan* (1991 Plan) was prepared in response to the legal and policy requirements existing at that time. Since the EIS for the 1991 Plan was issued, many of the laws and policies have changed. Pierce County has developed the Nisqually River Basin Plan to meet the updated laws and policies for stormwater planning.

NPDES Stormwater Permit

Under the federal "Clean Water Act," municipal stormwater discharges are subject to federal regulations under the *National Pollutant Discharge Elimination System* (NPDES) permit program. An NPDES Municipal Stormwater General Permit is required for larger municipalities with separate storm sewer systems that discharge to surface waters. In response to NPDES requirements, Pierce County adopted its Stormwater Management Program (SWMP) in 1998. Ecology reissued the NPDES permit in January 2007. The current NPDES Permit and the County's SWMP are described in Chapter 2.

The Nisqually River Basin Plan includes multiple projects and programmatic measures that would be consistent with the current requirements of the NPDES stormwater permit and Pierce County SWMP. The Basin Plan recommends solutions to both site-specific and basin-wide stormwater problems. In comparison, the "No Action" Alternative would not propose multiple projects and programs to address stormwater and water quality issues in the Nisqually Basin.

Under the Basin Plan, Pierce County would adopt the updated stormwater management standards in the *2005 Stormwater Management Manual for Western Washington*. Adoption of either Ecology's manual or an equivalent manual is required for all municipalities covered under the current (January 2007) NPDES Municipal Stormwater Permit.

One programmatic measure would increase the inspection of public and private stormwater facilities to ensure compliance with current stormwater regulations, including NPDES requirements. Another program would develop a maintenance manual containing BMPs for Pierce County's stormwater management facilities. The BMP Manual would be designed to achieve compliance with the Pierce County's NPDES permit.

Section 303(d) List and Total Maximum Daily Loads

Section 303(d) of the "Clean Water Act" (CWA) requires Ecology to prepare a list of water bodies that are not meeting, or will not meet, water quality standards.

If a water body is not in compliance with standards for a particular pollutant and implementation of technology-based approaches are insufficient, the CWA requires that a *Total Maximum Daily Load* (TMDL) of the pollutant be calculated. The TMDL is the maximum amount of the pollutant that can be discharged to the water body without violating the water quality standard for the pollutant. TMDLs are implemented through NPDES permits and "Best Management Practices". Section 303(d) requirements and TMDLs are described in Chapter 2.

Under Section 303(d), Ecology has listed the Mashel River, Nisqually River (lower reaches), Ohop Creek, Red Salmon Creek, Clear Lake, Harts Lake, and Ohop Lake (see Table 4-20). Ecology recently established TMDLs for fecal coliform bacteria in Ohop Creek, Lynch Creek (a tributary to Ohop Creek), and Red Salmon Creek.

The Nisqually River Basin Plan includes programmatic measures to implement a TMDL program in the Nisqually Basin. One program would develop a TMDL for fecal coliform bacteria. Another program would monitor surface water quality in key streams and lakes in the Nisqually Basin, including water bodies with pending TMDLs or TMDL implementation plans.

Overall, the projects and programs in the Basin Plan would improve discharges into water bodies with established or pending TMDLs, which would cumulatively improve water quality. In the long term, the number of impaired (303d listed) water bodies would be reduced in the County. In comparison, the "No Action" Alternative would result in few, if any, projects and programs that would address water quality problems.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) makes available affordable flood insurance to communities that adopt approved floodplain management regulations that meet or exceed Federal Emergency Management Agency (FEMA) standards.

The FEMA process includes a Community Rating System (CRS) that offers reduced insurance rates in areas where flood protection measures are implemented. Under the CRS program, Pierce County was the first county in the nation to earn a "Class 5" rating, and currently holds a "Class 3" rating. The NFIP and CRS program are described in Chapter 2.

The Nisqually River Basin Plan includes projects and programs that would reduce flood hazards in the Nisqually Basin. Projects to replace culverts would reduce localized flooding of roadways and adjacent properties. Recommended studies would improve emergency response and support development of measures to reduce specific flooding problems in the areas of McKenna and Wilcox Flats along the Nisqually mainstem. The proposed acquisition and restoration projects would preserve and enhance riparian areas and floodplains that provide natural storage of floodwaters.

The projects and programs under the Basin Plan would reduce overall flood hazards, which would possibly improve the County's CRS rating and make the area eligible for reduced flood insurance. To help meet the prerequisites for a better rating, the Basin Plan has been developed to be consistent with the CRS process to obtain a better rating.

In comparison, the "No Action" Alternative would result in few, if any, projects and programs that would address flooding problems. The "No Action" Alternative would not likely improve the County's CRS rating.

Regional Watershed Planning

Several regional planning processes are related to basin planning in Pierce County. These various plans include the *Puget Sound Water Quality Management Plan*, *2003 Nisqually Watershed Management Plan*, and *1987 Nisqually River Management Plan* (see Chapter 2). Pierce County generally has considered these plans and supporting information when developing the proposed Basin Plan.

The *Puget Sound Water Quality Management Plan*, developed in 1991 and amended in 2000, requires all cities and counties in the Puget Sound basin to adopt stormSurface Water Management that include minimum requirements for new development and redevelopment. These minimum requirements are listed in Ecology's *2005 Stormwater Management Manual for Western Washington*. The proposed Basin Plan would adopt the updated stormwater management standards in the *2005 Stormwater Management Manual for Western*

Washington, and therefore would be consistent with the *Puget Sound Water Quality Management Plan*.

The 1998 "Watershed Management Act" provides the framework for locally-based watershed planning. Under the Act, the Nisqually River Watershed has been designated as *Watershed Resource Inventory Area* (WRIA) 11. The *2003 Nisqually Watershed Management Plan* has a broad focus for entire Nisqually Watershed within Pierce, Thurston, and Lewis Counties. The *2003 Nisqually Watershed Management Plan* collected a great deal of hydrologic, land use, water quality, and habitat information that facilitated preparation of this Basin Plan. The recommendations contained in the *2003 Nisqually Watershed Management Plan* also have been considered during development of the Nisqually River Basin Plan.

In Substitute House Bill (SHB) 323, the Legislature directed Ecology in 1985 to create a comprehensive management plan for the Nisqually River. A Task Force created the *1987 Nisqually River Management Plan* (*1987 NRMP*), which now is coordinated by the Nisqually River Council. The *1987 NRMP* recommends policies and guidelines but does not identify specific projects or methods for their implementation. Because Pierce County has adopted or endorsed the *1987 NRMP* for those policies that affect County planning, the *1987 NRMP* must be considered during the Pierce County basin planning process. The projects and programs within the proposed Basin Plan are consistent with the policies in the *1987 NRMP*. One proposed measure in the Basin Plan is to provide funding for staff support at the Nisqually River Council.

Endangered Species Act

The federal *Endangered Species Act* (ESA) directs the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) Fisheries to promulgate a list of endangered and threatened species and to designate critical habitat for these species. The ESA also regulates the "take" of a listed species, which can include any act that kills, "harms," or injures a species and may include habitat modification. Federally-related projects that would likely affect an ESA-listed species, such as County actions requiring a federal permit or receiving federal funding, may require consultation with USFWS or NOAA Fisheries. The ESA process is described in Chapter 2.

In addition to the federal ESA listings, several Washington state agencies maintain lists of rare or endangered plants and animal species and habitat. The Washington Department of Fish and Wildlife (WDFW) publishes a *Priority Habitats and Species* (PHS) list and a *Species of Concern* (SOC) list. The PHS List is a catalog of habitats and species considered to be priorities for conservation and management. The SOC List includes all state-listed endangered, threatened, sensitive, and candidate species, as well as federally ESA-listed fish stocks. The Washington Department of Natural Resources (DNR) also lists rare plants and endangered ecosystems under the *Natural Heritage Program*. These state listings are used by local and state agencies for processing "Forest Practice Applications and Hydraulic Project Approvals," reviewing proposals under SEPA, protecting critical areas under the GMA, and other conservation planning.

Pierce County has several federal ESA-listed species that have the potential to affect surface water management. The Nisqually Basin supports populations of Chinook salmon and steelhead, and has the potential to support populations of bull trout. For these listed fish species, the ESA requires NOAA Fisheries to develop and implement recovery plans for their conservation and survival. Federal recovery plans in draft or final versions are available for the Puget Sound ESU Chinook salmon and Coastal-Puget Sound DPS bull trout. Chapter 4 describes the fish populations in the Nisqually Basin planning area.

The proposed Basin Plan includes a number of projects and programmatic measures that are designed to protect or restore habitat and improve water quality for federal and state listed species. Implementing the Basin Plan in combination with other habitat improvement efforts would likely have positive, cumulative impacts on the aquatic communities and improve habitat for federal and state listed species and for other native species in the Nisqually Basin.

In comparison, the "No Action" Alternative is based on continuing implementation of the 1991 Plan and other County programs, which would result in limited, if any, habitat restoration and protection for the Nisqually Bain. The 1991 Plan was adopted before the ESA listing of Chinook salmon, bull trout, and steelhead trout in the Puget Sound area.

The "No Action" Alternative would not address most of the identified water quality and habitat problems in the Nisqually Basin, and would not result in basin-specific habitat restoration projects and programs. Taking "No Action" to protect or improve water quality may result in degradation to fish and wildlife habitat through continued pollution of the water, and may, ultimately, exacerbate conditions for those aquatic species listed under endangered species legislation (Ecology, 2003).

Although the proposed Basin Plan would likely result in overall long-term benefits, individual projects could adversely affect federal and state listed species. Species could be affected in the short term by construction activities that could result in erosion or removal of vegetation. Pierce County would determine if listed species and habitats of concern are present during future environmental review and permitting of individual projects.

Proposed projects would be located and designed to avoid impacts on listed species and habitats, where possible, and would include BMPs to reduce construction impacts. Pierce County would coordinate individual projects under the Basin Plan with appropriate agencies and tribes that regulate endangered species, to identify site-specific mitigation measures and obtain required permits and approvals.

Under the "No Action" Alternative, future projects, if any, similarly would be located and designed to avoid impacts on ESA-listed species, would include required site-specific mitigation measures, and would be coordinated with resource agencies and tribes.

Pierce County Comprehensive Plan and Zoning

The *Pierce County Comprehensive Plan* is codified as Title 19A of the Pierce County Code. The Plan guides development and accommodates population growth for the next 20 years. It integrates citizen's ideas, concerns, and preferences into statements of how the County should

be developed, what development regulations should accomplish, what facilities and services levels are needed, and how publicly funded improvements should support these objectives.

Under the land use in the Plan, and Pierce County zoning codes, the eastern portion of the Nisqually Basin planning area is zoned mostly for forest land and the western portion for rural residential development (see Figures 4-1 and 4-2). The majority of the Nisqually Basin planning area is located outside the Pierce County Urban Growth Areas (UGAs).

Under the Basin Plan, future capital projects would be located and designed to comply with site-specific land use and zoning policies, designations, and regulations. Individual projects would obtain applicable zoning permits and approvals at the time they are proposed. Similarly under the "No Action" Alternative, potential projects, if any, would be consistent with the County land use and zoning regulations and would obtain applicable permits.

The *Pierce County Comprehensive Plan* addresses stormwater, water quality, and habitat primarily in the Land Use Element (Chapter 19A.30), Environment and Critical Areas Element (Chapter 19A.60), and Utilities Element (Chapter 19A.90). The projects and programs in the proposed Basin Plan would be consistent with the policies and objectives in the Plan. In comparison, the few projects and programs under "No Action"," if any, would not help the County meet the goals and objectives concerning stormwater in the Plan. The key policies in the comprehensive plan are identified in Chapter 2.

Pierce County Critical Areas Ordinance

The *Growth Management Act* (GMA) requires Pierce County to designate critical areas and to adopt regulations to protect these areas. Pierce County's Critical Areas Ordinance (Pierce County Code Title 18E) establishes development standards for sites that contain or are adjacent to identified critical areas. The Pierce County critical areas (or hazards) are wetland, landslide, erosion, seismic, volcanic, mine, aquifer recharge, fish and wildlife habitat, flood, marine shoreline critical salmon habitat, and oak and prairie areas (PCC section 18E.10.050). The proposed Basin Plan would not include any changes to the Pierce County Critical Areas Ordinance itself.

The proposed Basin Plan includes site-specific projects and basin-wide programs that would protect and enhance critical areas in the Nisqually Basin. Several projects would restore riparian areas, wetlands, and fish and wildlife habitat. Other acquisition and restoration projects would preserve and enhance the original floodplain that provides natural storage of floodwaters. Programmatic measures would enhance riparian habitat and provide improvements to water quality, which would benefit critical areas. Other programs would control invasive species and restore native vegetation. The "No Action" Alternative, in comparison, would include few projects and programs, if any, which would benefit critical areas.

The proposed projects in the Basin Plan would be located and designed to avoid critical areas, where possible. If a stormwater project were located within or adjacent to a designated critical area or its buffer, then the future project would comply with the Critical Areas Ordinance and obtain applicable critical areas approvals. The presence of a critical area(s) and any site-specific mitigation for individual projects under the Basin Plan would be determined during future

review under the Critical Areas Ordinance. Under the "No Action" Alternative, future projects, if any, similarly would avoid critical areas where possible and would comply with the Critical Areas Ordinance.

Project-Specific Permits and Approvals

Individual projects under the Basin Plan may require project-level federal, state, and local government approvals and permits. Proposed projects would complete environmental review under SEPA and obtain required permits and approvals when individual projects are proposed and prior to construction. The location, design, construction, and operation of individual projects under the Basin Plan would comply with all applicable federal, state, and Pierce County regulations and policies. Any future projects under the "No Action" Alternative, if any, similarly would comply with applicable regulations and would obtain required permits and approvals.

A number of environmental and permitting programs could apply, depending on a projects location and characteristics. The major permits and approvals are described in Chapter 2, and are listed below:

- Section 401 Water Quality Certification
- Corps Section 404 Wetland Permit
- Endangered Species Act Consultation
- Hydraulic Project Approval (HPA)
- Archaeological and Cultural Coordination
- Shoreline Management Act and Shoreline Master Program
- Pierce County Critical Areas Ordinance
- Pierce County Zoning and Development Regulations
- SEPA Environmental Review
- NEPA Environmental Review (if federal funding or permit)

SEIS References

Federal Register, Volume 70, Number 170. Friday, September 2, 2005. *Endangered and Threatened Species; Designation of Critical Habitat for 12 Evolutionarily Significant Units of west Coast salmon and Steelhead in Washington, Oregon, and Idaho: Final Rule*.

Federal Register, Volume 70, Number 185. Monday, September 26, 2005. *Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Bull Trout; Final Rule.*

United States Fish and Wildlife Service (USFWS), 2004. *Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (Salvelinus confluentus), Volume I (of II) Puget Sound Management Unit.* Region 1. U.S. Fish and Wildlife Service. Portland, Oregon.

Glass, D., and E. Salminen, 2002. Nisqually River Level 1 Watershed Assessment (WRIA 11). Watershed Professionals Network, Envirovision, Geoengineers.

Washington State Department of Ecology (Ecology), 2003. Final Environmental Impact Statement for Watershed Planning Under Chapter 90.82 RCW. Ecology Publication #03-06-013. July 18, 2003.

Pierce County Planning and Land Services (PALS), 1999. Upper Nisqually Community Plan. Adopted September 28, 1999.

RESPONSE TO COMMENTS

This section provides comments and responses to comments received on the proposed Nisqually River Basin Plan and DSEIS. The proposed Nisqually River Basin Plan (Basin Plan) and DSEIS were issued on June 9, 2008 for public review. Comments on the DSEIS were due to Pierce County Planning and Land Services Department (PALS) by 4:30 p.m. on July 11, 2008. Two public meetings were held during this comment period:

1. June 18th, 2008, at the Weyerhaeuser Elementary School, 6105 365th Street East, Eatonville, Washington. Held from 6:30 to 8:30 p.m.
2. June 19th, 2008 at the Eatonville Community Center, 305 Center Street West, Eatonville, Washington. Held from 6:30 to 8:30 p.m.

Comments received during the 30-day comment period and at the two public meetings were compiled and are presented in this section. The individual comments within each letter have been numbered in the right margin, and responses are provided after each letter. These letters are organized alphabetically. Questions that were received during the public meetings have also been included as comments, and are addressed in the pages following the written comments.

Several of the comments address the same issue or a similar issue. To address these broader issues, one detailed response is provided up front in a section called "Common Responses." This section precedes the written letters, so that subsequent responses can be referred back to the initial common response.

COMMON RESPONSES

1. **Common Comment**: The Basin Plan does not adequately address the risks posed by flooding and channel migration along the upper Nisqually River.

Response: The Basin Plan includes numerous specific capital projects, additional studies, and public awareness recommendations to address flood risks within the basin. The instability of the Nisqually River channels creates uncertainty with respect to what areas are at-risk to flooding and/or bank erosion. The risks to public safety and property have been substantiated by recent flooding events, particularly the event that occurred in November 2006.

The headwaters of the Nisqually River are located in Mount Rainier National Park (MRNP) where the river and tributary streams originate from the glaciers on the south slope of Mount Rainier. These high gradient streams in the upper portions of the basin are capable of transporting large amounts of sediment and debris during high flow events. As the river flows away from the mountain, the gradient decreases and mobilized sediments are deposited. This process can cause the river bed to rise (i.e., aggradation), and result in a braided river system with multiple flow channels that are subject to unpredictable changes. The dynamic nature of this system is exacerbated by retreating glaciers as more loose sediments are exposed to erosion by surface water runoff.

Each the following sections address a specific aspect of those comments. In general, the following sections describe how Pierce County Surface Water Management Division (SWM) plans to address flooding and channel migration hazards on the upper Nisqually River, and how these plans are integrated into the basin plan in the form of information and recommendations.

1-A. Channel Migration Zone (CMZ)

Common Comment: The Basin Plan does not adequately address the channel migration zone (CMZ) in the upper Nisqually River.

Response: The Basin Plan proposes a channel migration zone study to provide the basis for regulating development under Pierce County's Critical Areas Ordinance (see Pierce County Code 18E.70). The CMZ is the area where the main part of a river changes location in the valley floor, either by an abrupt change or more gradually by erosion or destabilization of the channel banks. CMZ studies can show areas of severe, moderate and low migration risk. Pierce County regulates severe CMZ areas, which have the highest risk of being occupied by a river. These areas are deemed high hazard and high-risk for life, safety and damage to buildings and other property improvements.

A CMZ study was completed for a portion of the upper Nisqually River in 2007. The study is currently being reviewed for adoption by Pierce County. Significant concerns raised by citizens and the Pierce County Planning Commission in January 2008 extended the review time to allow for broader county-wide review. In April 2008, the Pierce County Council adopted a resolution (No. R2008-55) that initiated the formation of an ad hoc Citizens' Advisory Committee (CAC) to evaluate and provide recommendations to the Pierce County Council regarding CMZ issues. SWM is currently assisting with the formation of the CAC. The CAC will consist of twelve

representatives from a variety of stakeholder groups, such as property owners, watershed councils, land use advisory committees, and floodplain management professionals.

The CAC will provide opportunities for public and stakeholder involvement through a series of meetings and discussions. Citizens of the Upper Nisqually Valley are encouraged to participate in these activities. Ultimately, the CAC will make recommendations to the Pierce County Planning Commission and the Pierce County Council on studies, policies, and regulations pertaining to CMZs. For more information, including the results of the Upper Nisqually River CMZ Study, go to the URL: http://www.piercecountywa.org/pc/services/home/environ/water/cip/cmz.htm.

To address comments related to CMZ regulations in the Upper Nisqually Valley, section 6.3.2 (Mainstem Flooding Analysis Results) of the Basin Plan has been modified to provide additional information as discussed above.

1-B. Nisqually Park Levee

Common Comment: The Basin Plan does not adequately address the Nisqually Park levee repairs, the risks associated with extreme events, or channel migration.

Response: Pierce County maintains approximately 4000 feet of levee along the north bank of the Nisqually River near the Nisqually Entrance of Mount Rainier National Park (MRNP). This levee system provides some flood protection to the Nisqually Park Subdivision (less than a 100-yr level of protection); however it is not considered adequate to provide protection from river migration. In fact, most levees do not provide adequate protection against channel migration, especially in high gradient and high velocity river reaches. Several comments expressed concern with regard to the condition of the levee, coordination with MRNP, and the vulnerability of the levee to channel migration.

SWM intends to continue maintenance along the entire length of the existing levee, including portions inside the MRNP boundary. When the levee is damaged, repairs will be made as long as the river still occupies the same channel. All repairs to the levee are coordinated with MRNP to ensure consistent structural integrity along the length of the levee.

An example of this occurred after the November 2006 flooding event, when the Nisqually Park levee sustained substantial damage. SWM repaired the levee along the frontage of Nisqually Park including upstream areas inside the MRNP boundary (up to the Sunshine Point campground). SWM's levee repairs were tied into levee repairs completed by MRNP along the immediate frontage of Sunshine Point campground. The tie-in point was fortified with additional rock that included facing and toe structure. The repair project was completed in winter of 2007. Repair of the 2006 levee damage cost approximately $900,000.

Aside from ongoing maintenance and repairs, the Basin Plan makes no recommendations for structural measures to modify the Nisqually Park levee (e.g., raise the height, increase the length) to provide a higher level of protection than what is currently provided. Alternatively, SWM proposes to address flooding and channel migration zone hazards in the Nisqually Park area through a combination of non-structural measures such as property acquisition, floodplain management, CMZ regulations/mapping, and public education.

To address the comments concerning the Nisqually Park levee, a new study recommendation has been added to the Basin Plan (see Chapter 9). ST19-NIS-ST02 is a recommendation for an analysis of the changes to the river's floodplain and floodway in the vicinity of Nisqually Park. The study will include an alternatives analysis that will examine a wide range of measures for mitigating flood and channel migration zone hazards in the Upper Nisqually Valley.

1-C. Common Comment: Excessive large woody debris is causing or exacerbating flooding along the upper Nisqually River.

Response: Recruitment of large woody debris (LWD) is a natural function of the river; additionally, LWD is an important element of aquatic habitat in the upper Nisqually River. The steep-gradient and high flow velocities of the upper Nisqually River and tributaries streams not only transports large amounts of sediment during high flows, but also carries debris from the eroded areas, such as LWD from uprooted trees. Recent flood events have transported considerable amounts of LWD along the upper reaches of the Nisqually River. Several comments expressed concern as to whether the amount of LWD was adversely affecting the conveyance of the river and exacerbating bank erosion and channel migration. To address these comments and others, a new study recommendation has been added to the final version of the Basin Plan (see Chapter 9). ST19-NIS-ST02 is a recommendation for an analysis of the changes to the river in the vicinity of Nisqually Park such as channel aggradation and the accumulation of debris. The study will include an alternatives analysis that will examine a wide range of measures for mitigating flood and channel migration zone hazards in the Upper Nisqually Valley.

1-D. Common Comment: The Basin Plan is not consistent with the Upper Nisqually Valley Community Plan or the Mount Rainier National Park General Management Plan.

Response: The Nisqually River Basin Plan is not a land use plan; rather, it is intended to serve as the work plan for Pierce County SWM. The Basin Plan used zoning and land use data compiled by Pierce County Planning and Land Services (PALS) to estimate potential future development that could affect drainage, water quality, or habitat conditions in the planning area. The Basin Plan also considered the Upper Nisqually Valley Community Plan (1999) and the Mount Rainier National Park General Management Plan (2002), which had been completed prior to the beginning of the Nisqually River basin planning process.

Upper Nisqually Valley Community Plan – Pierce County adopted the Upper Nisqually Valley Community Plan as a supplement to the County's Comprehensive Land Use Plan. Under the plan, the communities of Ashford and Elbe are largely zoned Village Center, which allows for a mix of commercial, residential, and civic uses. The area adjacent to Mount Rainier National Park also was rezoned to Tourist Commercial. This zone is restricted to four uses: lodging, restaurants, and sales of general merchandise and rental of recreational equipment. Flood and debris flow hazards are discussed in the Natural Environment section of the plan. These sections recognize the flooding and channel migration hazards in the Nisqually Park area, as well as the debris flow hazards along the valley floor. The plan specifies that development is to occur outside of floodplains wherever possible, and also emphasizes the importance of Critical Areas as they pertain to Pierce County Code Title 18E.

Mount Rainier National Park General Management Plan – The National Park Service developed this plan to guide management of MRNP over the next 20 years. The MRNP Plan focuses on activities and facilities within the park boundaries. However, it does describe the communities within the Upper Nisqually Valley as gateway communities and recognizes the benefit of tourist facilities within these gateway communities. The plans preferred alternative calls for a welcome center along State Route 706 near a community such as Ashford or Elbe. The plan also recognizes flood hazards and recommends avoiding development in floodplains wherever possible. The plan also addresses debris flow hazards and the unstable conditions on the Nisqually River where sediment deposition threatens facilities such as Sunshine Point campground.

Pierce County SWM staff discussed the Nisqually Basin and MRNP plans with the MRNP staff at a number of Nisqually River Council (NRC) meetings. These interactions helped assure coordination of the Nisqually Basin and MRNP planning efforts.

The Upper Nisqually Community Plan and MRNP plans are based on the same land use assumptions as the Nisqually Basin Plan, as laid out in the Upper Nisqually Valley Community Plan. All three plans also recognize flooding, debris flow, and channel migration hazards, and emphasize the need to avoid development in these critical areas.

1-E. Common Comment: The basin planning process did not include sufficient public outreach in the upper basin area.

Response: Stakeholder involvement is an important component of the Pierce County's basin planning process and has been integral to the development of the Nisqually River Basin Plan. Chapter 3 describes the stakeholder involvement strategy. A major element of the stakeholder involvement strategy is public involvement and frequent interaction with citizens of the basin. Throughout the course of the development of the plan, four public meetings were held, two resident surveys were conducted, and SWM staff continually attended Nisqually River Council meetings to provide presentations and give updates on the plan. Specific events, dates and locations of public involvement activities are provided in Appendix B and again in Table B-1 (below).

TABLE 10-4

Public Involvement Activities held during the Nisqually River Basin Planning Process

Event	Date	Location	Description of Activity
Resident Survey	March 2005	(Mailing)	Mailed a questionnaire and letter to 1705 basin residents to solicit input regarding problems.
Public Meeting for the Nisqually River Basin Plan	June 1st, 2005	Weyerhaeuser Elementary School	Informed residents of the planning process and solicited information regarding drainage/flooding, water quality, and/or fish habitat problems in the basin.
Nisqually River Council Meeting	July 21st, 2006	Ohop Grange	Presented an overview of the Nisqually River Basin Characterization
Public Meeting for the	September	Weyerhaeuser	Presented an overview of the Nisqually

TABLE 10-4
Public Involvement Activities held during the Nisqually River Basin Planning Process

Event	Date	Location	Description of Activity
Nisqually River Basin Plan	6th, 2006	Elementary School	River Basin Characterization and solicited input of identified problems.
Resident Survey	July 2007	(Mailing)	Mailed a questionnaire and letter to 782 lakeshore property owners to obtain information about lake conditions.
Storm Drainage and Surface Water Management Advisory Board Meeting	September 20th, 2007	Pierce County Environmental Services Building	Presented an update of the Nisqually River Basin Plan, and on overview of the Basin Characterization
Citizens Advisory Committee of the Nisqually River Council	October 4th, 2007	Yelm Prairie Hotel	Presented an update of the Nisqually River Basin Plan
Nisqually River Council Meeting	October 19th, 2007	Center for Sustainable Forestry at Pack Forest	Presented an update of the Nisqually River Basin Plan
Storm Drainage and Surface Water Management Advisory Board Meeting	March 20th, 2008	Pierce County Environmental Services Building	Presented an overview of the results of the Nisqually River Basin Plan.
Public Meeting for the Nisqually River Basin Plan	June 18th, 2008	Weyerhaeuser Elementary School	Presented the results of the Nisqually River Basin Plan, and provided an opportunity to answer questions during the 30-day review period for the Draft Supplemental Environmental Impact Statement (DSEIS).
Public Meeting for the Nisqually River Basin Plan	June 19th, 2008	Eatonville Community Center	Presented the results of the Nisqually River Basin Plan, and provided an opportunity to answer questions during the 30-day review period for the Draft Supplemental Environmental Impact Statement (DSEIS).
Pierce County Planning Commission Meeting	June 24th, 2008	Pierce County Courthouse Annex	Presented the results of the Nisqually River Basin Plan, and provided an opportunity for the public to testify and comment on the proposed draft plan. It was also an opportunity for Pierce County staff to answer questions raised by the PC members

Several comments expressed concern that none of the public meetings were held in a location in the Upper Nisqually Valley. To address this concern, SWM plans to hold an additional public meeting on August 19, 2008 to discuss the basin plan.

Also, please note that Pierce County is currently working on forming the CAC for CMZ issues, which will provide a public forum for ongoing issues related to channel migration hazards on the upper Nisqually River and other rivers in Pierce County as well as CMZ regulations.

2. **Common Comment**: The basin plan does not address flooding of buildings along SR 7 in Elbe.

Response: Several comments referred to flooding problems in Elbe, where stormwater drainage is not adequate to convey water across State Route 7. The highway floods, as well as local buildings such as the Post Office. The Basin Plan had identified a flooding problem in the vicinity of Elbe (see ALD-03 in Table 5-1) based on discussions with the staff at Pierce County Transportation Services Division. Additional field investigations by SWM staff concluded that the drainage problem on adjacent property is due to inadequate capacity of the state right-of-way drainage system for State Route 706.

In response to the comment, SWM initiated follow-up field investigations, which found that the drainage problems will likely require modifications to both State and County drainage facilities. To address these concerns, a new recommendation has been added to the final version of the Basin Plan (see Chapter 9). ST19-NIS-ST03 is a recommendation calling for SWM to work with the Washington State Department of Transportation (WSDOT) to investigate the cause of the problem and identify feasible project alternatives that will mitigate the problem. A project to mitigate the problem will likely fall within WSDOT's jurisdiction in which Pierce County can help facilitate and work with WSDOT to solve.

3. **Common Comment:** The Basin Plan does not address bank erosion at the upstream end of Alder Lake.

Response: Several comments expressed a concern for bank erosion at the upstream end of Alder Lake, particularly in areas where such erosion threatens structures and property. Investigations conducted during the basin planning effort found that a dike/ bank revetments have been constructed in the vicinity of Elbe, and that these revetments are maintained by Tacoma Public Utilities in association with Alder Lake and the operation of the Nisqually Hydroelectric Project. Reservoir operations, water surface levels, and siltation associated with Alder Lake are managed by Tacoma Public Utilities as part of the Nisqually Hydroelectric Project. Pierce County SWM staff discussed reservoir issues with Tacoma Public Utilities staff during development of the Basin Plan. The Basin Plan does not address these issues because the lake operations and revetments are outside of the County's jurisdiction.

COMMENT LETTER 1

Rick Adams

P.O. Box 3

Elbe, WA 98330

(360) 569 2601

rbadams@mashell.com

Roy Huberd,

Pierce County Surface Water Management

2702 42nd St Suite 201

Tacoma, WA 98409-7322

RE Draft Supplemental Environmental Impact Statement for the Proposed Nisqually River Basin Plan

Roy,

Thanks for the opportunity to comment on the DEIS for the Nisqually River basin.

Per our discussion on the 18th of June at Weyerhaeuser Middle School, I would like to recommend that the flooding that occurs in Elbe between 541 and 542nd street be included in this document. 1-1

This has been a serious problem for years, and is well documented. The US Post office is annually inundated resulting in closure, as is the Elbe Water and Sewer Districts manhole covers that flow to the treatment plant placing their plant in risk of overflow.

The ditching that was done to direct the water from the DNR hills to the north and west during the CCC era of the 1930's is in need of cleaning, the culverts that cross the highway need to be enlarged and what water that does reach the west side of SR706 is blocked by the "Mt Rainier Scenic Railroad Dining Co. and Hobo Inn" and Tacoma Rail main line tracks. Where there were once outlet ditches, to send the water to the low area to the east, the Nisqually River, now Alder Reservoir, today exist impoundments to outflow that cause water to cover SR-7 and the intersection of SR-7 and 541st Street East, creating unsafe driving conditions, (*when Interstate 5 floods in the Chehalis area, **SR-7 Is the alternate route** for the traffic and commerce moving between Los Angeles and Vancouver B.C*) and water to pour into the manholes of the

community's sewer collection system, threatening safe and effective sewer treatment operations, water quality and their operating license.

The entire Elbe area, from the intersection of SR-7 and SR-706 to the northern railroad crossing on SR-7, to the Alder Reservoir to the west and the DNR forests to the East necessitates a comprehensive and collaborative approach to resolve this increasingly costly problem before Elbe's sewer treatment plant is damaged by uncontrolled infiltration or someone is hurt or killed by water covering SR-7. The unresolved flooding of Elbe threatens traffic safety, water quality and has cost the Post Office their electronic equipment and customers timely and important mail services.

Please include the Elbe flooding in the EIS.

This document references a NPDES Permit Pierce County is required to retain. My communications with the EPA and DOE inform me that the Nisqually basin is not included in the areas identified by either agency, the census tracts served by the collection and treatment system in the county's urban/suburban area identifies the Counties license required service area. (See attached map from DOE) 1-2

I read the permits intent as

July 5, 1995
FINAL
FACT SHEET
STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
FACT SHEET FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) AND STATE WASTE DISCHARGE GENERAL PERMITS FOR STORMWATER DISCHARGES FROM THE MUNICIPAL SEPARATE STORM SEWERS LOCATED IN:

2. THE SOUTH PUGET SOUND WATER QUALITY MANAGEMENT AREA AND THE PORTION OF THE KITSAP WATER QUALITY MANAGEMENT AREA LOCATED IN PIERCE COUNTY

II. PURPOSE OF THE PERMIT
These permits authorize the discharge of stormwater from municipal separate storm sewers owned or operated by the permittees, to surface and ground waters of the State of Washington. As required by §402(p)(3) of the Clean Water Act, discharges covered under these permits must effectively prohibit non-stormwater discharges into storm sewers, and must apply controls to reduce the discharge of pollutants to Waters of the U.S. to the maximum extent practicable. As authorized by RCW 90.48.030 and .162, Ecology is also taking action through issuance of these permits to control impacts of stormwater discharges to waters of the state, which include ground waters.
Discharges from agricultural runoff, irrigation return flows, process and non-process wastewaters from industrial activities, and stormwater runoff from areas served by combined sewer systems are not regulated directly by these permits. These types of discharges may be

regulated by local or other state requirements if they discharge to municipal separate storm sewers. These municipal stormwater permits authorize the municipal separate storm sewer to discharge stormwater which comes from industrial facilities. However, many industrial activities need an industrial stormwater NPDES permit issued by Ecology to discharge stormwater into municipal storm sewers.

The rural areas of the Pierce in the Nisqually basin are not included in this license as Pierce County Utilities is not collecting and releasing treated water from areas of low density in the rural areas of Pierce County.

If the Final EIS is to include reference to the NPDES permit, please include in the final EIS, the document (s) issued by the EPA and DOE that requires the Nisqually basin be included for Pierce County to be in compliance with the referenced state and federal license mandate. If it is not, please include Pierce County's justification for the reference in this document.

Much of the upper basin is zoned in 10 acre or as much as 40 acre lots and the rest is in forestry. For example the two communities of Ashford and Elbe lie within a 27,000-acre planning area. If fully developed (20 years) to the capacity envisioned by the Upper Nisqually Community plan, they will constitute 233 acres. (Elbe- 47 acres Ashford –186, with much of Ashford severely restricted by wetlands). These 233 acres represent .00862 % of the entire planning area. The balance now consists of rural 10 and 40 and designated forestlands. There are no threatened or endangered species in the basin above the La Grande dam, the upper reaches of the Nisqually River or its tributaries.

Please illustrate how the NPDES permit applies to the Upper Nisqually above the dams. 1-3

The Nisqually River council is an important participant in our community, but is not accountable to our elected officials for the effectiveness of their use of public funds. Before these dollars are awarded, the EIS needs a thorough and complete description of how the $385,000 that is set-aside for the Nisqually River Council will be utilized to address storm water issues in the basin. 1-4

Much work can be done on the ground to resolve existing problems that will be or are presently identified in this document with the dollars requested by the Nisqually River Council.

This document makes no mention of the dramatic and ongoing erosion of the shoreline property along the east end of Alder Reservoir. As we spoke during the open house, regarding Tacoma Powers response to Utilities request to address the erosion to the properties in Elbe, you informed me that their response was that their license does not require them to address flooding. 1-5

The erosion occurring to the properties under county jurisdiction are not caused by "flooding", but by the buildup of materials deposited in the delta created by the reservoir as it has been operated for electrical generation. The historic Elbe Lutheran Church, Gayle Adams property,

Elbe Water District Well, and the Elbe Sewer treatment plant are in grave danger of being eroded into the reservoir in the next high water.

Because the deposits that create the reservoir delta are the cause of the erosion, the EIS should include and identify the **cause** of the erosion. Please include in this EIS Tacoma Powers responsibility for creating the deposits.

This EIS must address the responsibility by Pierce County and Tacoma Public Utilities to permanently resolve this "erosion" emergency.

The Elbe community recognizes the loss and damage to its property began in the late 1980's as a result of the accumulation of deposits in the reservoir directing the Nisqually River directly north east. Every fall since, the river has eroded these properties further. This erosion is caused by irresponsibly managed surface water. Tacoma Public Utilities can longer hide behind the "non flood control" clause of their federal permit. Elbe's erosion problems are not related to flooding, but 60 years of electrical generation operations.

There is no excuse for this erosion to continue.

This document addresses the McKenna dike, but makes no mention of the need to improve/redesign the Nisqually Park Dike at the entrance to Mt Rainier National Park and the needs of the property owners impacted by the decisions that Utilities make concerning its future.

Please address in this document, the upper basin Nisqually River issues concerning the dike at Nisqually Park and the need to work with Mt Rainier National park as they work to improve their dike within the park to protect their entrance. The two dikes must not be repaired independently of the other. 1-6

I raised my concern, during the public comment period for the recognition within the DEIS of the need for a discussion or evaluation of the myriad of conflicting regulations Utilities operates under that impact the efficiency and effectiveness of implementing its surface water management responsibilities.

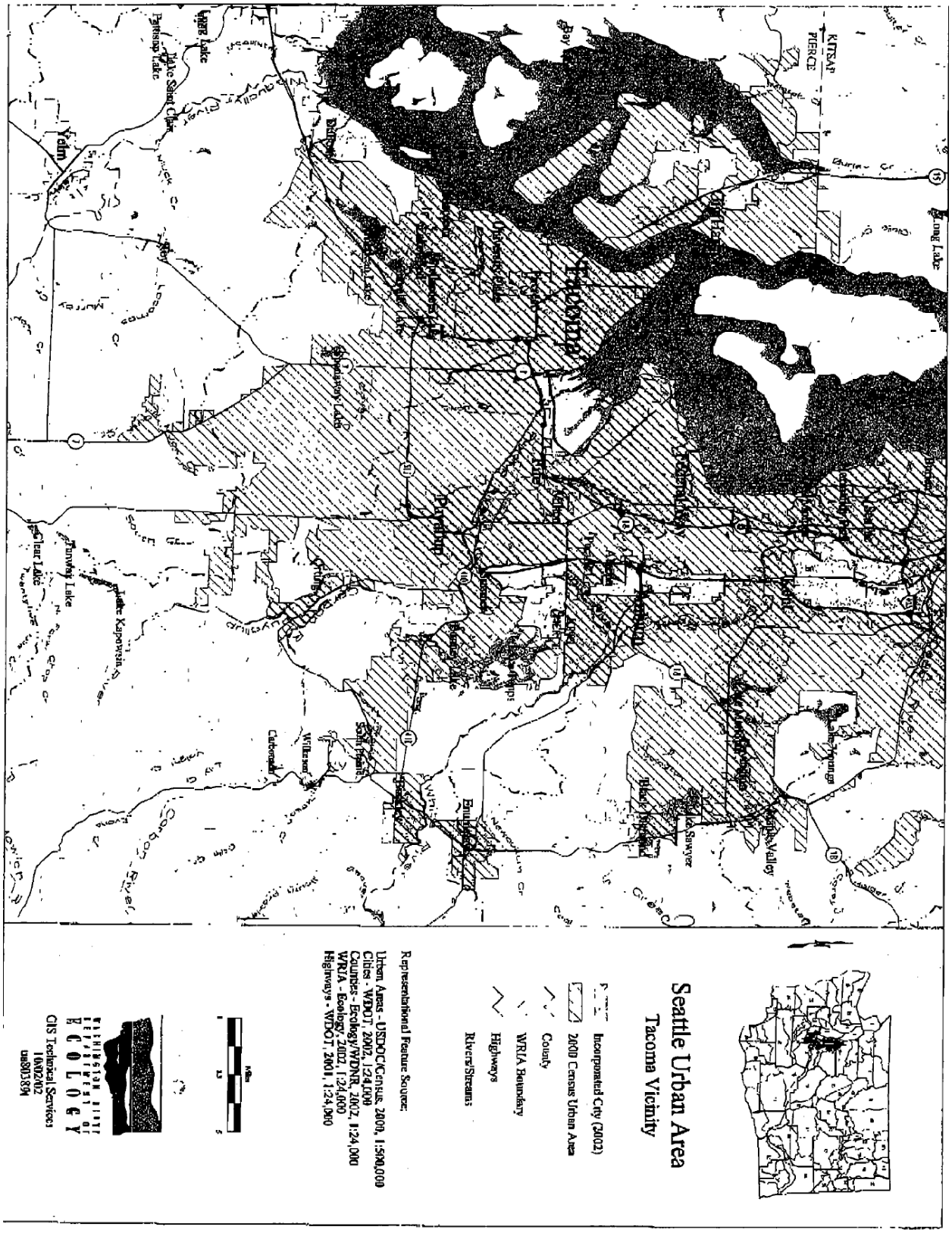
There is no mention of the conflicting regulatory environment that you are required to operate within. Please use this document as an opportunity to identify other agency regulations you are mandated to follow that hinder or prohibit, are inappropriate or unnecessary in subareas or the entire basin, to recommend a package of regulatory reform. By doing so, you may find this EIS a useful tool in assisting Utilities insure the timely and efficient resolution to surface water challenges, and be more effective managers of the public resources and environment. 1-7

There are only so many dollars to go around.

Sincerely,

Rick Adams

Rick Adams


Seattle Urban Area
Tacoma Vicinity
Incorporated City (2002)
2000 Census Urban Area
County
WRIA Boundary
Highways
Rivers/Streams
Representational Feature Source:
Urban Areas - USDOC/Census, 2000, 1:500,000
Cities - WDOT, 2002, 1:24,000
Counties - Ecology/WDNR, 2002, 1:24,000
WRIA - Ecology, 2002, 1:24,000
Highways - WDOT, 2001, 1:24,000
Miles
WASHINGTON STATE DEPARTMENT OF ECOLOGY
GIS Technical Services
10/02/02
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Puyallup
Sumner
Bonney Lake
Yelm
Eatonville
Orting
Buckley
Enumclaw
Carbonado
Wilkeson
Tumwater
Lacey
Olympia
Tenino
Rainier
Yelm Lake
Clear Lake
Tanwax Lake
Lake Kapowsin
Puyallup River
Nisqually River
Carbon River
Mud Mountain Dam
Mount Rainier National Park
Mount Rainier
Eatonville
Ashford
Elbe
Alder Lake
Mayfield Lake
Mossyrock
Mossyrock Dam
Packwood
Packwood Lake
Ohanapecosh Park
Ohanapecosh Lake
Longmire
Paradise
Nisqually Glacier
Cowlitz River
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Yelm Lake
Clear Lake
Tanwax Lake
Lake Kapowsin
Puyallup River
Nisqually River
Carbon River
Mud Mountain Dam
Mount Rainier National Park
Mount Rainier
Eatonville
Ashford
Elbe
Alder Lake
Mayfield Lake
Mossyrock
Mossyrock Dam
Packwood
Packwood Lake
Ohanapecosh Park
Ohanapecosh Lake
Longmire
Paradise
Nisqually Glacier
Cowlitz River

RESPONSE TO COMMENT LETTER 1:

1-1 Thank you for providing detailed information regarding the flooding problem at Elbe. Several comments were received regarding this issue; please refer to Common Response 2 at the beginning of this section.

1-2 Pierce County is covered by the Phase I Municipal Stormwater National Pollutant Discharge Elimination System (NPDES) permit originally issued in 1995 and then revised January 17, 2007. Pierce County applies the requirements of the permit throughout its unincorporated jurisdiction. In 2007, the Washington State Department of Ecology (DOE) issued another "Phase II" NPDES permit to smaller jurisdictions, based on the census track data referred to in the comment. The area specified was already covered by Pierce County's Phase I permit, and that coverage continues. Details on NPDES are provided in Section 2.1.1; subsection National Pollutant Discharge Elimination System of the Basin Plan. Additional details are provided in Section 10.3.8 of the SEIS.

1-3 The Phase I NPDES permit applies throughout unincorporated Pierce County.

1-4 A programmatic recommendation (PRG11-03) in Chapter 9 of the Basin Plan calls for a stewardship coordinator to enhance the Nisqually River Council's capacity to preserve waterfront land, implement non-point source pollution controls, assist with habitat preservation and recovery, and provide opportunities for education and student implemented activities. The stewardship coordinator is a member of the County staff that would work in cooperation with the Nisqually River Council.

1-5 Thank you for providing detailed information regarding the bank erosion problem in the Community of Elbe. Several comments have been received on this issue, so please refer to Common Response 3 at the beginning of this section.

1-6 Thank you for your comment. Several comments were received regarding the Nisqually Park levee and the hazards posed by the upper Nisqually River. Please refer to the common response entitled "Flooding and Channel Migration Hazards on the Upper Nisqually River," specifically, the section addressing the "Nisqually Park Levee."

1-7 Thank you for your comment regarding current regulations affecting the basin. Please note that the basin plan is intended to serve as the work plan for Pierce County SWM, it is not a regulatory document, and cannot address broader regulatory issues. However; the existing policies and regulations that affect stormwater management in unincorporated Pierce County are described in Chamber 2. This chapter includes discussion of pertinent federal, state and county policies and regulations as they pertain to the basin plan. Various plans and policies were discussed in the SEIS.

COMMENT LETTER 2

Roy Huberd - Comments on theDraft Nisqually River Basin Plan

From: "Andrew Carey" <andrewbcarey@gmail.com>
To: <rhuberd@co.pierce.wa.us>
Date: 7/4/2008 12:44 PM
Subject: Comments on theDraft Nisqually River Basin Plan
CC: <rbrake@co.pierce.wa.us>

Dear Roy and Randy:

Please find my comments on the Draft Nisqually River Basin Plan; the comments were a little rushed because I was not aware of the public comment period until recently. I hope you find the comments useful and that you can address them fully.

I would like to request that you extend the comment period and hold public meetings in Ashford for those residents of the Upper Nisqually Valley who are rightfully very concerned about surface water managment, flood plains, channel migration zones, levee maintenance, water availability to homes and other issues.

--
Andrew B. Carey, Ph.D.
Serendipity Consulting
38419 570th St. Ct. E
Ashford, WA 98304

Ashford: 360-569-0016
Oympia: 360-866-0539

Post-it® Fax Note 7671	Date AUGH	# of pages ▶ 1
To MIKE MILNE	From ROY HUBERD	
Co./Dept. B & C	Co. P. County	
Phone #	Phone # 253 798 6793	
Fax # 206 749 2200	Fax #	

Aiming for Healthy Forests:
http://www.treesearch.fs.fed.us/pubs/29208

Comment on the Draft Basin Plan Carey--I

I am writing comments on the Nisqually Basin plan because I am concerned that the planners have overlooked important stakeholders and pressing issues of public safety and safeguarding of public infrastructure. I am also concerned that there has been inadequate cooperation and coordination among governmental and non-governmental stakeholders. I will endeavor to become increasingly specific about what I deem are serious inadequacies, perhaps even fatal flaws, in the plan as I develop my review below. 2-1

The **Executive Summary** says this plan is a comprehensive guide to water management that, among other things, seeks to reduce flood hazard and demonstrate coordinated and responsible use natural resources. The danger to Nisqually Park and its damaged levees is mentioned in ES-5. The situation is much more complex and pressing. Pierce County not only has deemed this levee inadequate but also has designated a Channel Migration Zone the encompasses most of the Upper Nisqually River Valley (UNV). But insufficient attention has been paid to remediation of this threat through coordination with Mt. Rainier National Park (MRNP) which encompasses a major part of the watershed. Multi-century storm events have caused considerable damage to MRNP that resulted in considerable economic and social impacts on the citizens of the UNV, and significant impacts on the parts of Pierce County to the West that also rely on the tourism and recreation associated with the Park. Large floods not only damaged levees, they also damaged the Kernahan Road Bridge and destroyed the WADNR Bridge at National. 2-2

Very significantly, they have also deposited massive amounts of large woody debris (LWD) in the UNV that so badly exceed normal LWD levels, that LWD, instead of modulating hydrologic function, will now contribute to aberrant function, including undesirable channel migration. The UNV contains a wide and active river bed that allows normal channel migration; migration occurs with every storm. But excessive LWD is now confining the river to narrow channels rather than promoting channel migration within the active river bed that helps to slow the current and reduce the force of floods. Much of the LWD is in MRNP and much between MRNP and Kernahan Bridge. This massive LWD could contribute not only to a breach of the Nisqually Park levee, but also to channel migration, lows of village centers, loss of significant parts of SR 706, Kernahan Bridge, and even the SR 7 and railroad bridges at Elbe. Personal property loss, damage to public infrastructure, huge impacts to natural resources use (timber and recreation), and loss of sustainability of UNV communities could result. This situation is pressing and serious as indicated by the 2006 river flows and recent Pierce County CMZ analyses. 2-3

Capital improvements and property acquisitions in UNV (in wetlands, CMZ, and floodplain) are given a medium priority and an estimated $800, 000 need (CIP 19 COP AC01) vs. a high priority for shellfish, vegetation management, and invasive species. This seems unconscionable given the surface water/river management problems in the UNV and the UNV's highly valuable role as *the* year-round gateway to MRNP under the UNAC 1999 community plan, its role in supporting MRNP under NPS Vision 66, Vail Agenda, and MRNP Management Plan, and community/county/state/nonprofit investments in the Mt. Tahoma Ski Trails System, the Ashford Cultural Center and Museum, acquiring forest lands to preserve a natural entrance corridor to MRNP, the 2-4

Comment on the Draft Basin Plan Carey--2

proposed bicycle trail to Ashford, proposed and ongoing railroad upgrades and extension to Elbe and beyond, and other efforts.

The **Introduction** calls for advising other entities and jurisdictions with goals of addressing flooding and reducing flood hazards (**Table 1.1**). Yet the discrepancies between MRNP General Management Plan's assessment of flood and channel migration hazards and the Pierce County CMZ study could not be more at odds and uncoordinated. 2-5

Chapter 2 calls for involving the public (**NFIP CRS Steps**); the UNV community has not been involved; *****I request you extend the comment period for this plan and to hold one or more community meetings in Ashford to seek comments and involvement.***** 2-6
The CRS also cites coordination with other local governments, county agencies, state agencies, and federal agencies, yet, as pointed out above, the lack of coordination seems egregious and even the amount of conflict seems excessive. The **GMA** states the need for collaboration with the public for protection, for development, and for capital improvements. Please do that. 2-7

Chapter 3 call for involving citizens in problem identification, development of solutions that are realistic and acceptable to the community. That has not been done. *****I request you extend the comment period for this plan and to hold one or more community meetings in Ashford to seek comments and involvement.***** 2-8

Chapte 3.2.3, MRNP: staff notified the park of the plan. This seems *pro forma*. Given MRNP's role in the Upper Nisqually watershed close, integrated, and ongoing involvement is a necessity.

Page 3-11: merely working with Lewis County on a CMZ is inadequate to meet the plan's goals. Skate Creek Road/FS Road 52 is close to being undermined now. Kernahan Bridge is threatened. The community of Paradise Estates could be isolated and stranded in the even of a flood, lahar, or other disaster. The DNR bridge no longer exists to provide an second route out; the FS road is closed in the winter (didn't open till July of this year), and if damaged this spring may not be open this fall. These are matters of public safety and must be addressed as the community resides on the boundary between the two counties and are as much citizens of Ashford and the UNV as of Lewis County. 2-9

Page 4-5: The Upper Nisqually Community Plan (UNCP) seems mischaracterized. The UNCP identifies the Park Gate community (Nisqually Park) and Echo Valley as residential community and a centers of residential development; the zoning presented seems inaccurate; Nisqually Park is 3 homes/acre. This failure to understand and consider the UNCP is a critical flaw in this Basin Plan. The Tourist Commercial area near MRNP's gate, Nisqually Park, Echo Valley, Alpine Village, and the less developed, but still residential areas along SR 706 between MRNP and Ashford (including Murray Road) are at substantial risk according to public comments by Randy Brake. However, the extent of property loss and potential loss of human life seems grossly underestimated. It is imperative that this be addressed in full. Some areas (Tourist Commericial, Nisqually Park, and Echo Valley) should be able to be placed in a category of low risk to 2-10

Comment on the Draft Basin Plan Carey--3

100 or 200 year events, but high risk due to volcano eruption, lahars, earthquakes, etc. This would require significant investment in infrastructure. However the infrastructure investments would protect not only these communities but the *gateway function* of access to public lands including the Washington Department of Natural Resources, Mt. Baker-Snoqualmie National Forest (including Glacier Wilderness), the Gifford Pinchot National Forest (including the Tatoosh Wilderness, Skate Creek, and multiple high elevation lakes), and Mt. Rainier National Park. This basin plan must address protecting these local, county, state, and national interests. The year-round residents of the UNV may be relatively few, but visitors number in the *millions*. Partnerships among the governmental stakeholders should be a focus of the plan.

Page 4.51: Does not address water supply problems to Nisqually Park and Alpine Village and restrictions on property rights and home development that are being enforced against residential property owners. This situation, albeit minor in the grand scheme of things, is very important to the affected citizens and should be addressed, or these citizens may find themselves without any future recourse. 2-11

Chapter 5 seems to only address very specific locations, such as culverts, in the UNV and does not address the larger question/larger view of threats to lives, property, and infrastructure I briefly identified above, but specifically: unusually massive LWD loads in the upper reaches; a levee deemed inadequate by county engineers to withstand >50 year floods or to prevent channel migration through critical areas; management, lack of management, and lack of interagency coordination for the reaches in MRNP; seemingly no addressing of inter-county and Pierce County management of LWD and hydrologic function in the reaches between Ashford and MRNP, etc. 2-12

Page 6-11: Rain-on-snow events in the fall present the most common recurring cause of high (flood-level) water flows in the UNV. Such flows are fairly accurately predicted by the Advanced Hydrologic Prediction Service. So far there has been no mention in this plan of the AHPS and how informing citizens and local organizations such as fire departments of how to access and monitor it as part of an overall plan for public safety. 2-13

Page 6-19 etc.: It is gratifying to see the problems of levee maintenance, channel migration, and avulsion in the UNV mentioned in the basin plan.

6.4.1 seemingly ignores the role of unusually high amounts of LWD in (1) creating massive debris dams that can then lead to overtopping of levees (which reportedly was a factor in the loss of Sunshine Point Campground in MRNP), (2) creating debris dams that collapse can lead to channel scouring and damaging debris flow; (3) avulsion that causes losses of patches of forests, adding even more huge volumes of LWD to the stream bed, instead of just some stream bank erosion, which adds a few trees at a time, (3) avulsion that causes loss of roads (now ongoing at FS RD 52), and (4) which can accumulate at bridge abutments and support causing loss of bridges. The complete picture of hydrologic function is needed to complete this plan. Aggradation of sediments; recruitment, movement, and accumulation of LWD; seasonal flows, peak flows, rain-on-snow events are all important. Tools for management are relatively few: culvert and 2-14

Comment on the Draft Basin Plan Carey--4

bridge design and maintenance, management of LWD (intentional management to meet hydrologic, environmental, and social goals is possible), point- and reach-specific sediment management, and design, construction, and maintenance of levees at critical points provide the active-management tool box; zoning, floodplain and CMZ designation, public information, and warning systems provide the passive-management toolbox. Both active and passive management must be addressed in the Basin Plan if it is to be successful in meeting its goals.

RESPONSE TO COMMENT LETTER 2

2-1 Pierce County acknowledges your concerns regarding adequate stakeholder involvement. Stakeholder involvement is an important component of Pierce County's basin planning process and has been integral to development of the Nisqually River Basin Plan. Please refer to Common Response 1-E for additional information.

2-2 Thank you for your comment. Several comments were received regarding channel migration hazards in the Upper Nisqually Valley. Please refer to Common Response 1 for additional information. Specific responses to your concerns for the channel migration zone, Nisqually Park levee, and coordination with Mount Rainier National Park are contained Common Responses 1-A, 1-B, and 1-D, respectively.

2-3 Thank you for your detailed comment regarding adverse impacts of large woody debris (LWD). The Basin Plan has been updated to address this issue. The LWD accumulations are likely related to channel aggradation and channel migration hazard issues discussed under the Common Response 1, and a specific response regarding LWD is contained in Common Response 1-C.

2-4 Pierce County acknowledges your comment regarding project prioritization. Capital improvement projects and programmatic recommendations in the Basin Plan are prioritized using a standard ranking system developed by SWM for use in all of its basin plans throughout the County. The ranking system is designed to apply a consistent set of weighted criteria to capital improvement projects and programmatic recommendations in all basin plans. The points allocated to each ranking criterion were carefully chosen to reflect the priorities of SWM. To provide a better understanding of the ranking methods, a narrative of the scoring criteria has been added to Appendix J of the Basin Plan.

2-5 Thank you for your comment regarding coordination with MRNP related to the Upper Nisqually River CMZ study. The Upper Nisqually River CMZ study was completed under a separate effort and is not part of the Basin Plan. The Basin Plan is intended to serve as Pierce County SWM's work plan and does not affect regulation of CMZs or other critical areas. However, your comment relates to the overall issue regarding channel migration hazards in the Upper Nisqually Valley. A detailed response has been prepared and is presented at the front of this section. Please refer to Common Comment 1 for additional information regarding flooding and channel migration hazards, Common Response 1-A regarding the CMZ study, and Common Response 1-D regarding Mount Rainier National Park.

2-6 Thank you for your comment. As a member of the National Flood Insurance Program (NFIP) and an active participant in the Community Rating System (CRS), Pierce County agrees that community involvement is an important element of floodplain management

and flood mitigation planning. Please refer to Common Comment 1-E for a detailed response regarding stakeholder involvement activities.

2-7 Pierce County acknowledges that coordination with other local governments, county agencies, state agencies, and federal agencies is an important aspect of the CRS. Refer to the discussion of stakeholder involvement in the response to comment 2-1.

2-8 Specific community involvement activities conducted during the development of the Nisqually River Basin Plan are presented in Table B-1 (see response to comment 2-6). These activities included public meetings to solicit information regarding problems within the planning area and provide an opportunity to comment on the proposed recommendations.

2-9 Pierce County appreciates the comment. However, the scope of the Basin Plan is limited to unincorporated areas of Pierce County. Although Pierce County will continue to work with Lewis County on projects and studies where a joint effort makes sense (e.g., the Channel Migration Zone (CMZ) study for the Upper Nisqually River), recommendations in the Basin Plan must specifically address problems within Pierce County.

2-10 Figure 4-2 in the draft Basin Plan shows the zoning in the study area. This information was used to estimate potential for future development to cause drainage, water quality, or habitat problems. The evaluation of future land use was based on zoning information provided by PALS.

2-11 Pierce County appreciates the comment. Please note that the Basin Plan is intended to serve as Pierce County SWM's work plan. It does not address water supply, property rights, or development regulations because SWM does not perform these functions. We understand that water supplies are being addressed as part of the 2514 WRIA 11 Watershed Planning process. Land use and development regulations are addressed by the Pierce County Comprehensive Land Use Plan.

2-12 Thank you for the comment regarding problems in the Upper Nisqually River Valley. For specific responses, please refer to the following:

- Response to comment 2-3, regarding LWD;
- Response to comment 2-2, regarding the Nisqually Park levee;
- And responses to comments 2-5 and 2-6, regarding interagency coordination and coordination with MRNP.

2-13 Thank you for the suggestion. Text will be added to Chapter 6 to provide information regarding the Advanced Hydrologic Prediction Service (AHPS).

2-14 Please refer to response to comment 2-3 above.

COMMENT LETTER 3

Comments on the SEIS Carey--1

PLANNING & LAND SERVI
JUL 08 2008
PIERCE COUNTY

To: Adonais Clark, Environmental Designee, Pierce County PALS

Subject: Comments on the SEIS for the Nisqually Basin Plan

Attached are my comments on the SEIS and on the Nisqually River Basin Plan, as the SEIS offers two alternatives, take it, or leave it. The Nisqually River Basin Plan is woefully inadequate in the way and degree it addresses issues, public involvement, and interagency/interorganizational coordination in the Upper Nisqually Valley.

Andrew B. Carey, Ph.D.
Proprietor, Serendipity Consulting
Formerly: Chief Scientist and Emeritus Scientist, Pacific Northwest Research Station, USDA Forest Service; Courtesy Professor of Forest Ecology, University of Washington and Oregon State University, and other universities.
38419 570th St. Ct. E
Ashford, WA 98304
360-569-0016

Comments on the SEIS Carey--2

Comments

Page 10-1: Public meetings were not held in the Upper Nisqually areas of the the Nisqually Basin. I request that the comment period be extended and public meetings be held in Ashford to solicit the comments and advice of a populace seriously concerned about the issues. 3-1

10-1: The Nisqually River Basin Plan (NRBP) fails to address numerous salient issues (review attached); until it is brought up to standard it should not be adopted.

10-7: the alternatives in this SEIS are woefully inadequate, especially given the statements in the NRBP that data, modeling, and other technical details are inadequate or lacking and that Upper Nisqually residents have not be consulted even though that consultation is required by the NRBP itself. 3-2

Serious issues in the upper watershed have not been addressed (see attached comments) and must be addressed; interagency coordination is lacking; and the NRBP has failed to achieve the coordination with other planning and effort it requires of itself.

10-19: the stated goals illustrate the internal conflicts and inconsistencies therein:

"The six long-term goals of the 1991 Plan are listed below:
1. Prevent the loss of life, the creation of public health or safety problems, and the loss or damage of public and private property.
2. Establish and adopt a systematic and comprehensive approach.
3. Minimize expenditure of public funds.
4. Maintain the varied uses of the existing natural drainage system within the County.
5. Prevent the degradation of the quality of both surface water and the water entering the region's aquifers.
6. Coordinate with public and private sectors."

Minimizing expenditure of public funds has already undermined item 6 and will preclude items 1 and 2. This incoherence is unacceptable.

As I read the SEIS, I can not but conclude that it is a farce: accept the NRBP or nothing; this is unacceptable; "take it or leave it" is not a range of alternatives. Further information on the inadequacy of the "take it" option is in the attached comments on the NRBP. 3-3

RESPONSE TO COMMENT LETTER 3:

3-1 Several public meetings were conducted as part of the stakeholder and community involvement activities for the Nisqually River Basin Plan (see response to comment 2-6). These meetings were held in the central portion of the planning area (typically in the vicinity of Eatonville). Recent comments such as this one have indicated a need for additional public involvement within this area of the basin, particularly to address residents concerns for flooding and channel migration along the mainstem river. To help address this concern, the County has convened a citizens' panel (see response to Common Response 1-A).

3-2 The Basin Plan and SEIS are based on reasonable and professional analysis techniques recognized by Pierce County as appropriate for basin planning and environmental impact analysis. Pierce County considers the alternatives in the Basin Plan and SEIS to adequately address the objectives of basin planning in Pierce County. The draft Basin Plan recommends a new study (ST19-NIS-ST01) to update the existing floodplain mapping between Alder Lake and Kernahan Road. For a discussion of stakeholder involvement and consultation conducted under the basin plan, please see the response to Common Response 1-E above.

3-3 Your opinions on the alternatives presented in the basin plan and SEIS are noted. The Basin Plan has been modified to address several of your concerns. The final decision on the proposed basin plan will be made by Pierce County based on findings in the planning and EIS processes, which include the consideration of public comments and concerns.

COMMENT LETTER 4

Elbe Water and Sewer District

PO Box 4 ~ Elbe, WA 98330-0004
Phone 360-569-2668 ~ Fax 360-569-2394
Gayle W. Adams, Commissioner ~ Julie L. Clark, Commissioner ~ David Rowe, Commissioner

Post-it® Fax Note 7671	Date 7-11-08	# of pages ▶ 6
To Mike Milne	From Roy HUBERD	
Co./Dept. B & C	Co. Pierce Co.	
Phone #	Phone #	
Fax # 206 749-2200	Fax #	

Roy Huberd,

Pierce County Surface Water Management

2702 42nd St Suite 201

Tacoma, WA 98409-7322

RE: Comments to the DEIS for the Nisqually River Basin Plan EIS

Dear Mr. Huberd,

Please include in the EIS the flooding of the Elbe Post office and properties on the north side of SR-7 between the post office and the north entrance to the Elbe Mall /Chevron. 4-1

Our Post office is regularly flooded and requires sandbagging and pumping by the local fire department.

Our manhole covers are often submerged in water for days as water infiltrates our collection pipes threatening the operations of our treatment plant. If we raise them anymore, they will become a danger to traffic and make 541st.E impassable.

Please record our concern for the lack of drainage to the west for the water that backs up on the east side of SR-7. Please include an answer to this ongoing problem.

Please include our very serious concern for the erosion taking place behind the Historic Elbe Church, our well site and protection area, Mr. Adams property and our Sewage Treatment Plant on the east end of Alder Reservoir. This is a very serious problem, caused by 64 years of Tacoma Power generating operations. 4-2

The buildup of rock and sand deposited by the river as it slows entering the reservoir is now directing the water into the mentioned properties and community infrastructure. Please include in the EIS a requirement to remove the deposits in the reservoir or build a dike along the full length of the affected land as soon as possible. 4-3

For the record, the commissioners are very concerned for the survival and/or the ability of our well and sewage treatment plant to be useable subsequent to the upcoming fall rainy season.

Thank You,

Julie Clark

Julie Clark

Chair: Elbe Water Commissioners

RESPONSE TO COMMENT LETTER 4:

4-1 Thank you for you comment and information regarding flooding in Elbe. The Basin Plan has been updated to address flooding at the post office. Please refer to the response to Common Response 2 above.

4-2 Thank you for you comment and information regarding erosion at the east end of Alder Reservoir. Please refer to the response to Common Response 3 above.

4-3 Sediment deposition in the reservoir is also addressed in Common Response 3 above.

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COMMENT LETTER 5

Mary L. Foster
P.O. Box 179
30926 Mount Tahoma Canyon Road
Ashford, WA 98304-0179
(360) 569-2860
maryfoster@rainierconnect.com

RECEIVED JUL 8 2008 SURFACE WATER MANAGEMENT

July 8, 2008

Adonais Clark
Environmental Designee
Pierce County Planning and Land Services Department
2401 South 35th Street, Suite 175
Tacoma, Washington 98409

Dear Mr. Clark:

I am writing comments on the Nisqually River Basin Plan. I believe that the planners have overlooked important stakeholder concerns as well as pressing issues of public safety and safeguarding of public infrastructure. I am also concerned that there has been inadequate coordination among governmental and non-governmental stakeholders. Please review and respond in writing to each of my comments and questions below.

Executive Summary:

Page ES-4: More intense development may occur in several small areas near Roy, Eatonville, and the Mount Rainier National Park boundary.

What consideration have you given to the prediction for more intense development near the Mount Rainier National Park boundary? There is an immediate flood threat to the Sunshine Point/Nisqually Park levee at a very weak inflection point inside the Mt Rainier National Park boundary. Is there a plan to work with Mt Rainier National Park for an immediate reinforcement of this weak point before this fall/winter flood season? If not, why not? 5-1

Page ES-5: Another area of concern in the Nisqually Park community near the Mount Rainier National Park boundary where County-maintained levees sustained extensive damage during a flood event in November 2006.

I do not see any specific, timely response planned for this area of concern. The upper Nisqually River has been very adversely impacted by the flood events of November 2006. There are extreme accumulations of large woody debris deposited in the river channel from eroding banks during that flood event. Has there been an assessment of the potential detrimental effects of such an abnormally high accumulation of large woody debris and how it may possibly relate to potential flooding? 5-2

Chapter 2 references involving the public (NFIP CRS Steps):

The Upper Nisqually community has not been sufficiently involved. I request that you extend the comment period for this plan and hold one or more community meetings in Ashford to seek comments and involvement. The CRS also cites coordination with other local governments, county agencies, state agencies, and federal agencies. The GMA states the need for collaboration with the public for protection, for development, and for capital improvements. Please establish evidence of this collaboration. 5-3

page 1 of 3

***Chapter 3** references involving citizens in problem identification, development of solutions that are realistic and acceptable to the community.*

That has not been done. I request that you extend the comment period for this plan and hold one or more community meetings in Ashford to seek comments and involvement. 5-4

Section 5:
Page 5-19: NIS-24 Kernahan Road Bridge crossing the Nisqually River. Kernahan Road Bridge over the Nisqually River has historically been susceptible to damage during major flooding events. The bridge had to be rebuilt in 1994 and was again damaged in February 1996.

The Kernahan Bridge is the only winter egress from the communities of Paradise Estates, Mountain Meadows, Bavarian Retreat and other property owners in adjacent Lewis County. Without the bridge, these communities would be stranded without food or medical facilities. What provisions does the Basin Plan make for protecting the bridge from flood damage? 5-5

Page 5-19: NIS-25 Nisqually River near Mount Rainier National Park Entrance. Historically, the Nisqually River channel has migrated during major flooding events causing damage to property and infrastructure.

What plans are included in the Basin Plan for dealing with this problem? 5-6

Section 6:

Page 6-16: A third area of concern is the upper Nisqually River near Mount Rainier National Park, where flooding events have caused extensive bank erosions and channel migration.

The upper Nisqually River near Mount Rainier National Park is listed as the "third" area of concern, yet there are no plans in the Basin Plan to address this concern. Please explain what plans there are to address this concern, given the fact that this area has been identified as an area of "more intense development". This area is the gateway community to Mount Rainier National Park, as specified in long-range plans over the past 40 years by the National Park Service, with a specific emphasis by MRNP on locating visitor services in this area near MRNP instead of inside the Park. 5-7

Page 6-19: Upper Nisqually River
The County recently completed a channel migration study for the upper Nisqually River (Pierce County, June 2007). The study characterizes the upper Nisqually River as "a braided river with a history of abrupt [channel] migration[6] and full scale avulsion[7] that occur over short periods of ten years or less."
The purpose of the study was to delineate "Channel Migration Zones" (CMZs) that will be used for floodplain management, maintenance of existing infrastructure (e.g., bridges, levees).
Recent flooding events on the upper Nisqually River have caused considerable bank erosion and channel migration (see Figure 6-3), leading to damages of property and infrastructure.
In November 2006, the headwaters of the Nisqually River received nearly 18 inches of rain in a 36-hour period (Mount Rainier National Park, 2006). The resulting floodwaters on the Nisqually River caused extensive damage to roads and campgrounds within Mount Rainier National Park.
A County-owned levee near the park sustained substantial damage, requiring that a major portion of the levee be rebuilt (see Figure 6-4). The levee protects the Nisqually Park subdivision. Although no homes were damaged in the November 2006 flood, there has been concern from residents that erosion at the levee could lead to a levee failure.

What provision does the Basin Plan make to address this danger? Insufficient attention has been given to dealing with this threat through coordination with Mt. Rainier National Park, which includes a major part of the watershed. Storm events have caused considerable damage to MRNP. The results are large economic and social impacts on the citizens of the upper Nisqually Valley, and also on other parts of Pierce County that also rely on the tourism associated with the Park. The floods have damaged levees and the Kernahan Road Bridge. The DNR Bridge at National was destroyed. The floods also deposited large amounts of large woody debris in the Nisqually River in the upper Nisqually area. The woody debris level is high enough that, instead of modulating hydrologic function, it now contributes to undesirable channel migration. The upper Nisqually contains a wide and active riverbed that allows normal channel migration; migration occurs with every storm. However, excessive large woody debris is now confining the river to narrow channels rather than promoting channel migration within the active riverbed that helps to slow the current and reduce the force of floods. Much of the LWD is in MRNP and much between MRNP and Kernahan Bridge. This massive LWD could contribute not only to a breach of the Nisqually Park levee, but also to channel migration, loss of significant parts of SR 706, Kernahan Bridge, and even the SR 7 and railroad bridges at Elbe. Personal property loss, damage to public infrastructure, huge impacts to natural resources use (timber and recreation), and loss of sustainability of the communities could result. This situation is pressing and serious as indicated by the 2006 river flows and recent Pierce County CMZ analyses. 5-8

A channel migration study has been done, but that study makes no provision for action to address proactively the danger. Please elucidate the plans to address this situation. 5-9

Section 9

Page 9-51: CIP19-COP-AC01: Upper Nisqually River Property Acquisition: $748,300:

This property is apparently the "Allen Estate". This land has already been purchased by the Nisqually Land Trust, for $780,000 with a federal land-acquisition grant from the U.S. Fish and Wildlife Service, with the money passing through the state Department of Natural Resources. Since County money is no longer needed for the purchase of this land, I request that the Basin Plan be corrected to note this fact and that these funds be reallocated for other benefits for the upper Nisqually valley. 5-10

I request detailed responses and action to the questions and requests submitted in this letter.

Sincerely,

Mary Foster

Mary L. Foster

cc: Harold Smelt
Roy Huberd ✓

RESPONSE TO COMMENT LETTER 5:

5-1 Thank you for your comment. Several comments were received regarding channel migration hazards in the Upper Nisqually Valley. Please refer to Common Response 1 for additional information. Specific responses to your concerns for development near Mount Rainier National Park, channel migration hazards, Nisqually Park levee, and coordination Mount Rainier National Park are contained Common Responses 1-D, 1-A, 1-B, and 1-D, respectively.

5-2 Several comments were received regarding channel migration hazards in the Upper Nisqually Valley. Please refer to Common Response 1 for additional information. Specific responses to your concerns for damages to the Nisqually Park levee and the accumulation of LWD are contained Common Responses 1-B and 1-C, respectively.

5-3 Thank you for your comment. As a member of the National Flood Insurance Program (NFIP) and an active participant in the Community Rating System (CRS), Pierce County agrees that community involvement is an important element of floodplain management and flood mitigation planning. Please refer to Common Response 1-E for a detailed response regarding stakeholder involvement activities.

5-4 Pierce County acknowledges your concerns regarding adequate stakeholder involvement. Stakeholder involvement is an important component of Pierce County's basin planning process and has been integral to development of the Nisqually River Basin Plan. Please refer to Common Response 1-E for additional information.

5-5 Pierce County appreciates the comment. However, the scope of the Basin Plan is limited to unincorporated areas of Pierce County. Although Pierce County will continue to work with Lewis County on projects and studies where a joint effort makes sense (e.g., the Channel Migration Zone (CMZ) study for the Upper Nisqually River), recommendations in the Basin Plan must specifically address problems within Pierce County.

5-6 Several comments were received regarding channel migration hazards in the Upper Nisqually Valley. Please refer to Common Response 1 for additional information. A specific responses to your concern for channel migration is contained in Common Responses 1-A.

5-7 Several comments were received regarding flooding and channel migration hazards in the vicinity of the Nisqually Park Entrance. Please refer to Common Response 1 for additional information. A specific response to your concern for coordination with related plans is contained in Common Responses 1-D.

5-8 Several comments were received regarding flooding and channel migration hazards in the vicinity of the Nisqually Park Entrance. Please refer to Common Response 1 for additional information. A specific response to your concern for coordination Mount Rainier National Park is contained in Common Responses 1-D.

5-9 Several comments were received regarding flooding and channel migration hazards in the Upper Nisqually Valley. Please refer to Common Response 1 for a response to your concern.

5-10 The recommendation for property acquisition in the Upper Nisqually Valley is not specific to one parcel. The recommendation has been changed to be more general.

COMMENT LETTER 6

MCC
Media Consultants Corporation

RECEIVED JUL 10 2008 WATER MANAGEMENT

July 8, 2008

Adonais Clark
Environmental Designee
Pierce County Planning and Land Services Department
2401 South 35th Street, Suite 175
Tacoma, Washington 98409

Dear Mr. Clark:

I am writing comments on the Nisqually River Basin Plan. I believe that the plan has not included many important stakeholder concerns. I request that you extend the comment period for this plan and hold one or more community meetings in Ashford to seek comments and involvement.

Please review and respond to the comments on the following pages.

Best regards,
MEDIA CONSULTANTS CORPORATION

Burke Garrett
President

cc: Harold Smelt
Roy Huberd ✓

Post-it® Fax Note 7671	Date Aug 4	# of pages ▶ 2
To Mike Milne	From Roy Huberd	
Co./Dept. B & C	Co. P.Co.	
Phone # 206 749-2200	Phone # 253 798-6783	
Fax #	Fax #	

Attachment: Communication to Pierce County: Comments on the Nisqually River Basin Plan; Burke Garrett, July 8, 2008

P.O. Box 179
Ashford, WA 98304-0179
360 569 2360
Fax 360 569 2861
burke@garrett.org

Communication to Pierce County: Comments on the Nisqually River Basin Plan
Burke Garrett, July 8, 2008

Page ES-5: Another area of concern in the Nisqually Park community near the Mount Rainier National Park boundary where County-maintained levees sustained extensive damage during a flood event in November 2006.

Is there any specific, timely response planned for this area of concern? The upper Nisqually River has been very adversely impacted by the flood events of November 2006. There are extreme accumulations of large woody debris deposited in the river channel from eroding banks during that flood event. Has there been an assessment of the potential detrimental effects of such an abnormally high accumulation of large woody debris and how it may possibly relate to potential flooding? 6-1

Page 6-16: A third area of concern is the upper Nisqually River near Mount Rainier National Park, where flooding events have caused extensive bank erosions and channel migration.

Please explain plans in the Basin Plan to address this concern. This area has been identified as an area of "more intense development" by the Basin Plan. This area is the gateway community to Mount Rainier National Park, as specified in long-range plans over the past 40 years by the National Park Service, with a specific emphasis by MRNP on locating visitor services in this area near MRNP instead of inside the Park. 6-2

Page 6-19: Upper Nisqually River – comments

What provision does the Basin Plan make to address the danger described on this page? Insufficient evidence has been provided that effort has been given to dealing with this threat through coordination with Mt. Rainier National Park, which includes a major part of the watershed. A channel migration study has been done, but that study makes no provision for action to address proactively the danger. Please elucidate the plans to address this situation. 6-3

Chapter 3 references involving citizens in problem identification, development of solutions that are realistic and acceptable to the community.

The plan has not sufficiently involved residents of the upper Nisqually valley. I request that you extend the comment period for this plan and hold one or more community meetings in Ashford to seek comments and involvement. 6-4

Burke Garrett

RESPONSE TO COMMENT LETTER 6:

6-1 Thank you for your comment regarding accumulations of large woody debris (LWD). The Basin Plan has been updated to address this issue. The LWD accumulations are likely related to channel aggradation and channel migration hazard issues discussed under the Common Response 1, and a specific response regarding LWD is contained in Common Response 1-C.

6-2 Several comments were received regarding flooding and channel migration hazards in the vicinity of the Nisqually Park Entrance. Please refer to Common Response 1 for additional information. A specific response to your concern for coordination with related plans is contained in Common Responses 1-D.

6-3 Several comments were received regarding flooding and channel migration hazards in the vicinity of the Nisqually Park Entrance. Please refer to Common Response 1 for additional information. A specific response to your concern for coordination Mount Rainier National Park is contained in Common Responses 1-D.

6-4 Pierce County acknowledges your concerns regarding adequate stakeholder involvement. Stakeholder involvement is an important component of Pierce County's basin planning process and has been integral to development of the Nisqually River Basin Plan. Please refer to Common Response 1-E for additional information.

COMMENT LETTER 7

UNITED STATES POSTAL SERVICE

Co./Dept.	Co.
Phone #	Phone # 253 798-6793
Fax # 206 749-2800	Fax #

Thank you Mike. Nathan

July 9, 2008

Roy Huberd
Pierce County Surface Water Management
2702 42nd St Suite 201
Tacoma WA 98409-7322

RE: Draft Supplemental Environmental Impact Statement (DSEIS)
For the Proposed Nisqually River Basin Plan

The United States Postal Service provides essential services to the citizens of Elbe. At the present time the post office leases premises from a private landlord. This is not a federal site. There is no feasible alternative to this location, which it has occupied for many years.

This post office building is regularly threatened by storm water flowing across the property. It is solely dependant upon one storm drain to drain the area. When that drain fails, the water enters the building. The most recent flooding of the premises left a high water mark 8 inches high inside the building, last December. At that time, the entire resources of Pierce County Fire District #23 were tied up for ten hours, pumping water, directing traffic, sandbagging the building, carrying out salvageable carpets and furniture. If there had been another emergency, they would have had to leave, and the resultant damage would have been much higher. The total replacement costs for computers, other electronics, office furnishings and clean-up reached thousands of dollars. This has been an ongoing problem. On several occasions I have endeavored to get some relief from Pierce County. 7-1

This problem cannot be solved by simply cleaning out the storm drains. The problem arises when the downstream drainage site is overcome by the sheer volume of water, the water cannot go any further, and the storm drain is completely plugged. Then there is nowhere for the water to go but inside the post office building and to flow across State Route 7. At the time of a flood, the Fire Department is forced to rig hoses to pump the floodwaters

over State Route 7. The resultant standing water, firemen and hoses over the roadway present a danger to people and traffic.

Please record my very serious concerns for the Elbe area's surface water management of this flooding issue. Please consider a long term solution to the lack of drainage for storm water that causes the flooding of the post office, surrounding businesses and State Route 7. 7-2

Thank you for your attention.

Sincerely,

Susan Griswold

Susan Griswold, Postmaster
Elbe WA 98330-9998

RESPONSE TO COMMENT LETTER 7:

7-1 Thank you for you comment and information regarding flooding in Elbe. The Basin Plan has been updated to address flooding at the post office. Please refer to the response to Common Response 2 above.

7-2 Please refer to the response to Common Response 2 above.

COMMENT LETTER 8

Roy Huberd - Nisqually Basin Plan Comments

From: "Kathy Hatcher" <kathandl@centurytel.net>
To: <rhuberd@co.pierce.wa.us>
Date: 7/4/2008 2:18 PM
Subject: Nisqually Basin Plan Comments

Mr. Huberd;

Please find attached; comments/questions and concerns on the proposed Nisqually basin Plan.

Kathy Hatcher
PO Box 8
(56916 384 Ave Ct E)
Ashford, WA 98304

NISQUALLY BASIN PLAN COMMENTS

Hatcher-

EXECUTIVE SUMMARY:

* Nisqually River Basin Plan responsible for surface water management in unincorporated Pierce County-

As the Upper Nisqually Basin Gateway to Mt Rainier Communities of Ashford and Elbe cover the upper 1/3 of the Nisqually River Basin , We would like to go on record as requesting a community meeting for the Upper Nisqually communities with appropriate County representatives to educate the community on the Nisqually basin Plan and how it relates to the upper basin communities. 8-1

* Mainstream Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01)

What does this entail? Does it include the extreme amount of LWD in the Upper Nisqually deposited during the 11/2006 flood event? 8-2

* Reference to the area of concern: Nisqually Park levee near Mt. Rainier NP

After this note of concern, is there any plan to remedy the concern? 8-3

GOALS AND OBJECTIVES:

* In the Goals and Objectives of the NBP the first objective states " Reduce Flood hazards, property loss and repetitive Damage reduced. Also stated in the introduction pg. 1-2 paragraph 4 and Applicable Programs, Policies and regulations pg 2-5 bullet point 2 "Involve the Public":

We would also like to go on record with the following concern:

There is an eminent/immediate Flood Threat to the Sunshine Point/Nisqually Park Levee at a very weak inflection point inside the Mt Rainier NP boundary . Is there a plan to work with Mt Rainier NP, for an immediate/timely repair/reinforcement of this weak point before this fall/winter flood season? 8-4

* Also stated in the first Goal and Objective:

Streams will not be adversely impacted by flood events and NIS -26:

The upper Nisqually River has been very adversely impacted by the flood events of November 2006 in the extreme accumulations of LWD washed in to the river channel from eroding banks and washing down the river channel during that flood event. Has there been an assessment of the potential detrimental effects of such an "abnormally high/excessive" accumulation of LWD and how it may possibly relate to potential flooding ? 8-5

*Goals and Objectives "Demonstrate coordinated and responsible use of public resources"

In relation to flooding issues, a coordinated effort with DNR, DOT, USNPS, private landowners seems to be lacking 8-6

* Goals and Objectives "Effective BMP's are identified and widely used:

Would using LWD, deposited in the Nisqually River channel during the 11/2006 flood event, to construct ELJ's (Engineered log jams) be a possible BMP's at weak inflection points to reduce flood hazards? (Examples: Sunshine 8-7

NISQUALLY BASIN PLAN COMMENTS

Hatcher-

Point Levee, River approaches to the Kernahan Rd Bridge and the SR 7 Bridge)

CHAPTER 3 STAKEHOLDERS:

* LEWIS COUNTY

Pg 3-11 Lewis and Pierce Counties are currently working together to map the "Channel Migration Zone" of the Nisqually river .

Can you enlighten us on this statement? Is there a process in place between the two counties? 8-8

CHAPTER 4 FLOOD HAZARD AREAS

* Pg 4-46 Channel Migration Zones "Areas where detailed studies have been mapped and accepted by Pierce County"

Would you elaborate on these studies? 8-9

CHAPTER 6 STORMWATER DRAINAGE & FLOODING ANALYSIS

* COP-02 SR 706 Between Ashford & Kernahan Rd. Flooding over roadway where Copper Creek passes under SR 706 E.

Clarify this problem area: Copper Creek does not cross SR 706 between Ahsford and Kernahan Rd. Copper Creek does not flood over SR 706. 8-10

Pg 6-19 Reference to Nisqually Park Levee:

Has there been a collaborative effort to finish the repair to the Mt Rainier portion of the levee? With out this repair the portion of the levee that Pierce County had repaired will be severely damaged or washed out. 8-11

TABLE 6-10

* Flooding over SR 706 0.05 mi W of Park Junction

Clarify this problem area: This is not a WSDOT Maintenance of Drainage issue, all WSDOT Maintenance structures and appurtenances are open. The flooding is from Sahara Creek drainage culvert that has been damaged on private land, which directs the water over embankments to SR 706, rather than to the drainage structures intended for Sahara Creek runoff. The structure damage on Sahara Creek has been causing flooding since 1996 flood events. 8-12

* NIS-24 Kernahan Bridge

Will Flood Hazard mapping and hydraulic Analysis provide for a resolution to the scour problem at the Kernahan 8-13

NISQUALLY BASIN PLAN COMMENTS

Hatcher-

bridge approaches?

CHAPTER 9

Prioritizes High and Medium priority projects relating to flood mitigation (ie; McKenna etc.)

The Upper Nisqually Basin communities and subdivisions also have a need for their Storm/Surface water fees to be used in Flood Mitigation issues along the Nisqually river. 8-14

Pg 9-68 " A ground survey should be conducted"

Is there a scheduled ground survey for the Upper Nisqually River up to and within Mt Rainier NP? 8-15

GENERAL BASIN PLAN COMMENTS:

NIS-25:

*** Makes no mention of National Park Service plans (To maintain/reinforce/protect levee in conjunction with Pierce Co)** 8-16

RESPONSE TO COMMENT LETTER 8:

8-1 Pierce County acknowledges your concerns regarding adequate stakeholder involvement. Stakeholder involvement is an important component of Pierce County's basin planning process and has been integral to development of the Nisqually River Basin Plan. Several comments were received regarding stakeholder and community involvement in the Upper Nisqually Valley; please refer to Common Response 1-E for additional information.

8-2 The LWD study recommended in the Basin Plan, Mainstem Nisqually LWD Assessment and Restoration Plan (ST11-NIS-ST01), is focused on assessing the need for LWD to improve habitat, not potential hazards.

8-3 Several comments were received regarding flooding and channel migration hazards in the Upper Nisqually Valley. Please refer to Common Response 1 for additional information. Specific responses to your concerns for the channel migration zone, Nisqually Park levee, and coordination with Mount Rainier National Park are contained Common Responses 1-A, 1-B, and 1-D, respectively.

8-4 Repairs to the Nisqually Park levee were complete in winter of 2007. Several comments were received regarding damage to the Nisqually Park levee after the November 2006 flood event. Please refer to Common Response 1-B for additional information.

8-5 Thank you for your comment regarding the accumulation of large woody debris (LWD). The Basin Plan has been updated to address this issue. The LWD accumulations are likely related to channel aggradation and channel migration hazard issues discussed under the Common Response 1, and a specific response regarding LWD is contained in Common Response 1-C.

8-6 Pierce County acknowledges your concerns regarding adequate stakeholder involvement. Stakeholder involvement is an important component of Pierce County's basin planning process and has been integral to development of the Nisqually River Basin Plan. Please refer to Common Response 1-E for additional information.

8-7 LWD is typically used and integrated in conjunction with river levee repairs which require rock facing and toe structures. LWD or Engineered Log Jams (ELJ) are not typically used as a sole means to stabilize a river levee or revetment, especially in a steep gradient channel and high velocity floe regime. SWM and MRNP continue to coordinate on the possibility of integrating LWD along the repaired levee reaches as a means to enhance fish habitat and to help further stabilize the channel bank.

8-8 Several comments and inquiries were received regarding the recent CMZ study on the Upper Nisqually River. For a detailed response, please refer to Common Comment 1-A.

8-9 Please see response 8-8 above.

8-10 Thank you for the comment. The location described for problem COP-02 was not accurate and has been corrected.

8-11 Repairs to the Nisqually Park levee were a coordinated effort between SWM and MRNP. Please refer to Common Response 1-B for additional details regarding the levee repair.

8-12 Thank you for the detailed information regarding flooding problem ELB-01. This is new information that was unavailable at the time of field investigations. The problem is caused by a culvert on private property and affects drainage under State Route 706. SWM will coordinate with Washington Department of Transportation to resolve this problem.

8-13 The recommended flood hazard mapping and hydraulic analysis for the upper Nisqually River will not directly address any scour issues for the Kernahan Road bridge. However, the modeling will provide river and hydraulic data that are necessary for a scour analysis of the bridge abutments. A scour analysis of the bridge abutments would be tied to a capital project to improve the Kernahan Road Bridge, which is a project for which Pierce County's Transportation Department Bridge Section would take the lead.

8-14 Pierce County acknowledges your comment regarding project prioritization. Capital improvement projects and programmatic recommendations in the Basin Plan are prioritized using a standard ranking system developed by SWM for use in all of its basin plans throughout the County. The ranking system is designed to apply a consistent set of weighted criteria to capital improvement projects and programmatic recommendations in all basin plans. The points allocated to each ranking criterion were carefully chosen to reflect the priorities of SWM. To provide a better understanding of the ranking methods, a narrative of the scoring criteria has been added to Appendix J of the Basin Plan.

8-15 The basin plan does not make a specific recommendation for a ground survey of the upper Nisqually River channel. However, such survey data would need to be collected to complete the study recommendation: Flood Hazard Mapping and Hydraulic Analysis – Upper Nisqually River (ST19-NIS-ST01). The description of this study has been modified to include a ground survey element.

8-16 Thank you for your comment. Additional text has been added to Chapter 3 to summarize relevant information from the Mount Rainier National Park General Management Plan. This summary includes a brief description of the parks plans for continual maintenance of its facilities.

COMMENT LETTER 9

Roy Huberd - Comments on the Nisqually River Basin Plan, Public Review Draft

From: "Ray Hanowell" <RHanowell@tpchd.org>
To: <RHUBERD@co.pierce.wa.us>
Date: 7/11/2008 1:38 PM
Subject: Comments on the Nisqually River Basin Plan, Public Review Draft
CC: "Dennis Tone" <DTone@tpchd.org>, "Frank Dibiase" <FDibiase@tpchd.org>, "James Hoyle" <JHoyle@tpchd.org>, "John Sherman" <JSherman@tpchd.org>

Roy,

We have concerns with Table 7-1, Water Quality Problems in the Nisqually River Basin Planning Area. The table is not accurate regarding the septic/drainfield problems and we question the need for address-specific identification of what should be a temporary problem. 9-1

Looking at our health department database for a number of the addresses listed in the table, none of these properties appear to have currently failing septic systems. Some had a failing septic system years back (as far back as the mid-1990s) and some had solid waste violations but no failing septic system. To our knowledge, our database provides the most accurate information on failing septic systems in Pierce County.

Failing septic systems are a temporary problem, once the health department is aware of the failure, with repairs usually being completed in a matter of weeks or months. Even if the information was accurate, we question the need to include specific addresses in the table for problems that should be corrected very early in the lifespan of the Basin Plan.

If you think it would be useful, the Basin Plan could include a current report from our database showing the number of open failing septic cases and solid waste cases within the Nisqually River Basin.

Thanks, Ray

Ray Hanowell
Environmental Health Specialist II
Environmental Health Program

****
This e-mail and any attachments may contain confidential and privileged information.
****

RESPONSE TO COMMENT LETTER 9:

9-1 Thank you for your comment. We have revised Table 7-1 to eliminate the specific locations for previously reported septic/drainfield failures. We have added a footnote to the table, stating that septic/drainfield failures are usually repaired soon after the problems have been identified. Thus, the specific system failures listed in Table 7-1 have probably been corrected. However, the failures may be indicative of the potential for other systems in the area to fail due to age, soil, water table, or other local conditions.

COMMENT LETTER 10

From: Donald J Russell <krdr1@juno.com>
To: <rhuberd@co.pierce.wa.us>, <dwrye@co.pierce.wa.us>
Date: 7/7/2008 8:01:17 AM
Subject: SWM's Recommended Lake Management Program

Roy and Dan,

Attached you find my comments, under DSEIS provisions, in regard to Surface Water Management's recommended Lake Water Quality Management Program, which is described in Appendix I of the Nisqually River Basin Plan.

Don

Click to for great deals on pitching machines and baseballs.
http://thirdpartyoffers.juno.com/TGL2141/fc/loyw6i3mj5anYTBz0NNrYNsFuTOUF0Hx6Y6orxf03OUKLJtbkuRLWO/

CC: <cindybeckett@comcast.net>, <clagettpark@earthlink.net>, <mpaulso@co.pierce.wa.us>, <mike.rhubright@ci.tacoma.wa.us>, <al_schmauder@hotmail.com>

PIERCE COUNTY'S RECOMMENDED LAKE MANAGEMENT PROGRAM

Preface

Currently Pierce County Water Program's Nisqually River Basin Plan is available for public review and comment. Contained within this Basin Plan is a recommended Lake Water Quality Management Program. My comments pertain to this Program and Surface Water Management's recommendation that the Pierce County Council adopt this Program as proposed.

The Recommended Plan and Likelihood of its Adoption by Council

Per Dan Wrye:

"The Nisqually Basin Plan contains a recommendation for a comprehensive lakes management program. That recommendation tries to answer the question 'what would a fully functional lakes program look like?' Its answer is based on a program of education, technical assistance, financial assistance, inspections, enforcement, monitoring, and coordination with Tacoma/Pierce County Health Department, Pierce Conservation District, and Surface Water Management. It also acknowledges that these three entities do not have sufficient funds to implement that program at this time."

Program Components

The recommended Program identifies the following components of a fully functional lake water quality management program:

1. Monitoring and [pollution] Source Identification
2. Volunteer Monitoring
3. Data Management and Dissemination
4. Education and Outreach
5. Community Technical Assistance
6. Inter-Agency Coordination and Information Sharing
7. Phased Implementation of the Aquatic Invasive Plant Program
8. Funding for Lake Projects
   a. Detailed Lake Studies
   b. In-lake control and management strategies
   c. Watershed strategies
   d. Provide funding for private projects
9. Enforcement
10. Legal Authority

It is recommended that the Program initially be developed and implemented for 16 lakes located in the Nisqually River Basin and eventually be expanded over a ten year period to apply to approximately 41 other lakes in unincorporated Pierce County. 10-1

Fully Funded Program Costs

Per Appendix I of the Nisqually River Basin Plan, pages I-27 and I-28:

It is estimated that Surface Water Management will require an additional 5 full time employees and $2,210,000 in supporting program budget per year. When combined, the total full time employee and supporting program budget for Surface Water Management Division will be $2,710,00 per year. Specific lake projects are projected to require an additional $2,125,000 per year in funding.

Commentary

It appears as if Surface Water Management (SWM) is recommending a Program to the Pierce County Council that they know will not be adopted. The balance of this paper presents an alternative lake water quality management program to that recommended in the Nisqually River Basin Plan. 10-2

The Nature of Lowland Lakes in Pierce County

The lowland lakes of Pierce County are vestiges of the last ice age. They were formed as large chunks of ice left behind by receding glaciers were surrounded by gravel deposited by subsequent major flooding events. When these chunks of ice melted they left depressions in the newly formed gravel flood plain surface. These depression contained groundwater with their surfaces reflective of the level of the local water table. Initially these lakes had clean gravel bottoms and clear water that was deficient in nutrients and therefore contained very little aquatic life. Over the eons nutrients (e.g., nitrates and phosphates) were conveyed to these lakes from their surroundings by atmospheric dry and wet precipitation falling on lake surfaces and inflowing surface and ground water. External loading is the term used to describe nutrient contributions to a lake from its watershed. Nutrient concentration increases, from external loading, eventually led to the establishment of relatively productive and stable ecosystems in the lowland lakes of the Puget Sound Basin.

The Impact of Human Activity on Pierce County's Lowland Lakes

The effect of the development activities of early white European settlers on Puget Sound Basin lowland lakes was to significantly increase external nutrient and sediment loading of these lakes. As nutrient and sediment loading increased so too did the population of aquatic life forms. Most aquatic plants draw their nourishment from nutrients contained in bottom sediments therefore the first lake response to increased external loading was a significant increase in native aquatic plant populations sometimes, to nuisance proportions. The second follow on response was invasion of these lakes by noxious forms of aquatic plants, which have, in many cases, displaced native aquatic plant populations.

Continual external loading of lakes and the resulting proliferation of aquatic life forms eventually resulted in the deposition and accumulation of a thick layer of nutrient rich bottom sediments. At some point in this process of bottom sediment buildup, organic matter decomposing bacteria began to deplete dissolved oxygen supplies. Depletion of oxygen in sediments causes previously unavailable stores of nutrients (particularly phosphorus) to be released into the overlying water column. This release of nutrients from sediments is referred to as internal loading. Once a lake begins to experience internal loading it becomes a self-perpetuating process as nutrients are continuously recycled within the lake itself. Internal loading results in a third response to nutrient enrichment, which is the proliferation of filamentous green algae and toxic forms of cyanobacteria (blue-greens).

Lake Studies

The stage of any lake's impairment as a result of external and internal loading is readily apparent to any observant lakeshore resident, recreation user, legislator or governmental agency personnel. There are few, and well known, causes of lake impairment. Initially the cause of impairment is nitrate, phosphate and silt (external) loading of a lake as a result of human activity in the lake's watershed, and at an advanced stage of impairment, phosphate releases from bottom sediments (internal loading). It doesn't take an expensive study by a consultant to determine the status of an impaired lake, nor the cause of its degradation.

Nutrient Sources and Mode of Transport

There are a number of sources of nutrients that enter lowland lakes located in the Puget Sound Basin. However two sources of nutrients have the most adverse effect on lakes in developing portions of Pierce County. These are septic system effluent and infiltrating stormwater runoff. Once septic system effluent and infiltrating stormwater runoff enters groundwater, the nutrients that they contain can be conveyed by groundwater flow to lakes located some considerable distance from the nutrient source. Nutrient laden groundwater discharging (external loading) into lakes fosters conditions favoring increases in aquatic plant, algae and cyanobacteria populations.

Surface water flow is a secondary means by which nutrients contained in septic system effluent, stormwater runoff, atmospheric deposition, fertilizers, animal wastes and silt can be conveyed to lakes (external loading). The low gradient and porous nature of Puget Sound Basin soils function to minimize the role that surface water flow plays in conveying nutrients and silt into lowland lakes.

In more seriously degraded lakes, nutrients (particularly phosphates) released from sediments (internal loading) can become the primary source of nutrients that enable

cyanobacteria to reproduce to (toxic) bloom proportions.

Puget Sound Lowland Lake Restoration Options

All options for the restoration of Puget Sound Basin lowland lakes are presented in a text titled Restoration and Management of Lakes and Reservoirs, Third Edition, by Cooke, Welch, Peterson and Nichols. Any reasonably well-educated citizen can acquire, read, and, as a result, assess the condition of "their" lake and make an intelligent choice regarding the appropriate action for its restoration. It doesn't require a consultant to tell lakeshore residents, recreational users, legislators or governmental agency personnel what their options are for restoring an impaired lake.

Agencies Involved In Lake Management Issues

To be successful any lake water quality management program will require the involvement and interagency coordination of and cooperation by the Puget Sound Partnership (PSP), Department of Ecology (DOE), Surface Water Management (SWM), Tacoma/Pierce County Health Department (TPCHD), Planning and Land Services (PALS), Department of Natural Resources (DNR), Department of Fish and Wildlife (WDFW), Pierce Conservation District (PCD) and citizens of the watershed. Unfortunately the track record of this happening is not particularly encouraging. 10-3

Citizens Role in Managing Lake Water Quality

The impetus for a lake water quality management program comes from citizens who live on the shores or are recreational users of Pierce County's many impaired lakes. Some of these citizens are already involved in lake water quality monitoring, are instrumental in advocating the restoration of their favorite lake's beneficial uses, and are frustrated by governmental agencies' apparent inability to do anything to effectively address this problem. They view Ecology as a deterrent to taking any action at all. They view TPCHD as doing little to prevent groundwater pollution from septic system effluent and consider the posting of toxic algae warning signs as a poor substitute for taking action to prevent nutrients contained in septic system effluent from polluting the groundwater that flows into lakes. They view SWM as either being unaware of, or unresponsive in regard to the impact that polluted stormwater runoff management practices are having on surface and groundwater quality and of the adverse impact that these practices are having on "their" lake.

The recommended SWM Lake Management Program does little to assuage citizens'concerns about legislators' and/or government agencies' inability (1) to remove the regulatory impediments that make it very difficult, time consuming and exceptionally expensive for anyone or entity to restore beneficial uses of impaired lakes, (2) to provide appropriate advice, counsel and support in their efforts to restore beneficial use of "their" lake, and (3) to undertake the requisite action [or provide citizens the funding, through 10-4

grants, so they can take action themselves] to restore "their" lakes' beneficial use.

In spite of these concerns many citizens stand ready to work with existing personnel from various agencies in a collaborative effort to restore their favorite lake, if they are only invited to do so. Unfortunately my experience is that most governmental agencies view citizen input as an irritant, rather than an invitation to engage in dialog and collaboration.

Ecology's Impediments to Citizen Action

On the one hand, Ecology is quick to point out that the activities of citizens living around or recreating in or on an impaired lake are the likely the cause of that lake's impairment. DOE cites lawn fertilizing, near lakeshore landscaping and inappropriate disposal of trash as contributing factors. [The truth of the matter is that these activities are relatively minor contributors to a lake's degradation.] Unfortunately this view leads to the conclusion that since these citizens are the cause of "their" lakes' impairment, and will benefit by its restoration, they should be the ones to plan, fund and implement its restoration.

On the other hand, Ecology is precluded by regulations from providing funding in the form of grants to individual citizens or lake associations. In spite of this fact DOE expects citizens/lake associations to (1) hire a consultant to determine the status and cause of "their" lake's impaired state, or determine its status and cause themselves, (2) hire a consultant to develop an integrated aquatic vegetation management plan [IAVMP] for "their" lake, or develop it themselves, (3) submit the IAVMP for approval by DOE, (4) apply for all other permits that may be required to work in the waters of the state, (5) provide the necessary funding for executing the DOE [and other agencies] approved restoration plan, and (6) contract with a DOE licensed pesticide applicator to actually execute the DOE approved restoration work.

Furthermore DOE considers that all such work done on an impaired (polluted) lake constitutes an act of pollution in itself and therefore must be done under the purview of DOE's NPDES permit. DOE has within its province the latitude to consider such work as restoration rather than an act of pollution. Regulatory requirements that govern restoration work are much less stringent. But DOE seldom applies its discretion to reduce the regulatory burden imposed upon those attempting to restore an impaired lake.

Agencies' Reluctance and/or Inability to Undertake Lake Restoration Work

Legislators and agency personnel frequently share DOE's view that lake shore residents and lake users actions are the cause of "their" lake's impairment and as the beneficiaries of restoration of its beneficial use should be the parties responsible for planning, funding and managing its restoration. This is a fallacious view. Lakes are important not only for their recreational use but also as recharge sources to groundwater from which most people in Pierce County obtain their drinking water. Toxic algae blooms not only are a public health hazard to lake residents and their pets, recreational users, livestock and wildlife, and degrade habitat for people and wildlife, they can also threaten the safety of

the groundwater upon which hundreds of thousands of people in Pierce County rely as their drinking water source.

Another fallacy commonly held is the notion that septic system effluent and the practice of infiltrating polluted stormwater via dry wells to underlying gravel soils, which contain regional aquifers, represents best management practice. Pollutants that are discharged to groundwater are transported long distances through the gravel soils of a glacial flood plain and can adversely affect water quality in lakes that are located some considerable distance from the points of their discharge into groundwater.

Governmental agencies are prone to claim that they are inadequately funded and staffed to perform the tasks that they are assigned to perform, thus many worthwhile programs are not undertaken, or are delayed. This may be true for some programs. However addressing lake water quality management issues need not be dependent upon the availability of additional funds and staffing additions for implementing an effective lakes water quality management program. The recommended lake management program relies more heavily on consultants and additional staff for its implementation than it does on citizen volunteers who can make a significant contribution in this regard at very little cost to agencies, require no staff additions and require little supervision. 10-5

The City of Lakewood's Lake Management Program

The City of Lakewood contracted with the Pierce Conservation District to establish and manage a lakes management program that involves the five lakes that are located within City of Lakewood limits. Water quality monitoring is done by citizen volunteers who are recruited, trained, equipped and supervised by one person (part time) from PCD. Water samples gathered by citizen volunteers following strict QC/QA procedures are analyzed once a month (May through October) by a DOE certified laboratory (Water Management Laboratories). The monitoring results are recorded, tabulated and made available to all interested parties. Total cost of this program to the City of Lakewood is approximately $12,000 per year. This program has been in effect now for nine years.

I, as a citizen volunteer working with the City, have written grant requests, which the City of Lakewood submitted in its own name to DOE. The City has received $100,000 in grant money as a result. A $50,000 grant was for treating Waughop Lake with calcium hydroxide to prevent or suppress toxic algae blooms during this summer in that lake. A second grant for $50,000 was obtained from DOE that enabled the City to hire a consultant (Herrera) to monitor and prepare a report on the results of Lake Steilacoom Improvement Club's application of calcium hydroxide this summer to prevent or suppress toxic algae blooms in that lake. The City has spent none of its own money on these two projects (matching funds for the Lake Steilacoom study where offset by the monies being spent by LSIC to treat the lake) and has made no additions to its staff to handle lake

monitoring or treatment activities taking place in Lakewood. I suggest that Pierce County consider emulating the effective and low cost approach to lake water quality management currently in effect in the City of Lakewood. 10-6

Potential Funding Sources

All parties discharging pollutants (nutrients) into surface or ground water should be paying an environmental mitigation fee to fund treatment of the lakes that are being adversely affected by discharge of these pollutants into surface and ground water. These would include septic tank owners, developers, owners of private infiltration ponds, agricultural and livestock operators, landfill operators, gravel mine operators and water purveyors, in so much as their withdrawal of groundwater diminishes the amount of water available to dilute pollutants entering groundwater.

It has been my observation that the TPCHD and SWM do not aggressively pursue grant money for restoration of impaired water bodies. They should be doing so.

Conclusion

In my opinion the recommended Lake Water Quality Management Program is being presented in the wrong context (i.e., in the Appendix of the Nisqually River Basin Plan, which addresses surface water management issues in a largely undeveloped portion of Pierce County), is off the mark (impaired lakes need "restoration" not "management"); is too expansive, too expensive, and its implementation schedule too slow to respond to a present public and environmental health threat problem; assures continuing employment opportunities for consultants; effectively precludes meaningful citizen volunteer involvement on an issue that is of great concern to them; and adds staff to existing bureaucracies that already have difficulty communicating with one another, coordinating their activities and effectively utilizing their existing resources. 10-7

I recommend that SWM come up with a more modest program that (1) advocates the removal of burdensome regulatory constraints that thwart rather than encourage and facilitate common sense restoration of beneficial uses of impaired lakes, (2) establishes a program to recruit, train, equip, and supervise citizen volunteers thus enabling them to monitor "their" lake, (3) facilitates [by providing funding and collaboration] lake studies and restoration activities that are carried out by citizens and lake associations on "their" lake, (4) encourages cooperation, collaboration and resource sharing with and between PSP, DOE, TPCHD, PALS, DNR, WDFW, and PCD so that action is taken, in a timely fashion and at reasonable cost, to restore full beneficial use of the many impaired lowland lakes located throughout Pierce County. 10-8

Don Russell
(7/6/08)

RESPONSE TO COMMENT LETTER 10:

10-1 As noted in Section 8 of Appendix I, SWM supports a phased implementation of the Lakes Management Program:

"The gap analysis identified the need for approximately 6.0 FTE and an additional $120,000 in supporting funding (aside from specific lake project funding needs) to implement a fully functional lake management program throughout unincorporated Pierce County… To implement these program components in just the Nisqually Basin, fewer resources would be required than for the County-wide program. It is estimated that 1.5 FTE and $25,000 in supporting funding could be used to start up the lake management program in the Nisqually Basin…
To support the phased implementation of the lake management program in the Nisqually Basin, it is recommended that 1.5 FTE and $25,000 in annual supporting funding be allocated through a programmatic measure to implement all components of the lake management program including monitoring and source identification, volunteer monitoring, education and outreach, and community technical assistance… It is recommended that an additional $100,000 of the capital project budget for the Nisqually Basin Plan be set aside annually to provide funding for implementing specific lake projects such as detailed lake studies, in-lake management activities, watershed strategies for improving lake water quality, and private projects such as septic system retrofits."

10-2 The Basin Plans include recommendations for projects and programmatic elements that are intended to serve the public by addressing needs related to flooding, water quality, and aquatic habitat.

As noted in Section 2 of Appendix I:

"Pierce County Public Works and Utilities, Water Programs Division (PCWP) [SWM] has identified the need to provide a fully functioning lake management program."

The comprehensive lakes management program described in the Nisqually Basin Plan is presented as a viable recommendation. As noted in Section 8 of Appendix I:
"Providing funding for implementing the lake management program in the Nisqually Basin will contribute significantly to the overall quality of watershed health in the basin and to meeting to goals of Pierce County for lake management."

10-3 The need for additional inter-agency coordination is discussed in Section 7.1.6 of Appendix I, "Inter-Agency Coordination and Information Sharing." The local agencies involved in management of surface water, water quality, and lakes have indicated that they desire greater inter-agency coordination; however they are limited by available staff resources. A fully functioning lake management program is estimated to require

an additional 0.1 FTE for SWM to provide inter-agency coordination and information sharing.

10-4 Pierce County SWM is committed to working together with citizens to improve watershed health. The Lake Management Program recognizes the need for additional technical assistance and education and outreach to citizens in Sections 7.1.4 and 7.1.5 of Appendix I, "Education and Outreach" and "Community Technical Assistance." A fully functioning program is estimated to require an additional 1.0 FTE to provide lake-focused education and outreach. This estimate includes 0.3 FTE for community technical assistance, discussed in program component 5, and 0.1 FTE for inter-agency coordination and information sharing, discussed in program component 6.

As noted in Section 7.1.5 of Appendix I:

"There is a need to provide a County staff person to answer questions on lake health and functions from property owners and recreational users. There is also a need to provide technical assistance to help lakeshore owners obtain grants for lake management activities, form lake management districts, and determine appropriate fees or rates."
Pierce County has very limited ability to impact state and federal agencies that require permitting and approvals for lake management activities. Through the Lake Management Program, Pierce County will seek to provide greater assistance to citizens to understand and complete the regulatory process and pursue funding for lake management activities.

10-5 SWM seeks to use its funds efficiently and effectively. Citizen volunteer involvement in monitoring and improving lake water quality is an important element in the Lake Management Program. The need for volunteer monitoring is discussed in Section 7.1.2 of Appendix I, "Volunteer Monitoring." Pierce Conservation District (PCD) was identified as an organization capable of coordinating a volunteer lake monitoring program because of its history of using volunteers in unincorporated Pierce County.

Citizen volunteer monitoring of lake conditions can provide valuable information on lake water quality and changing conditions, as well as serve as an educational experience. Citizen monitoring will require staff coordination and involvement in order to ensure high data quality needed for decision-making and to inform management activities. The results of citizen monitoring will also require data management and dissemination, as discussed in Section 7.1.3 of Appendix I.

As noted in Section 7.1.2 of Appendix I:

"Pierce Conservation District (PCD) currently coordinates volunteer lake monitoring programs for the cities of Bonney Lake and Lakewood. PCD does not currently have funding available to collect and test water samples from volunteers in unincorporated Pierce County…

There is a need to expand the volunteer monitoring of lakes performed in Pierce County. There is a need to recruit additional volunteers, train additional volunteers in lake monitoring techniques, collect and organize additional data from volunteers, collect samples from volunteers when appropriate, perform testing on samples, and work in conjunction with the staff in the monitoring program component to distribute the data to the public through a website. In addition, planning and implementation of volunteer outreach and volunteer appreciation activities will be needed…

A fully functioning program is estimated to require an additional 1.0 FTE to plan and implement the volunteer monitoring component of the lake management program. It is recommended that this staff position be added to PCD, increasing program efficiency by adding to the existing volunteer monitoring program at PCD. An increase in PCD funds will be necessary to complete this work…

An additional $35,000 per year in funding for the volunteer monitoring program will also be required to provide field equipment, travel costs, laboratory sample analysis, volunteer recruiting, volunteer appreciation, and other program elements. An increase in PCD funding for volunteer monitoring will be required to provide these supporting program costs."

As noted in Section 7.1.3 of Appendix I:

"Monitoring data needs to be organized and made accessible to other organizations and to the public. If additional monitoring is conducted through program components 1 and 2, data management and dissemination will be required as well.

There is a need to organize and make monitoring data and other program information accessible to other organizations and to the public, preferably through the web similar to the King County program. TPCHD will use a portion of the grant from Ecology for the toxic algae program to provide algae data on the web, but otherwise there are no current resources available for organizing and disseminating lake water quality monitoring data... A fully functioning program is estimated to require an additional 0.5 FTE to provide data management and dissemination as a part of the monitoring and source identification program component."

In addition to the valuable data provided by citizen volunteer monitoring, in some cases more detailed investigations are needed to understand complex lake functions such as water and nutrient budgets, stratification, and internal nutrient cycling. It is important to understand the cause and effect relationships for unique lake problems in order to develop effective and cost efficient management strategies. Not all lakes require detailed investigations, however it is important to plan ahead for the funding needs that are expected to arise in order to perform detailed lake studies and implement appropriate and targeted management activities once the causes of lake problems are

better understood. Section 7.1.8 in Appendix I describes the expected need for funding for lake projects, including detailed lake studies, in-lake control and management strategies, watershed strategies to improve lake health, and funding for private projects to improve lake health.

As noted in Section 7.1.8 in Appendix I:

"The need for detailed lake studies and specific capital projects to address problems in lakes is not yet known. These needs will be identified as the Lake Management Program is implemented, monitoring data results are analyzed, and community requests for action are received. However, once these needs are identified there is limited funding available for conducting detailed lake studies and implementing capital projects or programmatic actions to address problems in lakes. The recommended lake management program includes annual budget requests to implement specific projects once the needs for the projects are known. It is estimated that the cost of specific lakes projects could range from $200,000 to $1,000,000."

10-6 As discussed above in response to Response 10-5, citizen volunteer involvement in monitoring and improving lake water quality is an important element in the Lake Management Program. Elements of a volunteer monitoring program similar to that currently used by the City of Lakewood are included in the Lake Management Program. The need for volunteer monitoring is discussed in Section 7.1.2 of Appendix I, "Volunteer Monitoring." Unincorporated Pierce County encompasses a far larger area than the City of Lakewood, and the surface water management responsibilities and opportunities in Pierce County are different in scale and scope than those of the City of Lakewood. The Lake Management Program recommended in the Nisqually Basin Plan is intended to be a comprehensive program that addresses multiple needs, including monitoring and source identification, data management and dissemination, education and outreach, community technical assistance, inter-agency coordination, implementation of the aquatic invasive plant program, and funding for lake projects.

10-7 As discussed in response to Response 10-6, the Lake Management Program recommended in the Nisqually Basin Plan is intended to be a comprehensive program that addresses multiple needs, including monitoring and source identification, data management and dissemination, education and outreach, community technical assistance, inter-agency coordination, implementation of the aquatic invasive plant program, and funding for lake projects. As discussed in response to Response 1, the recommendation is for a phased approach to implementing the Lake Management Program in order to begin work as soon as possible to expand SWM's capacity to address lake management issues. The Lake Management Program is intended to provide greater opportunities for citizen volunteer involvement in lake management activities, as described in Sections 7.1.2, 7.1.4, and 7.1.5 of Appendix I. Based on the analysis of current lake management activities provided by SWM, PCD, and other agencies in Section 6, additional staff resources will be required in order to implement any additional lake management activities.

10-8 Thank you for your recommendation to implement a "more modest program." The lakes program recommended in the Basin Plan (a) is based on a "fully functioning program" (i.e., contains all necessary elements), and (b) is intended to be "phased in" over time (i.e., not fully implemented all at once.)

The extent, size, and application of any lakes program will be determined by the amount of support and funding decisions by the County Executive and Council. It may be that a "fully functioning program" as recommended by the plan, a "more modest program" recommended by the commenter, some other program, or no program at all. Again, these decisions will be made by the County Executive and Council.

COMMENTS FROM PUBLIC MEETINGS

NAME: Roy R. Huberd [note taker]

June 18, 2008

Public Meeting 6:30 - 8:30 p.m. at Weyerhaeuser Elementary School

Q1: Is the draft document (Nisqually Basin Plan) on the County web site and can it be downloaded?

Q2: What causes phosphorus problems in lakes?

Q3: Has there been a study to consider sewers for Ohop Lake problems?

Q4: What was the origin of the Lakes Management Chapter?

Q5: Who deals with toxic algae issues in lakes?

A6: Grandfathering property regulation does not help the quality of life on the lake.

RESPONSES

Q1. Yes. The draft basin plan is available for download from the County web site.

Q2. Too much phosphorus in a lake can trigger algal blooms that can cause a range of adverse impacts. Excessive algal populations can adversely affect dissolved oxygen, pH, and water clarity. Some types of algae can release toxic compounds. A variety of human activities can increase the amount of phosphorus entering a lake. Examples include fertilizer use, erosion from construction sites, and leakage from shoreline septic systems.

Q3. The Basin Plan did not include an evaluation of sewering the Ohop lake area. The Basin Plan is intended to serve as the work plan for Pierce County Surface Water Management (SWM). SWM does not have authority over wastewater treatment systems. Tacoma-Pierce County Health Department (TPCHD) regulates on-site wastewater treatment systems. During basin plan development, SWM coordinated with TPCHD with regard to failing on-site systems, with particular emphasis on systems located in shoreline areas.

Q4. The Lakes Management evaluation was suggested by the County Executive and members of the County Council.

Q5. TPCHD is the lead agency for issues related to toxic algae blooms.

NAME: Rick Adams, Gayle Adams

ADDRESS: P.O. Box 3, Elbe, WA 98330

PHONE: (360) 569-2772

June 18, 2008

Public Meeting 6:30 - 8:30 p.m. at Weyerhaeuser Elementary School

Q1: Both Rick and Gayle Adams asked if the County could or would address the problem of State Road 706 in the community of Elbe. They stated runoff from the mountains runs down a county road and cannot pass under SR 706, thus causing pooling and road hazards and road closures. They also included statements that the County road ditches and drain tiles could not hold runoff, prior to reaching SR 706.

Q2: What is the County doing about maintenance of private property ditches?

Q3: Can this plan deal with Alder Reservoir sediment buildup issues?

Q4: Are we aware of the future problems related to flooding of Elbe because the levee begun by the City of Tacoma has not been completed?

RESPONSES

Q1.The Basin Plan has been updated to address this issue. Please refer to the response to Common Response 2 above.

Q2. Pierce County generally does not maintain privately-owned ditches.

Q3. The Basin Plan is intended to serve as the work program for Pierce County Surface Water Management (SWM). The Basin Plan does not address sediment build-up in Alder reservoir because the reservoir is owned and operated by Tacoma Public Utilities under a federal license.

Q4. SWM has not performed any detailed evaluations of bank revetments or levees constructed by Tacoma Public Utilities (City of Tacoma). Investigations conducted during the basin planning effort bank revetments in the vicinity of Elbe are maintained by Tacoma Public Utilities in association with Alder Lake and the operation of the Nisqually Hydroelectric Project. Pierce County SWM staff discussed reservoir issues with Tacoma Public Utilities staff during development of the Basin Plan. The Basin Plan does not address these issues because the lake operations and revetments are outside of the County's jurisdiction. However, Pierce County will forward these comments to Tacoma Public Utilities.

NISQUALLY BASIN PLAN

QUESTIONS AND COMMENTS

NAME: Roy R. Huberd [note taker]

June 19, 2008

Public Meeting 6:30 - 8:30 p.m. in Eatonville

Q1: Does coordination between surface water management and the transportation sections of public works happen?

Q2: Can you tell us more about the channel migration zone committee being formed?

Q3: Whitman Lake level is changing due to beaver activity. Can anything be done?

Q4: Water quality is an issue at Whitman Lake. Can anything be done? Blue-green algae seems to be the problem.

RESPONSES

Q1. Yes. Pierce County Roads staff was involved in the development of the Basin Plan. A number of the problems investigated during plan preparation are located within County road rights-of-way. SWM worked with the Roads staff to identify appropriate solutions.

Q2. Please refer to the response to Common Response 1-A above.

Q3. Beaver activity is an issue at a number of locations within the planning area, in addition to Whitman Lake. The draft Basin Plan includes a new beaver management policy to help address this issue. The beaver management policy (PRG00-11) is described in Section 9.3.3 of the plan.

Q4. Water quality is a concern for a number of lakes within the planning area, in addition to Whitman Lake. The draft Basin Plan includes a new lake management program to help address algae and other lake water quality issues. The lake management program (PRG00-15) is described in Section 9.3.3 of the plan.

NAME: **Floyd Cochran**

ADDRESS: **P. O. Box 287, Elbe, WA 98330**

June 19, 2008

Public Meeting 6:30 - 8:30 p.m. at Eatonville

Mr. Cochran handed out news stories titled:

"Secrecy in sludge spraying"

"I now believe in the Eastern (sic) Bunny"

"A bipartisan leader working to protect our environment"

"Campers love Tacoma Power Parks, Why"

"Don't swim at Spanaway Lake Park"

"Drugs in water could affect human cells"

"Food allergies"

"Letter from Mr. Cochran to Paula O. White"

"County farmers get 87 sludge-spray permits"

"Initiative Measure 297"

"E. coli fouls Spanaway water"

"Skookum River issues"

"List of certified mailing receipts"

Q1: What action would Pierce County take concerning flooding of I-5 at Chehalis, Washington.

Q2: What action would Pierce County take concerning flooding of the Skookumchuck River.

RESPONSES

Q1. The Basin Plan is for the portion of the Nisqually Basin within Pierce County's jurisdiction. The plan does not address flooding near I-5 in Lewis County.

Q2. The Basin Plan does not address flooding of the Skookumchuck River because it is outside of the basin planning area.

NAME: Jack Gillette

ADDRESS: 6010 - 260th Street East, Graham, WA 98338

PHONE: (253) 847-1626

June 19, 2008

Public Meeting 6:30 - 8:30 p.m. at Eatonville

Q1: Can anything be done about flooding on Dean Kreger Road, about one mile down from mountain highway? County road crews do clean the ditches but the road still floods over in the winter. There are two existing culverts, an 8-inch and a 12-inch, about 700 feet apart, located between 408th Street East and 38th Avenue East. The 12-inch culvert spills and is washing out soil and road base. There exists a 6- to 8-foot drop into a pool.

RESPONSE

Q1. The Basin Plan has been updated to address this issue. A new capital improvement project recommendation for Dean Kreger Road has been added to Chapter 9.

NAME: Floyd Cochran

ADDRESS: P. O. Box 287, Elbe, WA 98330

June 27, 2008

Public Meeting

Q1: Mr. Cochran requested floodplain mapping and CMZ mapping information for his property located along the right bank of the Nisqually River.

Q2: He also wanted to know about development regulations which pertain to floodplains and CMZ.

RESPONSES

Q1. Please refer to the response to Common Response 1-A above.

Q2. Please refer to the response to Common Response 1-A above.

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NISQUALLY RIVER BASIN PLAN FSEIS DISTRIBUTION LIST

Centralia, City of
City Light Department
1100 North Tower
Centralia, WA 98531

DuPont, City of
303 Barksdale Avenue
DuPont, WA 98327

Eatonville, Town of
201 Center Street West
P.O. Box 309
Eatonville, WA 98328

Ms. Deborah Johnston
Fort Lewis
Fort Lewis, WA 98433

Lewis County
360 NW North Street, MS: ASR01
Chehalis, WA 98532

Mount Rainier National Park
55210 238th Avenue East
Ashford, WA 98304

Nisqually Indian Tribe
Attn: George Walker
4820 She-Nah-Num Drive
Olympia, WA 98513

Nisqually Land Trust
701 Prairie Park Lane E, Suite D
P.O. Box 1148
Yelm, WA 98597

Nisqually National Wildlife Refuge
100 Brown Farm Road
Olympia, WA 98516

Nisqually River Council
Attn: Justin Hall
12501 Yelm Hwy SE
Olympia, WA 98513

Pierce Conservation District
5430 66th Avenue East
P.O. Box 1057
Puyallup, WA 98371

Pierce County Council
County City Building
Tacoma, WA

Pierce County Library
- Graham Branch
- DuPont Branch
- Eatonville Branch

Pierce County Planning and Land Services
Attn: Adonais Clark/Kim Freeman
2401 South 35th Street
Tacoma, WA 98409

Pierce County Planning Commission
Attn: Toni Fairbanks
2401 South 35th Street
Tacoma, WA 98409

Pierce County Surface Water
Management Advisory Board
Attn: Dave Seabrook
6601 E Grandview Ave
Tacoma, WA 98404

Pierce County Transportation Services
2702 South 42nd Street
Suite 201
Tacoma, WA 98409-7322

Pierce County Water Programs

Pierce County Environmental Services
9850 64th Street West
University Place, WA 98467-1078

Puget Sound Partnership
Attn: Martha Newman
PO Box 40900
Olympia, WA 98504

Roy, City of
216 McNaught St
PO Box 700
Roy, WA 98580

Tacoma Public Utilities
3628 South 35th Street
Tacoma, WA 98409

Tacoma-Pierce County Health Department
Attn: Ray Hanowell
3629 South D Street
Tacoma, WA 98418-6813

Tanwax Citizens Group
http://www.tanwaxcreek.org/

Thurston County
2000 Lakeridge Dr SW
Olympia, WA 98504-6045

Thurston Shellfish Committee
Building 1
2000 Lakeridge Dr SW
Olympia, WA 98504-6045

University of Washington Pack Forest
9010 453rd Street East
Eatonville, WA 98328

Upper Nisqually Land Use Advisory Commission
2401 South 35th Street
Tacoma, WA 98409

Washington State Department of Ecology
Attn: Cindy James
P.O. Box 47600
Olympia, WA 98504-7600

Washington Department of Natural Resources
P.O. Box 47000
1111 Washington Street SE
Olympia, WA 98504-7000

Washington State Department
of Fish and Wildlife
Attn: Gina Piazza
502 High Street, Suite 112
Port Orchard, WA 98366

Washington State Parks and
Recreation Commission
7150 Cleanwater Drive S.W.
P.O. Box 42650
Olympia, WA 98504-2650
Kathy Hatcher
PO Box 8
56916 384 Ave. Ct.E.)
Ashford, Wa. 98304

Andrew Carey
Serendipity Consulting
38419 570th St.Ct.East
Ashford, Wa. 98304

Donald J.Russell
7746 Walnut Ave.
Lakewood Wa. 98498

Burke Garrett
Media Consultants
P.O. Box 179
Ashford, Wa.98304

Mary L. Foster
P.O. Box 179
30926 Mount Tahoma Canyon Road
Ashford, Wa. 98304

Susan Griswold
Postmaster
Elbe Wa. 98330

Julie Clark and Rick W. Adams
Elbe Water and Sewer District
P.O. Box 4

Elbe, Wa. 98330

Floyd Cochron
P.O.Box 281
Elbe Wa. 98330

Jack Gillette
6010 260 St. East
Graham Wa. 98338