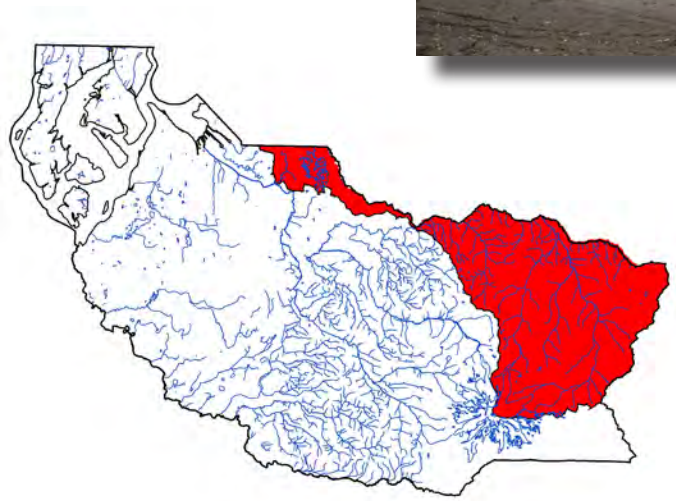
White River Basin Plan

VOLUME I - BASIN PLAN



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Pierce County
Public Works and Utilities
Surface Water Management

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APPENDICES (Volume II)

ABBREVIATIONS

1991 Plan	*Pierce County Storm Drainage and Surface Water Management Plan* (1991)
Alliance	Cascade Water Alliance
amsl	above mean sea level
ATV	all-terrain vehicle
Basin Plan	White River Basin Plan *(this document)*
B-IBI	Benthic Index of Biological Integrity
BMP	best management practice
CFR	Code of Federal Regulations
cfs	cubic feet per second
cfu	colony forming unit
CH_4	methane
CIP	Capital Improvement Program
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
Comprehensive Plan	*Pierce County Comprehensive Plan (1995)*
Corps	U.S. Army Corps of Engineers
CRS	Community Rating System
CWA	Clean Water Act
CWQMP	*Countywide Water Quality Monitoring Plan*
DAHP	Washington State Department of Archaeology and Historic Preservation
DEM	Digital Elevation Model
DNA	deoxyribonucleic acid
DNR	Washington State Department of Natural Resources
DO	dissolved oxygen
DPS	distinct population segment
DSEIS	Draft Supplemental Environmental Impact Statement
EA	environmental assessment
Ecology	Washington Department of Ecology

EDT	Ecosystem Diagnosis and Treatment
EIS	environmental impact statement
ELS	Early Life Stages
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESHB	Engrossed Substitute House Bill (Washington State)
ESU	evolutionarily significant unit
°F	degrees Fahrenheit
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FIRM	flood insurance rate map
FONSI	finding of no significant impact
GHG	greenhouse gas
FTE	full-time equivalent
GIS	geographic information system
GMA	Washington State Growth Management Act
GPS	global positioning system
HB	House Bill (Washington State)
HFC	hydrofluorocarbon
HPA	Hydraulic Project Approval
I-5	Interstate 5
IAVMP	Integrated Aquatic Vegetation Management Plan
L	liter
LFA	limiting factors analysis
LID	low-impact development
LOS	level of service
LWD	large woody debris
MIT	Muckleshoot Indian Tribe
MITFD	Muckleshoot Indian Tribe Fisheries Division
MS4	Municipal Separate Storm Sewer System
N/A	not applicable

NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NMFS	National Marine Fisheries Service
N_2O	nitrous oxide
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Polluant Discharge Elimination System
NRCS	National Resource Conservation Service
PALS	Pierce County Planning and Land Services
PCC	Pierce County Code
PCD	Pierce Conservation District
PFC	perfluorocarbon
PHS	Priority Habitats and Species
PRWC	Puyallup River Watershed Council
PSE	Puget Sound Energy
PSRC	Puget Sound Regional Council
PTI	Puyallup Tribe of Indians
PVC	polyvinyl chloride
RCW	Revised Code of Washington
REO	Regional Ecosystem Office
RM	river mile
ROE	Report of Exam
SDWA	Safe Drinking Water Act
SEPA	State Environmental Policy Act
SF_6	sulfur hexafluoride
SFHA	special flood hazard area
SMA	Shoreline Management Act
SMP	Shoreline Master Program
SOC	Species of Concern
SR	State Route
SRS	Service Response System
SWAB	Surface Water Management Advisory Board

SWM	Surface Water Management Division, Pierce County Public Works
SWM Manual	*Stormwater Management and Site Development Manual (2008)*
SWMP	Stormwater Management Plan
TDP	total dissolved phosphorus
TDS	total dissolved solids
TFWA	Timber, Fish, and Wildlife Agreement
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TP	total phosphorus
TPCHD	Tacoma-Pierce County Health Department
TPH	total petroleum hydrocarbons
TSS	total suspended solids
UGA	urban growth area
UPWC	Upper Puyallup Watershed Characterization
URS	URS Consultants
USBEM	Urban Stream Baseline Evaluation Method
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WCC	Washington Conservation Commission
WF	West Fork
WQMU	water quality management unit
WDFW	Washington Department of Fish and Wildlife
WR	White River
WRIA	watershed resource inventory area
WRMA	White River Management Agreement
WSDOT	Washington State Department of Transportation
WSP	water supply project
μg/L	micrograms per liter
μS/cm	microSiemens per centimeter

EXECUTIVE SUMMARY

ES.1 INTRODUCTION

The White River Basin Plan (Basin Plan) serves as a comprehensive guide to storm drainage and surface water management in the portions of the White River Basin that are under Pierce County's jurisdiction. The report was prepared by Pierce County Public Works and Utilities Surface Water Management (SWM), which is responsible for surface water management in unincorporated Pierce County.

SWM prepares basin plans to identify and prioritize capital improvement projects and other SWM activities in individual drainage basins. Basin plans address the stormwater drainage and flooding, water quality, and aquatic/riparian habitat aspects of surface water management in the major stream systems of the non-federal lands within unincorporated Pierce County. SWM uses the basin plans to develop its capital improvement, maintenance, repair, property acquisition, and program schedules and budgets.

SWM's basin planning process has three phases. **Phase 1** involves basin characterization, with a primary focus on identifying key problem areas and data gaps that will need to be addressed in Phase 2. **Phase 2** is the plan development and adoption phase. It builds on the findings of Phase 1 by filling information gaps, correcting information, performing hydrologic analyses based on planned future conditions, investigating problems, identifying alternatives, and developing recommendations. **Phase 3** involves plan implementation, monitoring, and updating. This Basin Plan documents the results of Phases 1 and 2 in the White River Basin planning process.

ES.2 GOALS AND OBJECTIVES

Before embarking on the basin planning process, SWM prepared a basin planning guidance document to promote consistency among the basin plans. The goals and objectives for the Basin Plan, listed in Table ES-1, are derived from the SWM 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 SWM's other basin plans.

Table ES-1
Goals and Objectives of the White 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	• Number of stream miles available for wild, native fish populations is increased

aquatic/riparian habitat	• Population numbers of species listed as endangered or threatened under the ESA are maintained or increased • Quality and quantity of available wetlands, riparian and uplands habitat is improved
Improve water quality	• State Surface Water Quality Standards (WAC 173-201a) are met • Number of impaired (303[d] 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 is reduced • Project value is favorable when measured in terms of costs and benefits • Polls demonstrate that public awareness of flooding, aquatic/riparian 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	• New development in flood-prone, riparian, or significant habitat areas is prohibited • Low-impact development techniques are widely used • Effective best management practices are identified and widely used

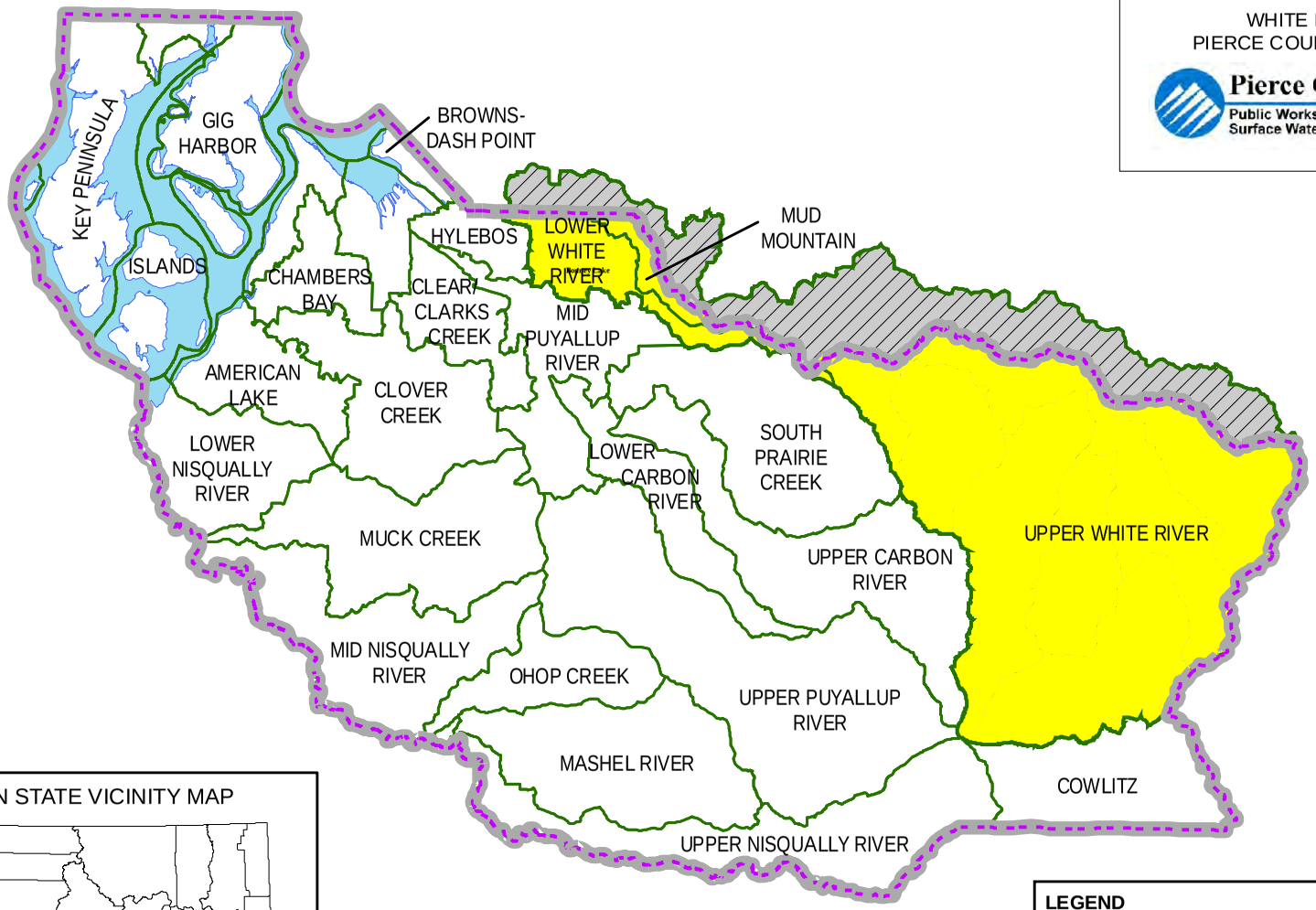
ES.3 WHITE RIVER BASIN

The White River Basin planning area comprises the Upper White River, Lower White River, and Mud Mountain Basins. These basins, which are collectively referred to as the White River Basin (see Figure ES-1), encompass approximately 496 square miles. Approximately 75 percent of the White River Basin is within Pierce County; the remainder is in King County.

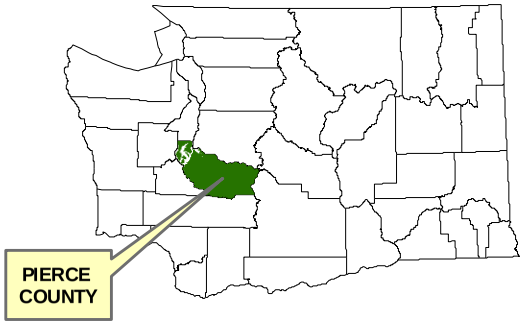
Figure ES-1
WHITE RIVER BASIN PLAN

WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON

Pierce County
Public Works and Utilities
Surface Water Management



WASHINGTON STATE VICINITY MAP



50,000 25,000 0 50,000 Feet

1 inch equals 50,000 feet

N W E S

LEGEND

- County Boundary
- Pierce County Basins
- Puget Sound
- White River Basin (Inside County)
- White River Basin (Outside County)

The basin planning area encompasses approximately 34 square miles of the 496 square mile White River watershed. Figure ES-2 shows the White River Basin planning area. The planning area does not include the entire White River watershed, because (1) the primary focus is on the unincorporated, non-federal portions of the watershed that are under Pierce County's jurisdiction, and (2) SWM is developing a separate plan (*Pierce County Rivers Flood Hazard Management Plan*) for portions of the White River and Greenwater River (a tributary to the White River) mainstems. The *Pierce County Rivers Flood Hazard Management Plan* will guide river management to reduce damages from floods while enhancing important fisheries resources. Since the *Pierce County Rivers Flood Hazard Management Plan* covers portions of the lower and upper White River and the Greenwater River (see Section 2.4.4) problems within these reaches are not addressed in this Basin Plan. In addition, much of the upper basin lies within national forest lands or Mount Rainier National Park. Therefore, the focus of this Basin Plan is on the Lower White River and Mud Mountain Basins.

The Basin Plan describes the key stakeholders and regulatory issues related to surface water management in the basin as well as the physical characteristics of the basin. The report describes the hydrology, water quality, topography, geology, and soils; existing and planned land uses; aquatic/riparian habitat conditions; and existing surface water management facilities in the basin. The Basin Plan also documents the stormwater drainage and flooding, water quality, and aquatic/riparian habitat problems in the planning area. These conditions and problems were identified based on a wide variety of data sources, including:

- Pierce County GIS data (e.g., topography, hydrography, land use)
- Pierce County Service Response Summary database
- Aquatic/riparian habitat and water quality data collected by Pierce County and its consultants
- Questionnaires completed by landowners in the planning area
- Input provided at public meetings
- Reports published by Pierce County, the Muckleshoot Indian Tribe, Puyallup Tribe of Indians, U.S. Geological Survey, Washington State Department of Ecology (Ecology), Federal Emergency Management Agency, and other sources
- Field investigations to assess potential problem areas.

The following section summarizes the stormwater drainage and flooding, water quality, and aquatic/riparian habitat problems, analysis, and recommendations.

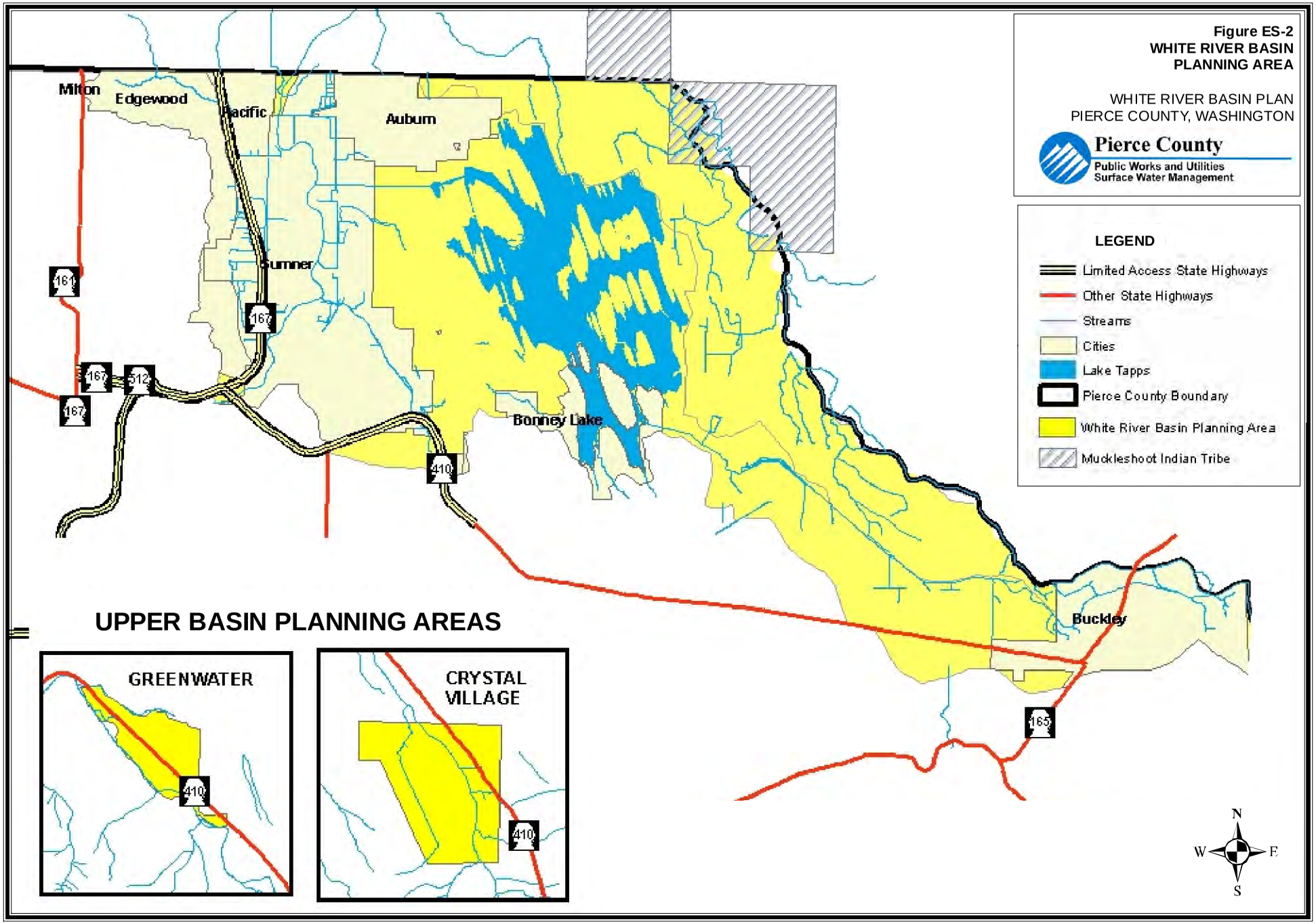


Figure ES-2
WHITE RIVER BASIN
PLANNING AREA
WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON
Pierce County
Public Works and Utilities
Surface Water Management
LEGEND
Limited Access State Highways
Other State Highways
Streams
Cities
Lake Tapps
Pierce County Boundary
White River Basin Planning Area
Muckleshoot Indian Tribe
Milton
Edgewood
Pacific
Auburn
Sumner
Bonney Lake
Buckley
161
167
512
410
165
UPPER BASIN PLANNING AREAS
GREENWATER
CRYSTAL
VILLAGE
N
W
E
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ES.4 PROBLEMS, ANALYSIS, AND RECOMMENDATIONS

Many of the streams in the Lower White River Basin are within the incorporated cities of Sumner and Auburn as well as King County. Most of the streams in the Upper White River Basin are within federal lands or commercial forest lands. There are opportunities for Pierce County to work in partnership with these other jurisdictions to address water resources issues in the basin. Problem analyses and Basin Plan recommendations, however, are only for the unincorporated areas of Pierce County.

The problems identified through a series of investigations were grouped into three general categories for analysis and development of recommendations: stormwater drainage and flooding, water quality, and aquatic/riparian habitat. A brief summary of the problems and recommendations for each of these categories is provided below.

ES.4.1 Flooding and Drainage Problems, Analysis, and Recommendations

Flooding and drainage problems were categorized into two general types of flooding: riverine and stormwater (minor stormwater drainage failures and roadway/driveway flooding).

Riverine Flooding

Flooding in the Lower White River Basin is a natural phenomenon that has been mitigated by means of engineered structures (dams and levees), including Mud Mountain Dam. Under the original water control plan, channel capacity of the White River downstream of Mud Mountain Dam was estimated to be at least 20,000 cubic feet per second. However, flooding has occurred downstream of the dam at discharges well below the original estimated channel capacity. The reduced flood capacity of the river was attributed to multiple factors including encroachment of development along the channel, channel aggradation, and limitations on channel dredging (U.S. Army Corps of Engineers, 2002).

Flood hazard reduction for the White River Basin focused on the floodplain property acquisition program. A capital improvement project to acquire property in the 100-year floodplain of the bypass reach of the lower White River is recommended. Acquiring and maintaining undeveloped properties preserves flood storage, preserves natural hydrology, and reduces the potential for future flood damages.

SWM maintains a system of flood control levees along the White River. Six potential levee setback sites were identified along the lower White River (GeoEngineers, 2007). Setting back existing levees to sites farther away from the river provides an opportunity to increase flood storage capacity of the river, potentially reducing downstream effects of flooding. All six sites are along portions of the White River mainstem covered by the *Pierce County Rivers Flood Hazard Management Plan*, and are therefore not addressed in this Basin Plan.

Stormwater Flooding

Stormwater or local flooding is addressed through routine maintenance, responses to citizen complaints, and, if necessary, capital projects to provide increased conveyance capacity (e.g., culvert replacement) or enhanced detention storage. Reported stormwater flooding problems in the White River Basin planning area consist of minor roadway/driveway flooding. After problem sites were visited, the problems were screened and separated for analysis. Most problems were eliminated from further analysis because they were considered maintenance issues, located on private property or private roads, located in incorporated areas, or because additional information was required.

One capital improvement project has been recommended to address a local roadway flooding issue at 185th Ave. E. Another capital improvement project has been recommended to address a local flooding problem in Crystal River Ranch Estates near Greenwater. The project involves replacing 18 to 20 undersized driveway culverts to reduce flooding on the roadway and private property.

Programmatic measures recommended in the Basin Plan that will address flooding issues include:

- Low Impact Development Program
- Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation
- Education, Outreach, and Technical Assistance Program
- Best Management Practices Manual for Pierce County Surface Water Management Maintenance Activities
- Beaver Management Policy.

ES.4.2 Water Quality Problems, Analysis, and Recommendations

Ecology has identified several water bodies within the White River Basin as “polluted.” The most common water quality problem is elevated water temperature, which is common for streams draining urban areas. To address water quality problems, the Basin Plan prescribes a number of programmatic measures, including:

- Program to Enhance Degraded Riparian Habitat and Water Quality
- Education, Outreach, and Technical Assistance Program
- Lakes Water Quality Management Program
- Coordinate with Tacoma-Pierce County Health Department to Address Reported Onsite Sewer System Problems.

In addition to improving the water quality of polluted streams, the Basin Plan also recommends focusing on protecting the water quality of Lake Tapps (see Section 7.3). Programmatic measures to address potential future Lake Tapps water quality problems consist of developing a

water quality monitoring program (in coordination with the Cascade Water Alliance) and a pollutant source identification program.

ES.4.3 Aquatic/Riparian Habitat Problems, Analysis, and Recommendations

In general the lower White River mainstem has fair aquatic/riparian habitat. To prevent further degradation of aquatic/riparian habitat, the Basin Plan recommends a capital improvement project to acquire property along the riparian corridor of the bypass reach, from the Lake Tapps diversion to its outlet. Several potential restoration sites were identified along the reach of the White River that will be covered by the *Pierce County Rivers Flood Hazard Management Plan*.

Aquatic/riparian problems identified on other water bodies in the planning area include channelization, low flow, invasive vegetation, potential nutrient loading, and sedimentation. These problems can be addressed using programmatic measures that benefit existing aquatic/riparian 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. Programmatic measures recommended to improve and preserve aquatic/riparian habitat include:

- Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation
- Program to Enhance Degraded Riparian Habitat and Water Quality
- Invasive Species Management Program
- Habitat Monitoring Program
- Education, Outreach, and Technical Assistance Program.

ES.5 BASIN PLAN SUMMARY

The Basin Plan contains three (3) capital improvement projects, 18 programmatic measures, and two (2) studies to address stormwater drainage and flooding, water quality, and aquatic/riparian 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"[1] groups. Studies were not prioritized with the capital improvement projects and the programmatic measures.

Estimated costs of the recommendations by priority group over the 10-year implementation period are as follows:

[1] "Low-Priority" does not mean "not a priority." "No-Priority" actions have already been excluded from this Basin Plan. Rather, "Low-Priority" means that 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.

- "High-Priority" recommendations: $389,000
- "Medium-Priority" recommendations: $4,567,950
- "Low-Priority" recommendations: $1,196,400.

In addition, two studies to fill information gaps totaling $170,500 have been identified. Table ES-2 presents the estimated costs of the Basin Plan recommendations by project type and priority group. Table ES-3, Table ES-4, and Table ES-5 list the capital improvement projects and programmatic measures in each priority group. Table ES-6 lists the recommended studies.

Table ES-2
Estimated Costs of Plan Recommendations

Project Type	High-Priority	Medium-Priority	Low-Priority
Capital improvement projects	-	$2,000,000	$619,700
Programmatic measures	$389,000	$2,567,950	$576,700
Studies	$170,500		
Total estimated cost	**$6,323,850**		

Table ES-3
High-Priority Recommended Projects

ID Code	Project Title	Rating Score	Estimated Cost
PRG00-02	Update Stormwater Management Manual	385	$2,000
PRG00-08	BMP Manual for Pierce County Surface Water Management Maintenance Activities	401	$11,000
PRG00-04	Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation	367	$14,000
PRG00-06	Education, Outreach, and Technical Assistance Program	402	$52,000
PRG00-03	Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit	380	$310,000
		Total estimated cost	**$389,000**

Table ES-4
Medium-Priority Recommended Projects

ID Code	Project Title	Rating Score	Estimated Cost
PRG00-09	Invasive Species Management Program	338	$11,000
PRG00-11	Enhance Cooperation with Cities and Other Agencies	211	$90,000
PRG15-04	Enhance Puyallup River Watershed Council's Capacity	285	$93,750
PRG00-01	Low-Impact Development Program	277	$116,000
PRG00-05	Program to Enhance Degraded Riparian Habitat and Water Quality	309	$169,000
PRG00-14	Vegetation Management Program	343	$209,000
PRG00-07	Surface Water Monitoring Program	235	$240,000
PRG15-02	Lake Tapps Pollutant Source Identification and Monitoring Program	238	$359,200
PRG00-12	Lakes Water Quality Management Program	335	$1,280,000
CIP15-LWR-AC01	Acquire Property Adjacent to White River for Floodplain Preservation and Water Quality Protection	207	$2,000,000
		Total estimated cost	**$4,567,950**

Table ES-5
Low-Priority Recommended Projects

ID Code	Project Title	Rating Score	Estimated Cost
PRG00-10	Beaver Management Policy	174	$700
PRG00-13	Habitat Monitoring Program	203	$12,000
PRG15-03	Coordinate with Tacoma Pierce County Health Department to Address Reported Onsite Sewer System Problems	206	$116,000
CIP15-TAP-C01	185th Avenue East Drainage Improvements	68	$190,000
CIP21-UWR-C01	Crystal River Ranch Estates Drainage Improvements	159	$429,700
PRG15-01	Coordinate with the Cascade Water Alliance to Develop a Lake Tapps Water Quality Monitoring Plan	204	$448,000
		Total estimated cost	**$1,196,400**

Table ES-6
Studies and Costs

ID Code	Study Title	Estimated Cost
ST15-TAP-ST01	Lake Tapps Diversion Canal Stormwater Outfall Assessment	$50,000
ST15-TAP-ST02	White River Water Quality Assessment for Fecal Coliform, Temperature, pH, and In-stream Flow	$120,500
	Total estimated cost	**$170,500**

CHAPTER ONE INTRODUCTION

The Surface Water Management Division (SWM) of Pierce County Public Works and Utilities is responsible for surface water management in unincorporated Pierce County. In carrying out this responsibility, SWM plans, designs, secures permits for, builds, and maintains storm drainage and surface water management facilities. SWM also identifies nonstructural solutions to surface water problems such as monitoring needs, aquatic habitat enhancement, water quality improvement activities, enforcement, regulatory changes, and other services. Related responsibilities include compliance with the requirements of the federal Clean Water Act, the County's Stormwater National Pollutant Discharge Elimination System (NPDES) permit, the federal Endangered Species Act, and the State Water Pollution Control Act. Other related responsibilities consist of river levee maintenance, stream gaging, water quality monitoring, gathering of rainfall data, and emergency response during floods and public information. Fees paid by property owners in unincorporated Pierce County and grant funds pay for these facilities and services.

1.1 OVERVIEW OF BASIN PLANNING PROGRAM

SWM is preparing a series of 10 basin plans for drainage basins in the County. The basin plans comprehensively address flooding, water quality, and aquatic/riparian habitat aspects of surface water management in the stream systems of nonfederal lands within the County. SWM will use the basin plans to set priorities within each basin and to revise or supplement existing storm drainage programs outlined in the *Pierce County Storm Drainage and Surface Water Management Master Plan* (Pierce County 1991), also known as the Countywide Storm Drainage Plan or the 1991 Plan. The basin plans include advisory recommendations that may be useful to other departments or agencies in the basin.

The basin plans embody a comprehensive approach to surface water management. Historically, conventional stormwater drainage plans have had a single purpose: removal of excess water from public roads and away from properties as rapidly as possible. With this single purpose in mind, stormwater drainage solutions have tended to rely on piped systems and engineered channels that minimize resistance to water flow. But the conventional engineering approach has significant disadvantages. The value of natural water bodies as aquatic/riparian habitat and as a public amenity is often lost, as is the water body's ability to remove and break down pollutants and to store and meter out flood waters naturally. Rapid downstream flow of stormwater decreases opportunities for groundwater recharge, which in turn leads to a reduction in streamflow during dry periods. Pierce County seeks to avoid the disadvantages of conventional stormwater drainage approaches by preparing basin plans that provide practical solutions to surface water problems without sacrificing environmental quality. The specific goals and objectives of the basin plans are described in Section 1.2.

Pierce County basin planning is completed in three phases:

- Phase I is a characterization of physical, hydrologic, and cultural aspects of the basin. During the Phase I characterization, data needed for detailed analysis and subsequent project development are acquired by a combination of field work and compilation of published data and reports. A strategy for stakeholder involvement also is developed in Phase I.
- Phase II of basin planning involves analyzing and developing alternative solutions to the present and potential future flooding and environmental problems identified in Phase I. Alternative solutions are reviewed with stakeholders, preferred solutions selected, and a recommended basin plan prepared for consideration by the policy makers.
- Phase III of basin planning process is plan implementation and effectiveness monitoring.

Development of basin plans provides opportunities to ensure that actions taken to improve stormwater drainage comply with federal, state, and local laws and regulations. Of particular concern is compliance with the federal Clean Water Act (CWA), Endangered Species Act (ESA), and the National Flood Insurance Program (NFIP). The requirements of these laws and regulations have changed since the 1991 Plan was prepared. Federal, state, and local laws and regulations are discussed in Chapter 2 of this basin plan.

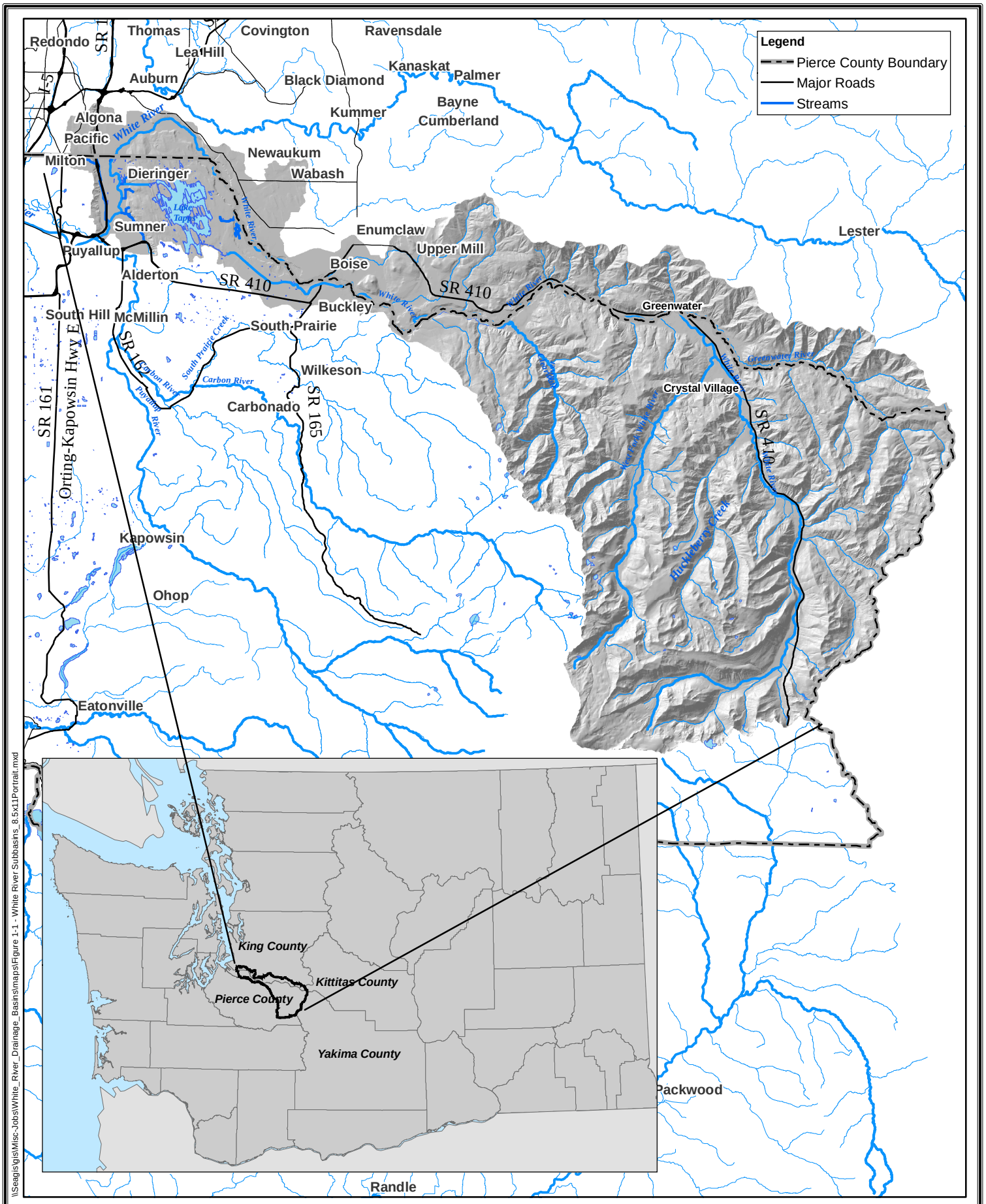
The basin plans enable coordination between cities within and adjacent to the basin and provide for programs that can leverage both County and cities' compliance requirements.

The basin plans provide information and recommendations that could be used for salmonid conservation and recovery planning. The information in the basin plans will support the County's efforts to use the Ecosystem Diagnosis and Treatment (EDT) method to determine the effects of environmental change on salmonid populations and assess the overall effectiveness of County actions on salmonid conservation and recovery. Adopted basin plans contain data and recommendations that can be used to obtain funding for salmon recovery activities and for permitting requirements.

The basin plans also support the County's Hazard Mitigation Planning, which is required by Federal Emergency Management Agency (FEMA) (as a result of Congressional action) for local governments to retain eligibility for federal disaster relief funding (44 Code of Federal Regulations, Section 201.1). The basin plans provide flood hazard planning information, which is consistent with FEMA's Hazard Mitigation Plan requirements.

1.2 PURPOSE, GOALS, AND OBJECTIVES OF BASIN PLANNING

Pierce County developed goals and objectives for the basin planning program in order to provide direction and consistency to the basin plans developed (Pierce County 2000).



Source: Pierce County Planning Cartography Lab, 2004

Pierce County
Public Works and Utilities
Surface Water Management

URS

1 inch equals 32,000 feet

0 16,000 32,000 Feet

0 5,000 10,000 Meters

Figure 1-1
PIERCE COUNTY AND WHITE RIVER BASIN LOCATION

WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON

\\Seagis\gis\Misc-Jobs\White_River_Drainage_Basins\maps\Figure 1-1 - White River Subbasins_8.5x11Portrait.mxd

1.2.1 Purpose

The purpose of the basin planning program is to create a comprehensive approach to reducing flood hazards, improving aquatic/riparian habitat, and improving water quality throughout unincorporated Pierce County by updating the 1991 Plan.

1.2.2 Goals and Objectives

In this instance, *goals* refer to the desired outcomes of implementing the plan. The goals should remain the same in each basin plan. The *objectives* describe measurable indicators that the goals are being achieved and may be supplemented to reflect the unique character of a specific basin. The goals (shown in bold) and objectives (listed as bullets) of the basin planning program are described below.

Reduce flood hazards

- Incidents of property loss and repeat damage are reduced.
- Streams will not be adversely impacted by flood events.
- Pierce County's standing under the FEMA Community Rating System is improved.
- New development is located outside flood-prone areas.

Improve aquatic/riparian habitat

- Number of stream miles available for wild, native fish populations is increased.
- Population numbers of fish, wildlife, and plant species listed as endangered or threatened under the ESA, particularly native (spring) Chinook, Steelhead, and Bull Trout are maintained or increased.
- Quality and quantity of available wetland, riparian, and upland habitat is improved

Improve water quality

- State Surface Water Quality Standards (WAC 173-201a) are met or exceeded.
- Number of impaired water bodies (as listed in Section 303[d] of the CWA) is reduced.
- The terms and commitments in Pierce County's NPDES permit for stormwater are in compliance.
- Risk of groundwater contamination is reduced.
- Rates of erosion are reduced.

Coordinate use of public resources responsibly

- Cost of maintaining stormwater facilities is reduced.

- Project value is favorable when measured against costs and benefits.
- Polls demonstrate that public awareness of flooding, habitat, and water quality issues has increased.
- Monitoring and enforcement programs demonstrate an increase in services per dollar spent.
- Basin plan implementation also implements elements of other Pierce County plans.

Influence location and methods for new development

- New development in flood-prone, riparian, or significant habitat areas is prohibited.
- Low-impact development (LID) techniques are widely used.
- Effective best management practices (BMP) are identified and widely used.

1.3 THE WHITE RIVER BASIN PLAN

This White River Basin Plan describes the physical system, current conditions, and land use planning in the basin. The plan identifies surface water management issues, such as water quality, flooding, and aquatic/riparian habitat, for the basin with a focus on the unincorporated areas of Pierce County.

White River Basin Plan also identifies capital facility projects and programs that help address critical current and future stormwater management issues in the basin. Phase III of basin planning will be implementation of the recommendations and long-term monitoring to evaluate improvements in basin conditions.

The basin plan planning area includes unincorporated areas of the White River Basin and those areas that have influence on surface water within unincorporated Pierce County. Portions of the mainstem White River and its tributary Greenwater River are covered by the Pierce County Rivers Flood Hazard Management Plan, and therefore are not included in this plan.

1.4 REPORT ORGANIZATION

The remainder of the report provides the basin information in the following order:

- Chapter 2: Describes the regulatory context in which the basin plan was prepared, including existing related planning programs.
- Chapter 3: Describes stakeholder involvement in Phase I of plan preparation and proposed involvement for Phase II of plan preparation.
- Chapter 4: Describes the overall existing physical and biological conditions in the White River Basin. Gives a more detailed description of rivers and streams in the basin prioritized by Pierce County for the Phase I characterization, and their condition as recorded during field surveys conducted by URS in September through November of 2004.

- Chapter 5: Describes various problems in the basin including flooding, degradation of water quality in the basin, and degradation of aquatic/riparian habitat.
- Chapter 6: Describes the analysis of flooding/drainage problems.
- Chapter 7: Describes the analysis of water quality problems.
- Chapter 8: Describes the analysis of aquatic/riparian habitat problems.
- Chapter 9: The Basin Plan. It contains the recommended capital improvement projects, programmatic measures, and additional studies.
- Chapter 10: Contains the analysis of the environmental impacts of the basin plan, as required by the State Environmental Policy Act (SEPA).

CHAPTER TWO
RELATED PROGRAMS AND REGULATIONS

The Pierce County basin plans are implemented within a framework provided by existing federal, state, and local policies, laws, regulations, and programs. The existing regulatory framework is described in detail in Chapter 3 of Pierce County's *Guidance for Basin Planning* (Pierce County 2000). The major federal, state, county water, and local management policies and regulations are described briefly in this chapter.

2.1 FEDERAL WATER MANAGEMENT POLICIES AND REGULATIONS

Coordination of the White River Basin Plan with federal programs, regulations, and policies is intended to ensure that Pierce County stormwater management efforts are consistent with the federal Clean Water Act (CWA), the Endangered Species Act (ESA), the National Flood Insurance Program (NFIP), National Environmental Policy Act (NEPA), and the Safe Drinking Water Act (SDWA).

2.1.1 Clean Water Act

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

National Pollutant Discharge Elimination System

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 NPDES permit program. Based on the criteria specified in the federal regulations, Pierce County was required to secure an NPDES permit for its municipal stormwater discharges with an effective date of March 1, 2009.

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, in July 1995. On January 17, 2007, Ecology reissued the Phase I municipal stormwater permit, and modified the permit in June 2009 to implement the outcomes of appeals.

Recommendations in basin plans must be consistent with the County's NPDES stormwater permit requirements and provisions of Pierce County's Stormwater Management Program (SWMP). The County's Stormwater NPDES Permit requires that the County address water quality when developing capital improvement projects for flood control. The NPDES permit also requires retrofitting facilities 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 the extent to which water quality features are needed.

The 1995 and 2007 versions of the municipal stormwater NPDES permit require that permit holders control pollutants in stormwater to the maximum extent practicable, primarily by implementing an SWMP. Pierce County's basin plans are part of the County's SWMP. Ecology approved Pierce County's SWMP in 1998. 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 (MS4)
- A program to reduce stormwater pollution from industrial facilities that discharge into the MS4 and 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 SWMP implementation. Pierce County's most recent Stormwater Management and Site Development Manual was adopted in 2008 (Ordinance 2008-59S). The County may need to update the manual to maintain compliance with future NPDES permits. The next version of the NPDES permit is due to be issued in 2012.

Section 303(d) List and Total Maximum Daily Loads

- Section 303(d) of the CWA requires Washington State to prepare a list of surface waters in the state where beneficial uses are impaired by pollutants. This list consists of water bodies that fail to meet the state's surface water quality standards and are not expected to improve within the next 2 years after application of technology-based methods to reduce effluent limits. The most current Washington State 303(d) list, which was completed in 2008 and approved by EPA in 2009, includes portions of the White River and several of its tributary streams. Most are impaired for temperature and fecal coliform bacteria, both of which can be associated with stormwater runoff. Lower reaches of the White River were listed as Category 5 waters, which are considered to be polluted. Upper tributaries, with tributary areas that are primarily Designated Forest Land or that originate in King County, have also been placed on the 303(d) list.
- 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 the application of BMPs. 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.
- TMDL development for the Lower White River is ongoing for pH. The TMDL for the Upper White River tributaries for sediment and temperature was completed in 2004 and the implementation report was completed in 2006. The recommendations in the implementation plan were to plant riparian areas and remove forest service roads. Most of the recommendations in the implementation plan were assigned to the U.S. Forest Service (USFS). The USFS is decommissioning roads as funds allow and plantings have occurred, but it takes time to grow trees to a level where they will produce effective shade. (White River Watershed Water Quality Improvement Project Summary, http://www.ecy.wa.gov/programs/wq/tmdl/). Ongoing assessments include studies on pH, nutrients, and temperature for the Lower White River and temperature, sediments, and habitat guidance for the Upper White River.
- Planned capital improvements for the White River Basin will need to recognize 303(d) listings and should anticipate development of TMDLs where they do not yet exist. Water bodies not on the 303(d) list should be managed so as to continue to meet state water quality standards. Additionally, the current Pierce County NPDES permit requires that the stormwater management program be amended to take into account TMDLs Section 404 Permit Program.

Section 404 Discharge of Fill Materials

- Section 404 of the CWA establishes a permit program for dredge or fill within waters of the United States, including associated wetlands. Storm drainage projects that involve

dredging or filling in wetlands are regulated under either nationwide general permits (for smaller projects) or individual permits. Section 404 is administered by the U.S. Army Corps of Engineers (Corps); the Corps' Seattle District is responsible for Section 404 permits in Pierce County. Discharge of dredge or fill material must be in accordance with EPA guidelines, which are aimed at minimizing or eliminating adverse environmental impacts. Permits usually require compensatory mitigation for any loss of wetlands.

- Future capital improvement projects within the White River, its tributaries, or its associated wetlands will require Corps 404 permits. Further, since this is a federal permit, such projects may trigger review under the NEPA, rather than solely under Washington's SEPA, as described in Section 2.2.3.
- The goal of wetlands protection is to avoid net loss of wetlands; 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 the *1991 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 wetland impacts if possible and include the costs of compensatory mitigation for projects where 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

The NFIP was created by Congress in 1968. Administered by FEMA, the NFIP makes flood insurance available to communities that agree to adopt and enforce floodplain ordinances designed to reduce flood damages. The NFIP sets minimum standards for floodplain regulations.

Pierce County has been a participant in the NFIP since 1988. 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 flood insurance rate map. Certification activities include stream channel modifications, installation of culverts, bridge construction, structure elevations, etc.

Regulation of development within flood hazard areas is conducted through the County's Critical Areas Regulations and Stormwater Management and Site Development Drainage Regulations.

Capital improvement activities and programs within the White River Basin will need to be consistent with these regulations.

The NFIP also includes the Community Rating System (CRS), which offers the potential for reduced insurance rates based on a community's rating. Pierce County, which received a Class 5 rating in 2000, was the first county in the nation to receive this high rating; this resulted in a 25 percent flood insurance rate discount for County landowners. In 2007 Pierce County received a Class 3 rating, in part because of the basin planning program which resulted in a flood insurance rate discount of up to 35 percent for floodplain residents. The rating must undergo a regular recertification audit. Only a handful of communities across the country have achieved this 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 help meet the prerequisites for a better rating, the White 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.

2.1.3 Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) of 1974 transferred responsibility for regulation of drinking water to the EPA and called on that agency to take a number of steps to protect the quality of the nation's drinking water supplies. The EPA has set maximum contaminant levels in drinking water for more than 100 substances. When the SDWA was amended in 1986, a new provision of the act required every state to develop a wellhead protection program. A wellhead protection program is a program that seeks to protect the quality of groundwater bodies that are used for water supply so that water arrives at the wellhead uncontaminated. In Washington State, the Department of Health was designated as the lead agency for wellhead

protection program development and administration, but delegated the responsibility to the counties. The Tacoma-Pierce County Health Department administers the wellhead protection program for Pierce County.

The location of new storm drainage or infiltration facilities and improvements to existing facilities must meet the requirements of the wellhead protection program.

2.1.4 Endangered Species Act

The ESA seeks to conserve endangered and threatened species. It directs the U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) to promulgate lists of endangered and threatened species and to designate critical habitat for these species. The species listings with the greatest potential to affect surface water management in Pierce County include the Chinook salmon, listed as threatened in March 1999; bull trout, listed as threatened in November 1999; and Puget Sound steelhead, which was listed as threatened in May 2007.

The ESA regulates activities that kill, injure, harass, or harm listed species or adversely alter their habitat. It regulates "taking" of listed species as defined in the Act, which includes harming them by significantly reducing their habitat and impairing their breeding, feeding, or sheltering patterns.

An action that involves federal funding or a federal permit, and which could have an effect on a listed species, requires that the involved federal agency (the "lead" agency) consult with USFWS and/or NOAA/NMFS. Following consultation, USFWS and/or NOAA/NMFS issues a biological opinion regarding the effects of the action.

Actions by the County as part of basin planning or management cannot, in most cases, result in "taking" of listed species. Additionally, proposed capital improvements that trigger federal funding (i.e. Federal Highways Administration) or permits (i.e. Corps 404 or Section 10) are likely to require ESA consultation and issuance of a concurrence letter or biological opinion and must be planned and designed to protect listed species.

2.1.5 National Environmental Policy Act

NEPA requires federal agencies to consider the environmental impacts of their proposed actions and reasonable alternatives to those actions. "Actions" may include federal funding or issuance of federal permits. There are three potential levels of environmental analysis: categorical exclusion, preparation of an environmental assessment/finding of no significant impact (EA/FONSI), and preparation of an environmental impact statement (EIS). Capital improvements that require federal permits or programs with federal funding may require environmental review under NEPA.

2.2 STATE WATER MANAGEMENT POLICIES AND REGULATIONS

A number of state laws and regulations guide the management of water resources. The most relevant laws and regulations include the Washington State Water Quality Standards (promulgated under the federal CWA delegation), the Growth Management Act (GMA), State Environmental Policy Act (SEPA), the Shoreline Management Act (SMA), the State Hydraulic Code, the Watershed Management Act, the State Shellfish Management Regulations, and the Non-Point Rule.

2.2.1 State Water Quality Standards

Washington State has adopted water quality standards for the discharge of stormwater to surface water and groundwater. These standards carry out the federal anti-degradation policy of the CWA. Violations of water quality standards are illegal. State regulations also call for the designation of special groundwater protection areas based on unique characteristics such as aquifer recharge areas, wellhead protection areas, or sole source aquifers.

Washington's surface water quality standards (Chapter 173-201A WAC) set limits on pollution in our lakes, rivers, and marine waters to protect beneficial uses such as swimming and fishing. They are the basis for assessing the quality of the state's waters. The standards set numeric limits for discharges to surface waters. Periodically, Ecology reviews the standards and, if needed, revises them to reflect current knowledge or new scientific information. Current standards were developed in 2006 and approved by EPA in 2008. They are due for review and revision.

During the federal review of Washington's 2006 rule revision, the EPA, NMFS, and USFWS expressed significant concern over the state's dissolved oxygen (DO) criteria. Their specific concern relates to the levels of DO in gravel beds, where salmonids spawn and fry develop. Ecology made a commitment to study some options for addressing DO criteria, including intragravel DO, and will propose changes based on that study as part of the revision process. A report was prepared by Ecology's Environmental Assessment Program providing scientific information about the characteristics of DO in Washington streams, and the freshwater DO criteria were not revised, although much review of the criteria was done prior to finalizing the rule (Ecology 2009).

Ecology is working with the tribes, the Washington Department of Fish and Wildlife (WDFW), NMFS, and USFWS to keep information current on salmonid presence in streams and where spawning and early rearing occur. Annually, starting in fall 2008, Ecology will request an updated dataset from the agencies and tribes. Ecology will use these new data to propose changes to the aquatic life uses for streams and rivers in the state.

The most recent water quality assessment conducted under current water quality standards for Washington State was approved by EPA in 2009. Lower reaches of the White River were listed as Category 5 waters, which are considered to be polluted and are placed on the 303(d) list.

Upper tributaries of the river that originate in King County have also been placed on the 303(d) list.

The County is responsible for compliance with state water quality standards and it will be important to be able to achieve project design in accordance with those requirements.

Protection of groundwater and surface water quality is achieved in part through design and maintenance of projects in a manner consistent with local, state, and federal requirements. The Ecology Stormwater Manual for Western Washington establishes minimum standards for local stormwater management for development activities. Pierce County's Stormwater Management and Site Development Manual incorporates those standards. The County must obtain a Stormwater General Construction Permit through Ecology for activities that disturb over an acre of land as part of NPDES compliance. NPDES permitting and the TMDL process for impacted water bodies are described in Section 2.1.1.

2.2.2 Growth Management Act

The GMA was adopted in 1991. The GMA requires governments of fast-growing counties, cities, and towns to prepare and adopt comprehensive plans and implementing regulations for managing growth. It also requires that all counties, cities, and towns adopt regulations protecting "critical areas" including wetlands, critical aquifer recharge areas, fish and wildlife habitat conservation areas, frequently flooded areas, and geologically hazardous areas. Pierce County's comprehensive plan is codified as Title 19A of the Pierce County Code. Critical areas regulations are found in Title 18E.

The GMA requires that counties make capital budget decisions in conformity with their comprehensive plans. Capital improvement projects recommended by the basin plan must therefore be consistent with the County's comprehensive plan, including the 6-year capital improvement plan. Land use decisions in the comprehensive plan will drive stormwater management needs by establishing future land uses, densities of housing, and impervious surfaces. Projects in the basin plan are subject to regulations to protect critical areas.

2.2.3 State Environmental Policy Act

SEPA is intended to ensure that environmental values are considered (in addition to technical and economic considerations) by state and local government officials when making decisions. Review under SEPA is triggered when a local government receives a permit application or when a public entity proposes an official action. Such an action may include adoption of a planning document such as a basin plan. SEPA determinations are made by a local lead agency and are subject to public review. A project that is determined to be likely to have "significant" environmental impact will require preparation of an EIS. Alternatively, the SEPA lead agency may make a "mitigated determination of non-significance," under which a defined set of mitigation measures are deemed sufficient to eliminate the need for an EIS or the impacts of an action may be determined not to be significant.

Adoption of the White River Basin Plan will be an "action" under SEPA and will require review. Additionally, most or all capital projects recommended in the plan will require state or local permits and will be subject to review.

2.2.4 Shoreline Management Act

The SMA establishes a state-local partnership to provide for the protection of Washington shorelands through coordinated planning and regulation. To this end, the SMA requires that local governments adopt shoreline management programs to balance the use and development of the shorelines for economic and residential use, public access and recreation, and preservation and restoration. The jurisdiction of the SMA is the area within 200 feet of the ordinary high water mark of a water body designated as a shoreline of the state or its associated wetlands. Within these areas, development must comply with the local Shoreline Master Program, which is adopted by the local jurisdiction and approved by Ecology. Pierce County's shoreline regulations require permits for development within the shoreline area. Any proposed capital projects located within the area of shoreline jurisdiction will be required to comply with its requirements. Pierce County is currently updating its Shoreline Master Plan to comply with state requirements for increased resource protection and preservation.

Water bodies in Pierce County regulated under the SMA and the County's Shoreline Master Program (SMP) include marine shorelines of Puget Sound, rivers and streams, and numerous lakes. Within the planning area, regulated water bodies include Lake Tapps, which is designated as a Freshwater Shoreline of Statewide Significance. The existing shoreline environment designations of Lake Tapps are Rural Residential and Conservancy (Pierce County, 2007).

2.2.5 State Hydraulic Code

The Washington State Hydraulic Code regulates any activity affecting the state's fresh or salt waters. The code, which is administered by the WDFW, requires any person, organization, or government agency whose construction project affects the bed or flow of a surface water of the state to obtain a Hydraulic Project Approval (HPA) permit. The WDFW uses the HPA permitting process to attach conditions to help ensure that construction projects are managed, sequenced, and conducted so as to protect fish, shellfish, and their habitat. Capital projects that involve construction within the waters of the White River or its tributaries will require HPA permits and compliance with their conditions.

2.2.6 Watershed Management Act

The Watershed Management Act provides a framework for statewide watershed planning, organized to involve local stakeholders in each of the State's 62 water resource inventory areas (WRIAs). The White River is part of WRIA 10, the Puyallup/White Basin. Watershed planning for the basin is being conducted as part of the Shared Strategy for Puget Sound, a collaborative effort between governments including Pierce County and local stakeholders for the watersheds that comprise the Puget Sound Basin. The watershed planning process has assembled a large

collection of information related to water quality and habitat conditions in the White River Basin and has made some determinations as to limiting factors for salmon productivity and priorities for recovery. Capital projects recommended in the White River Basin Plan can make use of the location-specific information collected by the watershed planning process in their design and location.

Associated with the Watershed Management Act is the Salmon Recovery Planning Act (ESHB 2496 [1998]), which established a statewide process to identify habitat factors limiting salmon production in the state. House Bill 2496 created the Governor's Salmon Recovery Office to lead Washington State's effort and to coordinate local recovery efforts. It establishes a local process for prioritizing and recommending habitat restoration projects and creates a Science Panel to review salmon recovery plans.

The Washington Conservation Commission (WCC) was authorized in 1998 to develop limiting factors reports for salmonids in Washington State watersheds. From 1998 through 2003, salmon habitat limiting factors analysis (LFA) reports were developed for all basins in Washington State that produced salmon or steelhead.

Salmon habitat criteria developed by a technical advisory group of basin experts are used to develop the limiting factors analysis for basins. Implementation of the Salmon Recovery Act is coordinated with the Watershed Management Act in accordance with a Memorandum of Understanding among various state agencies, committees, and commissions.

2.2.7 Non-Point Rule

The purpose of the Non-Point Rule (WAC) is to reduce pollutant loading from non-point sources, prevent new sources from being created, enhance water quality, and protect beneficial uses. The Non-Point Rule establishes criteria and procedures for ranking watersheds in Washington State and for developing and implementing action plans for watersheds in need of corrective or preventive actions to address non-point source pollution in watersheds. The planning process encourages collaborative problem solving among local, state, tribal, and federal interests. It relies on voluntary actions, local ordinances, and state and federal laws, regulations, and programs for implementation. Each lead entity (usually a county) convenes a committee to review and/or re-rank the watersheds wholly or partly within the county boundaries, using criteria specified by the state. Local watershed management committees are then formed to develop action plans for the ranked watersheds. Pierce County has prepared action plans for the Lower Puyallup River (Lower Puyallup Watershed Action Plan), which includes the White River Basin and the Upper Puyallup River (Upper Puyallup Watershed Characterization and Action Plan). The Puyallup River Watershed Council actively implements portions of these plans. Recommendations in the White River Basin Plan are consistent with the implementation and monitoring strategies for reducing non-point pollution in this plan.

2.3 PIERCE COUNTY WATER MANAGEMENT POLICIES AND REGULATIONS

Pierce County must manage surface waters in a manner that protects lives and property and complies with the federal and state water and wildlife management laws and regulations described above. Local water management plans and regulations include the *Pierce County Stormwater Management and Site Development Manual* (Pierce County 2009) and ordinances enacted pursuant to the state's GMA.

The state's GMA requires that communities identify critical natural resources and enact ordinances that protect them. Pierce County has passed a critical areas ordinance, Title 18E that regulates construction within specified distances of streams, lakes, or wetlands in order to comply with the GMA. Construction is regulated within 165 feet of streams, or lakes that support critical fish species or are adjacent to landslide areas, which accounts for the maximum base fish and wildlife buffer, 150 feet, plus an additional 15-foot building setback. For all other streams, rivers, and lakes, the buffer depends on the water type, ranging from 35 to 115 feet from the ordinary high water mark, with an additional 15-foot building setback. Construction is regulated within 315 feet of wetlands, which accounts for the maximum (Category I) wetland buffer, 300 feet, with an additional 15-foot building setback. Base buffers for wetlands range from 25 to 150 feet of the wetland edge, based on the wetland category, along with a 15-foot building setback. The Pierce County SMP contains additional policies and regulations that guide development in the shoreline area. An updated SMP is to be adopted in 2011.

2.4 LOCAL PROGRAMS AND PLANS

2.4.1 Upper and Lower Puyallup Watershed Characterization and Action Plans

The Upper Puyallup Watershed Characterization and Action Plan (2002) and the Lower Puyallup Watershed Action Plan (1995) areas cover most of the White River Basin study area. They provide a baseline characterization of physical and ecological conditions of the White River system. The mission of the plans is "to protect and enhance water quality and beneficial uses of water by reducing water pollution from non-point sources." The plans are the result of Washington State's Non-Point Rule.

2.4.2 Lake Tapps Boat Management Plan

The purpose of this plan is to have a strategy for ensuring safe boating activity and protecting the long-term recreational use of Lake Tapps. The plan specifically addresses community concerns regarding boat safety, law enforcement, noise, and quality of life on Lake Tapps.

To help facilitate development of the Lake Tapps Boat Management Plan, the Pierce County Council enacted Resolution 2004-91 on July 6, 2004, establishing an ad hoc advisory committee (referred to as the Lake Tapps Boat Management Plan Team). Team members were drawn

from lakefront property owners, recreation users who do not live on the lake, the boat sales and repair industry, PSE, Bonney Lake Police, and East Pierce Fire and Rescue. This resolution also tasked the Pierce County Planning and Land Services Department, Sheriff's Department, and Park and Recreation Services Department to provide support and facilitation for this planning process. The plan was adopted by Pierce County in 2005.

2.4.3 Bonney Lake Comprehensive Plan

The City of Bonney Lake is located at the south end of Lake Tapps. The City updated its comprehensive plan in 2004 (City of Bonney Lake 2004). It is subject to amendment every 2 years. Portions of the plan were last updated in December 2009.Although the White River Basin includes only a small portion of the city, the plan provides relevant information on land use, habitat, and projected growth patterns. The city urban growth area includes a small portion of unincorporated Pierce County.

2.4.4 Pierce County Rivers Flood Hazard Management Plan

SWM is developing a long-term plan to guide river management to reduce damages from floods while enhancing important fisheries resources in the Puyallup, White, Carbon, and Nisqually rivers. The Pierce County Rivers Flood Hazard Management Plan will identify and recommend regional policies, programs, and projects related to flooding and channel migration on major rivers to: (1) reduce risks to public health and safety, (2) reduce public and private property damage, (3) reduce facility maintenance costs, and (4) maintain or improve habitat conditions. The final plan is expected to be completed in 2011.

The following reaches are covered by the Pierce County Rivers Flood Hazard Management Plan, and are therefore not included in this Basin Plan:

- Lower White River (up to river mile [RM] 5.5)
- Upper White River near the confluence with the Greenwater River (approximately RM 43.5 to 47.5)
- Greenwater River from the confluence with the White River to approximately RM 5.

During the development of the plan, the County is coordinating with King County on its Lower White River Countyline Reach flood hazard reduction projects.

2.4.5 Pierce County Basin Planning Program

The Pierce County Basin Planning Program is a program of Pierce County Public Works and Utilities, Surface Water Management Division (SWM). SWM initiated the program in response to a recommendation in the 1991 Pierce County Storm Drainage and Surface Water Management Plan (1991 Plan). The 1991 Plan served as the first capital improvement program (CIP) and program plan for the Pierce County Storm Drainage and Surface Water Management Utility. The 1991 Plan did not identify any CIP projects within the White River Basin.

2.4.6 Tacoma-Pierce County Health Department Septic System Program

Tacoma-Pierce County Health Department's Septic System and Operation and Maintenance Programs work to ensure that septic systems are located and installed correctly and kept in good working condition. These efforts reduce the risk of contaminating groundwater and surface water, reduce the risk to people from exposure to untreated sewage, and help extend the working life of septic systems.

The Operation and Maintenance Program ranks septic systems as low, moderate, or high risk based on the type of system and where it is located. High risk systems include systems with many complex or maintenance-intensive components. These systems are required to be inspected yearly by a certified professional. Less complex systems are ranked as moderate risk and require inspection every three years. Gravity-drain systems are considered low risk and require inspections only at the time of sale or a change in property use.

The Operation and Maintenance Program requires inspections for all septic systems at the time of sale of a property. The goal is to ensure that the buyer receives a properly functioning system. The Operation and Maintenance Program also helps ensure that septic systems are kept in good working order by providing educational materials to homeowners about their system, its location, and actions they can take to keep the system working properly. This reduces the risk of contaminating groundwater and surface water, and reduces the risk to the community from exposure to untreated sewage. Good operation and maintenance practices also help extend the life of a septic system, saving money.

2.4.7 Inter-County River Improvement Agreement

Approved in 1914, the Inter-County River Improvement Agreement (Agreement) between Pierce and King Counties established the Inter-County River Improvement (ICRI) entity to provide flood control on the lower White and lower Puyallup Rivers. The Agreement called for the counties to fund the work of the ICRI jointly through an Inter-County River Improvement Fund.

Prior to 1906, the White River flowed north through King County into the Duwamish River. In November 1906, a large flood resulted in a debris jam blocking the Whiter River near Auburn and diverting most of the flow into the Stuck River in Pierce County. The Counties agreed that the flow would remain in the Stuck River and signed the Agreement for the purpose of jointly funding maintenance and control of approximately 11 miles of the White River and 8 miles of the Puyallup River. The Agreement is in effect until 2013. The Pierce County Rivers Flood Hazard Management Plan will include recommendations for collaborating with King County to renew the Agreement or jointly determining that it should be allowed to expire.

CHAPTER THREE
STAKEHOLDER INVOLVEMENT

Stakeholders are defined as those individuals and organizations with a "stake" or interest in the outcome of the planning process. Stakeholders may include elected officials, citizens, and representatives of tribes, government agencies, nonprofit groups, and businesses. The chapter describes efforts to involve the public and other stakeholders in the process.

3.1 STAKEHOLDERS AND RELATIONSHIP TO BASIN PLAN

The White River Basin Plan involves participation of citizens; the Storm Drainage and Surface Water Management Advisory Board (SWAB); federal, State of Washington, and local agencies; and Pierce County departments and programs potentially affected by implementation of recommended capital improvements projects and programmatic actions of this plan.

Citizens and landowners in the White River Basin planning area are the primary stakeholders. Other potential stakeholders include the City of Sumner, City of Bonney Lake, City of Buckley, Lake Tapps Task Force, Save Lake Tapps Coalition, Drainage District 11, Drainage District 24, Pierce County Planning and Land Services, Pierce Conservation District, Puyallup Tribe of Indians (PTI), Muckleshoot Indian Tribe (MIT), FEMA, U.S. Army Corps of Engineers, and the Cascade Water Alliance (Alliance).

Many stakeholders in the White River Basin are interested in the future management of Lake Tapps and the White River. Pierce County does not have control over management of water rights and water levels in Lake Tapps and the White River. The Washington Department of Ecology (Ecology) is responsible for issuing and regulating water rights in Washington. The Alliance is a nonprofit corporation comprising eight municipalities (five cites and three water and sewer districts) in the Puget Sound region. The Alliance is the current owner of Lake Tapps and its water rights. Pierce County and the Alliance signed a non-binding agreement in August 2005. They agreed to investigate the best practicable method of establishing Lake Tapps as a public water supply reservoir, as well as to coordinate protection and monitoring of water quality in Lake Tapps and the White River Basin. Also, Pierce County Parks is working with the Alliance and others to design and build a rafting area facility, or floating restroom for boaters on Lake Tapps. Pierce County and the Alliance are collaborating on a walking trail along the Lake Tapps Flume, as well.

Stakeholder involvement in the basin planning process is focused on addressing storm drainage, flooding, water quality, and aquatic/riparian habitat issues in the unincorporated Pierce County portions of the basin. Surface Water Management (SWM) incorporated considerable public information and public involvement in the development of the White River Basin Plan to respond better to the varied interest of people living and working in the basin. The following describes the core efforts undertaken in two phases.

3.2 PHASE I

SWM staff identified people, groups, and agencies with an interest in the outcome of the White River Basin Plan. An introduction to the basin plan and planning process was sent to the people identified. Stakeholders assisted in identifying issues and important values to consider in the plan at public meetings, through completed questionnaires and one-on-one meetings.

Dissemination of information about the basin planning process, acquisition of resident feedback on lake issues, and presentation of the draft Phase I findings for public comment were the focus of the Phase I stakeholder involvement.

3.2.1 Initial Public Meeting

To implement Phase I work, a public meeting was held to describe the basin planning process and solicit information from interested parties. Meeting announcements were mailed to individuals on the SWM mailing list for the White River Basin and published in the local newspaper. A meeting was held on January 12, 2005, at North Tapps Middle School, located at 20029 12th Street East in Sumner, Washington, from 7:00 to 9:00 p.m.

At the meeting, Pierce County staff and their consultants presented a description of the planning program and its goals. Questions and comments were invited. Meeting participants were asked to provide any information they might have on past flooding or water quality problems and the use of local streams by salmonids. A questionnaire was distributed to attendees with a request that they answer the questions and return the forms to the County project manager. The questions focused on land use, on-site sewage system use, use of pesticides and fertilizers, water quality and flooding, and habitat issues.

Additional briefings were held with the Lake Tapps Task Force, PTI, MIT, and public officials to describe the ongoing work by SWM and the basin characterization report development.

3.2.2 Initial Questionnaire: January 2005

A tabulated summary of the White River and Lake Tapps Basin Study Questionnaire distributed at the January 12, 2005, public meeting is included in Appendix A. Thirty-two people signed in at the meeting and 24 questionnaires were completed by participants. Not every question was answered on each questionnaire; therefore, results show a different number of responses for each question. A list of public meeting attendees follows the questionnaire.

In general, the results of the questionnaire indicate the following:

- A majority of the participants own a single-family, lakefront residence with landscaping that they water and fertilize.
- Greater than 60 percent of participants believe there is no water quality problem in Lake Tapps.
- Greater than 80 percent believe there is a weed (primarily milfoil) problem in the spring, summer, or fall.

- A majority believe there are too many boats on the lake in the summer.
- A majority of the participants would be willing to accept some limitations on the use of their property if they understood those limitations, especially regarding limits on fertilizer or pesticide use.
- Most participants were not aware of flooding or habitat problems in the basin area.

3.2.3 Public Meeting on Basin Characterization

A second public meeting was held on September 25, 2007, at North Tapps Middle School to communicate the results of the Phase I characterization report to the community. Twenty community members attended the meeting. Announcements were mailed to individuals on the SWM mailing list for the White River Basin and also published in the local newspaper.

At the September 2007 meeting, Pierce County staff and their consultants presented information gathered during Phase I of the basin planning process including water quality data, aquatic habitat data, and flooding information. Questions and comments were invited. Meeting participants were asked to provide any information they might have on past flooding or water quality problems and the use of local streams by salmonids. A questionnaire was distributed to attendees with a request that they answer the questions and return the forms to the County project manager. The questions focused on land use, septic system use, use of pesticides and fertilizers, water quality, flooding, and habitat issues.

3.2.4 Questionnaire: September 2007

Questionnaires were also sent out to 2,400 property owners in the White River Basin planning area. Questionnaires were sent to all properties within 150 feet of Lake Tapps and all properties in Greenwater. The questions focused on land use, septic system use, use of pesticides and fertilizers, water quality, flooding, and habitat issues. There were 367 completed questionnaires returned to Pierce County. A summary of the Fall 2007 Phase II White River and Lake Tapps Basin Study Questionnaire results is included in Appendix A.

In general, the results of the questionnaire indicate the following:

- Almost all of the respondents own a single-family, lakefront residence with landscaping that they water and fertilize.
- Greater than 70 percent of respondents believe that water quality is not a problem in Lake Tapps.
- More than 40 percent of respondents believe there is a weed (primarily milfoil) problem in the spring, summer, or fall.
- Approximately 18 percent of respondents indicated that algae blooms are a problem in Lake Tapps.

- Approximately 55 percent of respondents believe there are too many boats on the lake in the summer. Several respondents commented that speed limits and other safety practices need to be better enforced for lake boaters.
- Approximately half of the respondents would be willing to accept some limitations on the use of their property if they understood those limitations, especially regarding limits on fertilizer or pesticide use.
- Most respondents were not aware of specific flooding or habitat problems in the basin area. Past road or driveway flooding problems were identified by 12 percent of respondents (44 respondents). The flooding problems identified in the Phase II survey are evaluated further in Chapter 5 of the Basin Plan.
- Only seven respondents (2 percent) indicated that the septic system on their property had failed in the past. The average age of reported septic systems was 25 years, and the oldest septic system reported was 50 years old. Although not all respondents indicated that inspections were performed on their septic systems, the average date of last inspection of septic systems was 2004.

3.3 PHASE II

In Phase II of the basin planning process, decisions were made about the issues identified during Phase I. Stakeholder involvement in the evaluation and selection of remedies for flooding and environmental problems is critical to the success of the plan. If the stakeholder involvement strategy is effective, the final basin plan will have broad support among residents of the White River Basin and Lake Tapps area.

Public involvement in Phase II includes the County's SWAB review of a preliminary draft basin plan. The SWAB (Section 3.3.1) reviews all basin plans for consistency and compliance with County surface water management programs and policies. Following SWAB review, a public meeting will be held on the draft plan.

Based on comments received, final revisions to the draft document will be made. The final White River Basin Plan will be presented to the Pierce County Planning Commission for approval and the Pierce County Council for adoption.

3.3.1 Storm Drainage and Surface Water Management Board

The SWAB is a nine-member advisory board appointed by the Pierce County Executive and confirmed by the County Council to address surface water management issues in unincorporated Pierce County. Its mission is to work with Pierce County SWM to develop recommendations on the County's surface water management program for presentation to the Pierce County Council and Executive Office. Board members are involved in such issues as storm drainage, water quality, storm drainage plans, rate structures and capital improvement projects, financing, and annual program goals.

3.3.2 Public Meetings

After the SWAB approves the Draft Basin Plan, a public meeting will be held to describe alternative remedial actions and content of the draft plan and solicit comments. Notice of the meeting will be placed in local newspapers. Other avenues of suggested meeting notifications could include the Pierce County website, mailings to interested stakeholder groups, or issuing a press release.

CHAPTER FOUR
EXISTING CONDITIONS

4.1 INTRODUCTION

The White River Basin is part of the Puyallup-White River Basin, (WRIA 10), one of the 62 State WRIAs that were established by Ecology in the 1970s. The White River Basin includes the Upper White River, Lower White River, and Mud Mountain surface water basins delineated by Pierce County (Figure 4-1). The basin terminates at the confluence of the White River at the Puyallup River. Thus, this plan addresses 3 of the 26 surface water basins in unincorporated Pierce County. Practically, since most of the Upper White River Basin falls within National Forest lands or Mount Rainier National Park, the majority of this basin plan addresses surface water management in the Lower White River and Mud Mountain Basins.

The planning area is the area of the White River Basin within unincorporated Pierce County and those areas that have influence on surface water within unincorporated Pierce County. The following reaches are covered by the Pierce County Rivers Flood Hazard Management Plan (see Section 2.4.4), and are therefore not included in the planning area:

- Lower White River (up to river mile [RM] 5.5)
- Upper White River near the confluence with the Greenwater River (approximately RM 43.5 to 47.5)
- Greenwater River from the confluence with the White River to approximately RM 5.

The White River Basin originates at the glacial headwaters of Mount Rainier. The following description of the general course of the river is from Washington Road & Recreation Atlas (Benchmark Maps, 2000):

The White River flows about 75 miles from its source, the Emmons Glacier on Mount Rainier, to join the Puyallup River at Sumner. It defines part of the boundary between King and Pierce counties.

The source of the White River is the Emmons Glacier on the northeast side of Mount Rainier. The river flows from ice caves at the toe of the glacier. Its upper reach is contained within Mount Rainier National Park. Shortly after emerging from the Emmons Glacier, the White River flows generally east, by the White River Campground, then the White River Ranger Station, after which it turns north. The river is paralleled by much of its upper course by State Route 410, called the Mather Memorial Parkway in the national park. After several miles the river exits Mount Rainier National Park and enters Mount Baker-Snoqualmie National Forest.

The river turns gradually westward, passing several national forest campgrounds. Huckleberry Creek joins just below The Dalles Campground. Several miles downriver from there the White River is joined by one of its main tributaries, the West Fork White River, which also originates at a glacier in Mount Rainier National Park, in this case, Winthrop Glacier. A few miles downriver

from the West Fork confluence another major tributary joins, the Greenwater River. The small settlement of Greenwater is located at the confluence.

Below Greenwater, the White River flows generally west. It passes Federation Forest State Park and is then joined by another tributary, the Clearwater River. Several miles downriver from there the White River is impounded by Mud Mountain Dam, which creates a marshy intermittent lake called Mud Mountain Lake. The dam was built for flood control purposes. Mud Mountain Lake only fills with water during conditions of exceptionally high streamflow.

Below Mud Mountain Dam the White River enters the greater Tacoma metropolitan area. It flows between the cities of Buckley and Enumclaw, after which it makes a large bend northwest and then southwest, essentially flowing around Lake Tapps. North of the lake, the White River flows through the Muckleshoot Indian Reservation. Below that, to the west of Lake Tapps, the White River enters a broad floodplain and flows past the city of Pacific before emptying into the Puyallup River at Sumner.

The White River basin occupies approximately 496 square miles of Pierce and King Counties. As shown in Figure 4-1, the majority of the basin area (approximately 376 square miles, 75 percent) is located in Pierce County, whereas the smaller northern portion of the basin (25 percent) is located in King County (Table 4-1).

In this chapter both existing data and data collected during the fall 2004 field study are used to characterize current conditions in the White River Basin. General basin characteristics are presented, but the emphasis is on factors that influence the quality and quantity of surface water in the basin planning area.

4.2 PHYSICAL CHARACTERISTICS

Climate in the basin varies dramatically from east to west. As shown in Table 4-1, the principal type of precipitation in the subbasin changes based on the proximity to Mount Rainier and the steep rugged terrain in the eastern portion of the basin. In the eastern part of the basin, monthly average winter temperatures are below freezing whereas monthly average summer temperatures do not exceed 72°F (Table 4-2). In the western portion of the basin, monthly average winter temperatures are just above freezing and monthly average summer temperatures have not historically exceeded about 76°F (Table 4-2).

Precipitation data from three gauging stations in the basin are summarized in Table 4-3. Precipitation recorded at the gauges averaged 53 inches of rainfall (small variation in years recorded not averaged) and 34 inches of snowfall per year. About half of the basin precipitation occurs from October through December. The eastern portion of the basin—where elevations exceed 14,000 feet above mean sea level (amsl) on Mount Rainier—experiences extended cooler winter weather, resulting in heavy snowfalls (76 inches per year). This differs from the western end of the basin, where elevations range from 39 to 189 feet amsl and snow accumulations are not persistent during the winter months.

Average air temperatures at the Greenwater gauge (located in the eastern portion of the basin) range from approximately 36°F to 55°F, whereas air temperatures further west at Buckley

range from 41°F to 60°F. The temperature differences across the basin also affect the dominant type of precipitation. At Greenwater, the annual recorded rainfall is 57 inches and snowfall is 76 inches. Further west at Buckley, the averages change to 48 inches of rainfall and 11 inches of snowfall (Table 4-3).

4.2.1 Topography and Landforms

The White River Basin extends from the upper northern flanks of Mount Rainier (summit elevation of 14,411 feet amsl) to the confluence of the White and Puyallup Rivers (elevation of 39 feet amsl). Figure 4-1 depicts the variation in topography and landforms present in the basin by using raised relief shading to represent elevation differences. As shown on the figure, steep-walled valleys dominate drainage patterns in the eastern portion of the basin. In many places valley walls can rise more than 6,000 feet above the valley floor. Rivers in the eastern portion of the basin are fast flowing, braided, and capable of transporting large volumes of suspended and bedload material. The Mud Mountain Dam, located east of Buckley (Figure 4-1), provides flood control for the White and Puyallup Rivers.

Topography in the western half of the basin consists of low rolling hills and valleys formed during the last period of glaciation. The exception to this is the relatively flat plateau east of Lake Tapps, which was covered by the Osceola mudflow (discussed in Section 4.4.1). The White River and its floodplain continue to modify the existing topography. Lake Tapps, originally four small lakes (developed as a reservoir), is the largest surface water body in the basin.

4.2.2 Planning Units

The first step in basin planning is to divide the basin into manageably sized planning units for characterization. For this study, the characterization includes summarizing the topography and landforms; land use; soils; drainage systems; aquatic, riparian, and upland habitats; and water quality.

For purposes of this plan, unless otherwise indicated, the term “basin” is used to describe the total White River Basin drainage area that is located within unincorporated Pierce County. The term “subbasin” is used to define the next smaller subdivision of the total drainage area. The entire basin is approximately 496 square miles, including King County. The portion within Pierce County is approximately 376 square miles in area and the portion of the basin within unincorporated Pierce County contains 230 square miles. The White River Basin consists of the following three basins listed in Pierce County Code Title 11, Storm Drainage and Surface Water Management: the Upper White River, Mud Mountain, and Lower White River Basins, approximately 334, 13, and 30 square miles, respectively.

Subbasin Planning Units

The existing County basins were evaluated to delineate subbasins for basin planning purposes. Three sources of information were used: 10-meter Digital Elevation Models (DEMs) obtained from the Regional Ecosystem Office (REO 2006), river stream line coverage obtained from the

Washington Department of Fish and Wildlife, and basin boundary geographic information system (GIS) coverage obtained from Pierce County (Pierce County 2004).

To provide a base map delineating the subbasins, the individual DEMs obtained for the basin were merged into one continuous DEM. The resulting DEM was then used as the basis to create a three-dimensional depiction of a topographic (shaded relief) map of the basin. The streams coverage was added to the map. Subbasins were delineated on the shaded relief map based on the presence of closed topographic areas and stream patterns. Subbasin boundaries were then modified based on input from Pierce County. Additional information on the delineation process is presented in Appendix B.

This White River basin was subdivided into 10 subbasins (Figure 4-1). The geographic extent and size of each subbasin is summarized in Table 4-1, and general physical features are described below.

Lower White River Subbasins

Lower White River Subbasin. The Lower White River Subbasin was established based on the transition from the Cascade foothills to the Puget Sound lowlands. This subbasin drains 52 square miles of the plateau formed by the Osceola mudflow and landforms associated with the last glacial advance in the region. The White River flows for 22.5 miles in the subbasin, dropping in elevation from 620 to 39 feet at the confluence with the Puyallup River. In this subbasin, the White River and its tributaries are rainfall-fed. Stream flow in the White River is affected by the Lake Tapps diversion near Buckley. Diverted water is stored in Lake Tapps and eventually returned to the White River via the Dieringer Canal at RM 3.5.

Lake Tapps Subbasin. Delineation of the Lake Tapps Subbasin was based solely on the existing Pierce County basin coverage. The basin around the lake is very flat, and most drainage patterns are due to manmade conveyance or control features (i.e., ditches, berms, and storm drains). Available information is not sufficient to easily confirm the Lake Tapps Subbasin boundary, and detailed review of drainage facilities was outside the scope of this plan.

The Lake Tapps Subbasin was divided into six distinct water quality management units (WQMUs). URS developed WQMUs at specific locations in Lake Tapps based on consultation with Puget Sound Energy (PSE), the Cascade Water Alliance (Alliance), and the Puyallup Tribe of Indians (PTI), all of whom have interest in the operation of Lake Tapps. These WQMUs are shown in Figure 4-2. The WQMUs will be used to facilitate characterization and subsequent discussion of issues associated with Lake Tapps and the surrounding area.

Mud Mountain Subbasin. Mud Mountain Subbasin drains the portion of the basin from Mud Mountain Dam to the Puget Sound lowlands near Enumclaw. The subbasin encompasses an area of 55 square miles. This portion of the White River drops in elevation from 1,227 feet below Mud Mountain Dam to 620 feet at the western terminus of the subbasin, a length of 13.3 miles. In this subbasin, the White River and its tributaries are primarily rainfall fed.

Upper White River Subbasins

Middle White River Subbasin. The Middle White River Subbasin drains an area of 45.5 square miles. It encompasses the topographically closed area that drains a reach of the White River bounded on the upstream end by the confluence of the White River and Greenwater River, and the White River and the West Fork of the White River. On the downstream end the subbasin terminates at the Mud Mountain Dam Reservoir. This section of the White River is 15 miles in length and drops in elevation from 1,693 feet at the confluence with Huckleberry Creek to approximately 1,227 feet where it joins the reservoir. The Upper White River and Middle White River Subbasins differ in that the Upper White River Subbasin tributaries are fed primarily by snowmelt, whereas tributaries of the Middle White River Subbasin are fed primarily by rainfall.

Greenwater River Subbasin. The Greenwater River Subbasin is defined by the closed topographic area drained by the Greenwater River and its tributaries. The subbasin occupies 76.1 square miles and is bounded by the Huckleberry Mountains on the north, the west slope of the Cascade Mountains on the east, and the Upper White River Subbasin to the south. Headwaters start at an approximate elevation of 5,804 feet, and the river drops to an elevation of 1,693 at the confluence with the White River, a length of 23 miles. The river is fed primarily by snowmelt.

Clearwater River Subbasin. The Clearwater River Subbasin, like the West Fork White River Subbasin, forms part of the western boundary of the basin. It drains an area of 37.7 square miles. The subbasin encompasses Clearwater River from its headwaters at an elevation of 5,403 feet to the point where it enters the Mud Mountain Dam Reservoir at an elevation of about 1,227 feet, a distance of 11.6 miles. Clearwater River and its tributaries are fed primarily by snowmelt.

West Fork White River Subbasin. The West Fork White River Subbasin forms the western boundary of the eastern portion of the basin. It starts from the Winthrop glacier of Mount Rainier, but at a lower elevation than the Fryingpan Subbasin. Encompassing a land area of 66.8 square miles, it is defined as the closed area draining the West Fork of the White River, which originates in the upper part of the subbasin. From its headwaters to the confluence with the White River, the river is fed by snowmelt over a length of 20 miles. The river elevation drops from 6,394 feet at the headwater area to 1,837 feet at the confluence.

Huckleberry Subbasin. Huckleberry Creek drains an interior portion of the upper basin between the Fryingpan and Upper White River Subbasins on the south and east and the West Fork White River Subbasin on the west. The subbasin drains a land area of 37.3 square miles. Huckleberry Creek is fed by snowmelt; from the headwaters to the confluence with the White River it is 13.9 miles long. From the headwater area the stream elevation drops from 6,539 to 2,077 feet.

Fryingpan and Upper White River Subbasins. The Fryingpan and Upper White River Subbasins include the upper reaches of the White River from its headwaters on the north flank of Mount Rainier downstream to the confluence with Huckleberry Creek. The division of the drainage area into two subbasins is based on the Fryingpan Subbasin draining headwater areas fed by glacial melt, whereas the Upper White River Subbasin primarily drains areas of snowmelt. Over 90 percent of the Fryingpan Subbasin lies within the Mount Rainier National Park boundary. The Fryingpan and Upper White River Subbasins encompass 61.7 and 47 square miles, respectively. The White River flows a distance of 16.7 miles in the Fryingpan Subbasin, dropping in elevation from 6,594 to 2,589 feet. The river flows a distance of 10.1 miles through the Upper White River Subbasin and drops in elevation from 2,589 to 1,837 feet.

Table 4-1
White River Subbasins

Subbasin	Total Area (mi^2)	Planning Area (mi^2)	Incorporated Areas within Pierce County (mi^2)	Federal Lands (mi^2)	Tribal Lands (mi^2)	Hydrology	Upstream and Downstream Extent
Clearwater River	37.7	0	0	37.7	0	Snowmelt	Clearwater River Watershed: Headwaters Clearwater River to confluence with White River
Greenwater River	76.1	0.2	0	71.0	0	Snowmelt	Greenwater River Watershed: Headwaters Greenwater River to confluence with White River
West Fork White River	66.8	0	0	66.8	0	Snowmelt/ springs	West Fork White River Watershed: Headwaters West Fork to confluence with White River
Huckleberry	37.3	0	0	37.3	0	Snowmelt	Huckleberry Creek Watershed: Headwaters Huckleberry Creek to confluence with White River
Fryingpan	61.7	0	0	61.7	0	Snowmelt	White River: Headwaters White River to Silver Creek tributary
Upper White River	47.0	7.8	0	39.2	0	Snowmelt	White River: Confluence with Silver Creek to West Fork tributary
Middle White River	45.5	0.1	0	7.1	0	Rainfall	White River: West Fork tributary to upstream end of Mud Mountain Dam Reservoir
Mud Mountain	55.0	0.5	0.6	1.4	0	Rainfall	White River: Upstream end of Mud Mountain Dam Reservoir to Boise Creek tributary
Lower White River	52.0	11.7	10.5	0	4.8	Rainfall	White River: Boise Creek tributary to confluence with Puyallup River
Lake Tapps	17.0	13.4	3.6	0	0	Rainfall	Lake Tapps Diversion Dam to Lake Tapps outlet
Total Basin	496.1	33.7	14.7	322.2	4.8		

Note:
mi^2: square miles

Table 4-2
Average Monthly Temperature

Station	Buckley 1 NE (450945)[a]		Mud Mountain Dam (455704)[b]		Greenwater (453357)[c]	
	Average Max. Temperature (°F)	Average Min. Temperature (°F)	Average Max. Temperature (°F)	Average Min. Temperature (°F)	Average Max. Temperature (°F)	Average Min. Temperature (°F)
Jan	45	32.6	43.5	30.9	36.6	26
Feb	49	34	46.6	32.3	42.2	29.3
Mar	53.2	35.6	49.5	33.8	46.6	30.1
Apr	58.9	38.6	54.4	37.2	53.9	33.6
May	65.4	43.4	60.6	42.3	61.8	39.2
Jun	70.3	47.9	65.4	46.9	66.1	44.2
Jul	76.3	50.4	72	50.7	73.1	46.7
Aug	76.2	50.6	72.3	50.6	72.4	46.1
Sept	70.5	47.2	67.7	47	67.5	42.1
Oct	60.1	41.8	58.7	41.1	56.1	36.8
Nov	50.5	36.7	49.4	35.4	44.2	31.5
Dec	45.5	33.5	44.5	32.1	38.2	28.8
Annual	60.1	41	57	40	54.9	36.2

Source: Western Regional Climate Center (2005)

[a] Period of Record 1931 to 2005.
[b] Period of Record 1939 to 2005.
[c] Period of Record 1939 to 1981.

Note:
°F: degrees Fahrenheit.

Table 4-3
Average Monthly Precipitation

Station	Buckley 1 NE (450945)[a]			Mud Mountain Dam (455704)[b]			Greenwater (453357)[c]		
	Average Total Precipitation (in.)	Average Total Snowfall (in.)	Average Snow Depth (in.)	Average Total Precipitation (in.)	Average Total Snowfall (in.)	Average Snow Depth (in.)	Average Total Precipitation (in.)	Average Total Snow Fall (in.)	Average Snow Depth (in.)
Jan	5.88	4.1	0	6.19	4.1	1	7.85	24.2	8
Feb	4.65	2.1	0	4.97	2.5	0	6.02	13.6	9
Mar	4.69	1.6	0	4.97	1.9	0	4.86	12.4	6
Apr	3.98	0.2	0	4.63	0.5	0	4.26	3.2	1
May	3.22	0	0	4.06	0	0	3.01	0.1	0
Jun	3.04	0	0	3.83	0	0	2.76	0	0
Jul	1.33	0	0	1.78	0	0	1.15	0	0
Aug	1.64	0	0	2.08	0	0	1.62	0	0
Sept	2.57	0	0	3.05	0	0	3.29	0	0
Oct	4.53	0.1	0	4.9	0	0	5.33	0.2	0
Nov	6.54	1	0	7.18	1.1	0	7.89	5.5	1
Dec	6.36	2.2	0	6.68	3.6	0	9	16.4	3
Annual	48.43	11.2	0	54.32	13.7	0	57.03	75.6	2

Source: Western Regional Climate Center (2005)

[a] Period of Record 1931 to 2005.
[b] Period of Record 1939 to 2005.
[c] Period of Record 1939 to 1981.

Note:
in.: inch.

4.3 LAND USE

The majority of the urban land development in the White River Basin has occurred west of Enumclaw (Figure 4-3). Development east of Buckley is limited to the Greenwater community and residences along major roads, including Crystal Village, Crystal Village II, and Crystal River Ranch. Dominant land uses in the eastern portion of the basin are logging and recreational, especially on lands south of the Greenwater and White Rivers, which are part of Mount Baker-Snoqualmie National Forest or Mount Rainier National Park (Figure 4-3). Unincorporated areas of Pierce County are present in both the western and eastern portions of the basin (Figure 4-3). Except for general physical characteristics, lands within the National Forest and National Park are not the focus of this basin plan. Figure 4-3 shows existing land use and Figure 4-4 shows zoning. Tables 4-4 and 4-5 summarize the data in these figures. Future land use is projected assuming that all vacant parcels will be developed according to their zoning (Figure 4-4).

The existing land use categories evaluated included the following:

- Commercial/services: shopping centers, restaurants, gas stations, banks, offices, marinas, and motels
- Education
- Industrial: furniture manufacturers, metal fabricators, and food product manufacturers
- Open space/recreational: golf courses, resort camps
- Public facilities
- Quasi-public facilities
- Residential: single-family homes, multifamily homes, mobile homes, and residential outbuildings
- Resource lands: agriculture, fishing activities, quarries, and timberland
- Transportation, communications, utilities
- Vacant: vacant commercial, industrial, and residential land
- Water bodies: lakes and saltwater tidelands
- Unknown or unclassified: parcels with incomplete or no GIS data.

4.3.1 Existing and Projected Land Use

The discussion of land use focuses mostly on the western portion of the basin where most development has occurred, in particular in unincorporated Pierce County. The analysis of land use is based on an inventory of Pierce County tax parcel information supplemented by data from the *Pierce County Comprehensive Plan* (Pierce County, 1995; amended 2006).

Cities and adjacent areas, communities, and towns in the basin include the following:

- Upper White River Subbasin: Crystal Village, Crystal Village II, Crystal River Ranch
- Mud Mountain Subbasin: city of Enumclaw
- Middle White River Subbasin: Greenwater
- Lower White River Subbasin: cities of Sumner, Auburn, Pacific, Edgewood, and Algona
- Lake Tapps Subbasin: cities of Bonney Lake and Buckley.

Eastern Portion of Basin

In the eastern portion of the basin, the border of Pierce and King Counties is defined by the Greenwater and White Rivers. Although unincorporated areas of Pierce County are present, they lie within either Mount Baker-Snoqualmie National Forest or Mount Rainier National Park. Zoning and existing land use reflect the mostly rugged terrain and recreational use of the lands. Zoning is predominantly forest and rural residential. Outside the National Forest and National Park boundaries, existing land use is mostly resource use or vacant (Figure 4-4). Future land use, based on zoning is projected to continue as resource use except in the Middle and Upper White River Subbasins, where some vacant land is projected to be developed as residential. The community of Greenwater is located along the White River in the upper part of the Middle White River Subbasin. The communities of Crystal Village, Crystal Village II, and Crystal River Ranch are located along the White River, in the Upper White River Subbasin, west of the area designated as vacant.

Western Portion of the Basin

The majority of land development has occurred in the western portion of the basin. East of Lake Tapps zoning is a combination of forest, agricultural, and residential, except for the cities of Enumclaw and Buckley (Figure 4-4). Most of the unincorporated land is currently zoned rural residential, except for smaller dispersed areas that are zoned either agricultural or Reserve 5. Land of the Muckleshoot Indian Tribe (MIT) is located north and east of the lake, adjacent to the White River. The main water feature east of the lake is the Lake Tapps diversion canal that starts near Buckley and flows west, entering the southeast corner of the lake. West of Lake Tapps most areas fall within the boundaries of Bonney Lake, Auburn, Sumner, Edgewood, Algona, and Pacific .

West of Lake Tapps, existing land use continues as a mixture of residential and vacant land in unincorporated Pierce County. Continuing west, however, land use changes, with commercial corridors and very limited industrial use west of the White River around Sumner and Pacific. Industrial and commercial land use is mostly between the East and West Valley Highways. Current commercial land use in the Lower White River Subbasin is estimated to be 0.9 percent and industrial use 0.2 percent (Table 4-4).

Lake Tapps and the surrounding area fall within the Lake Tapps Subbasin. Lake Tapps has long been a popular area for water recreation. Consequently the land use surrounding the lake is mostly residential or open space/vacant. The cities of Auburn on the north and Bonney Lake on the south border the lake. As shown in Table 4-4, industrial and commercial account for only 0.6 percent of the land use in the Lake Tapps Subbasin (a total of 54 acres).

Impervious Surface

Land use affects surface water hydrology by altering the landscape from its natural condition and changing water drainage, storage, and evaporation characteristics. The creation of impervious surfaces such as roads, buildings, and parking areas has a particularly important impact. Impervious surfaces block precipitation from soaking into the ground (infiltration) and reduce the amount of vegetated areas available to absorb precipitation, as occurs under natural conditions. Therefore, the effect of various land uses on surface water hydrology is taken into consideration by estimating the percentage of each subbasin area covered by impervious surfaces.

Current and projected future land use in each of the subbasins was analyzed to estimate changes in the percent of impervious surface. The results of the analysis are summarized by subbasin in Table 4-6. The method used to make these estimates was based on *Guidance for Basin Planning* (Pierce County 2000) and is described in Appendix C of this report.

As shown on Figure 4-5 and in Table 4-6, the impervious surface estimates for current land use in the subbasins range from 0 to 14 percent. The highest percentages are in the Lake Tapps, Lower White River, and Upper White River Subbasins with 10, 14, and 8 percent, respectively. The remaining subbasins, where data was available, range from 0 to 4 percent.

Future Percentage Impervious

Projected future land use, based on zoning, indicates a conversion of open space to residential and some commercial uses, predominantly in the Lake Tapps and Lower White River Subbasins, and some increase of residential in the Mud Mountain Subbasin (Figure 4-6). Table 4-6 summarizes the predicted future percent impervious areas for the White River Basin. As shown in the figures, there is the potential for increased impervious areas, and related surface water impacts to the water courses west of Lake Tapps.

The projected increases in impervious surface estimates for the Lower White River, Lake Tapps, and Upper White River Subbasins are 6, 3, and 2 percent, respectively. The remaining subbasins had smaller increases, ranging from 0 to 0.1 percent. Figures 4-5 and 4-6 show that the greatest change in land use is the increase in commercial development west of Lake Tapps, followed by the increase in conversion of agricultural and vacant land to residential development.

The eastern portion of the basin did not have a significant increase in percent impervious surface at build-out. However, in the western portion of the basin, the area west of Lake Tapps shows substantial projected increases in percent impervious surface at full build-out. Based on tax parcel data, the current and projected future percent impervious surface in the western portion of the basin are shown in Figures 4-5 and 4-6, respectively. As shown in the figures, there are significant increases and potential for surface water impacts to the prioritized rivers/tributaries from future development.

Table 4-4
Existing Land Use in the White River Basin

Existing Land Use	Lake Tapps	Lower White River	Mud Mountain	Middle White River	Greenwater	Clearwater	Upper White River	Fryingpan	Huckleberry	West Fork White River
Commercial/Services (Acres)	36	64	0	7	4.75	0	0	0	0	0
% of Subbasin	0.42%	0.86%	0%	0.05%	0.06%	0%	0%	0%	0%	0%
Education (Acres)	120	46	0	0	0	0	0	0	0	0
% of Subbasin	1.40%	0.61%	0%	0%	0%	0%	0%	0%	0%	0%
Industrial (Acres)	17.64	11	0	93	17	0	0	0	0	0
% of Subbasin	0.21%	0.15%	0%	0.63%	0.21%	0%	0%	0%	0%	0%
Mobile Homes (Acres)	307	544	8	0	0	0	8	0	0	0
% of Subbasin	3.59%	7.27%	0.08%	0%	0%	0%	0.23%	0%	0%	0%
Multifamily Residential (Acres)	26.55	11.46	0	0	0	0	0	0	0	0
% of Subbasin	0.31%	0.15%	0%	0%	0%	0%	0%	0%	0%	0%
Open Space/Recreational (Acres)	88.52	415	95	0	0	0	22	0	0	0
% of Subbasin	1.03%	5.55%	1%	0%	0%	0%	0.64%	0%	0%	0%
Public Facilities (Acres)	0.76	2.35	0	0	0	0	0	0	0	0
% of Subbasin	0%	0.03%	0%	0%	0%	0%	0%	0%	0%	0%
Quasi-Public Facilities (Acres)	8.75	7	0	0	0	0	0	0	0	0
% of Subbasin	0.10%	0.09%	0%	0%	0%	0%	0%	0%	0%	0%
Residential Outbuildings (Acres)	138	71	2	3	2	0	2	0	0	0
% of Subbasin	1.61%	1%	0.02%	0.02%	0.02%	0%	0.06%	0%	0%	0%

Table 4-4 (Continued)
Existing Land Use in the White River Basin

Existing Land Use	Lake Tapps	Lower White River	Mud Mountain	Middle White River	Greenwater	Clearwater	Upper White River	Fryingpan	Huckleberry	West Fork White River
Resource Land (Acres)	861	1,437	8,493	14,369	643	12,899	1,295	0	0	6,018
% of Subbasin	10.06%	19.21%	89.20%	97.39%	7.75%	99.85%	10.02%	0%	0%	100%
Single Family Residential (Acres)	2,325	1,957	6	23	15.6	0	299	0	0	0
% of Subbasin	27.16%	26.16%	0.06%	0.16%	0.19%	0%	8.75%	0%	0%	0%
Transportation, Communications, Utilities (Acres)	367	721	184	0	0	0	1.8	0	0	0
% of Subbasin	4.29%	9.64%	1.90%	0%	0%	0%	0.05%	0%	0%	0%
Unknown (Acres)	179	174	0	2	0	0	29.7	0	0	0
% of Subbasin	2.09%	2.33%	0%	0.01%	0%	0%	0.87%	0%	0%	0%
Vacant (Acres)	921	1,337	734	94	7,600	19	1,758	0	0	0
% of Subbasin	10.76%	17.87%	7.71%	0.64%	91.74%	0.15%	51.46%	0%	0%	0%
Water Bodies (Acres)	2,820	125	0	0	0	0	0	0	0	0
% of Subbasin	32.94%	1.67%	0%	0%	0%	0%	0%	0%	0%	0%
Unclassified(ROW/River Bottom) (Acres)	345	558	0	163	0	0	0	0	0	0
% of Subbasin	4.03%	7.46%	0%	1.10%	0%	0%	0%	0%	0%	0%
TOTAL SUBBASIN AREA[a] (Acres)	8,561	7,481	9,521	14,591	8,284	12,918	3,416	0	0	6,018

Note:
[a] Total subbasin area within the planning area.

Table 4-5
Zoning in the White River Basin

Zoning	Lake Tapps	Lower White River	Mud Mountain	Middle White River	Greenwater	Clearwater	Upper White River	Fryingpan	Huckleberry	West Fork White River
Agricultural (Acres)	1,559	1,411	0	0	0	0	0	0	0	0
% of Subbasin	18.21%	18.86%	0%	0%	0%	0%	0%	0%	0%	0%
Community Center (Acres)	0	19.27	0	0	0	0	0	0	0	0
% of Subbasin	0%	0.26%	0%	0%	0%	0%	0%	0%	0%	0%
Designated Forest Land (Acres)	0	0	9,207	14,531	8,171	12,918	3,010	0	0	6,018
% of Subbasin	0%	0%	96.70%	99.59%	98.64%	100%	88.11%	0%	0%	100%
Employment Center (Acres)	0	36.95	0	0	0	0	0	0	0	0
% of Subbasin	0%	0.49%	0%	0%	0%	0%	0%	0%	0%	0%
Gateway Community (Acres)	0	0	0	20	40	0	0	0	0	0
% of Subbasin	0%	0%	0%	0.14%	0.48%	0%	0%	0%	0%	0%
Master Planned Resort (Acres)	0	0	0	0	0	0	19	0	0	0
% of Subbasin	0%	0%	0%	0%	0%	0%	0.56%	0%	0%	0%
Moderate Density SF (Acres)	478	722.75	0	0	0	0	0	0	0	0
% of Subbasin	5.58%	9.66%	0%	0%	0%	0%	0%	0%	0%	0%
Neighborhood Center (Acres)	21.18	0.32	0	0	0	0	0	0	0	0
% of Subbasin	0.25%	0.004%	0%	0%	0%	0%	0%	0%	0%	0%
Park & Recreation (Acres)	8.49	93	0	0	0	0	0	0	0	0
% of Subbasin	0.10%	1.24%	0%	0%	0%	0%	0%	0%	0%	0%
Public Institutional (Acres)	0.13	90		0	0	0	0	0	0	0
% of Subbasin	0%	1.20%	0%	0%	0%	0%	0%	0%	0%	0%
Reserve 5 (Acres)	398	328.57	0	0	0	0	0	0	0	0

Table 4-5 (Continued)
Zoning in the White River Basin

Zoning	Lake Tapps	Lower White River	Mud Mountain	Middle White River	Greenwater	Clearwater	Upper White River	Fryingpan	Huckleberry	West Fork White River
% of Subbasin	4.65%	4.39%	0%	0%	0%	0%	0%	0%	0%	0%
Rural 5 (Acres)	0	0	0	0	0	0	0	0	0	0
% of Subbasin	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Rural 10 (Acres)	6,093	4,188	15	41	71	0	0	0	0	0
% of Subbasin	71.17%	55.98%	0.16%	0.28%	0.86%	0%	0%	0%	0%	0%
Rural 20 (Acres)	0	0	299	0	1.27	0	386	0	0	0
% of Subbasin	0%	0%	3.14%	0%	0.02%	0%	11.30%	0%	0%,	0%
Rural Farm (Acres)	0	36	0	0	0	0	0	0	0	0
% of Subbasin	0%	0.48%	0%	0%	0%	0%	0%	0%	0%	0%
Unclassified(ROW/River Bottom) (Acres)	3	575	0	0	0	0	0	0	0	0
% of Subbasin	0.04%	7.69%	0%	0%	0%	0%	0%	0%	0%	0%
TOTAL SUBBASIN AREA[a] (Acres)	8,561	7,481	9,521	14,591	8,284	12,918	3,416	0	0	6,018

Note:
[a] Total subbasin area within the planning area.

Table 4-6
Current and Projected Percent Impervious Surface

Subbasin	Current Percent Average Impervious Surface	Projected Future Percent Average Impervious Surface
Lower White River	14%	20%
Lake Tapps	10%	13%
Mud Mountain	4%	4%
Middle White River	0.3%	0.4%
Greenwater River	0.4%	0.4%
Clearwater River	0%	0%
West Fork White	—	—
Huckleberry	—	—
Upper White River	8%	10%
Fryingpan	—	—

Notes:
See Appendix C for more detail.
— Indicates no data available.

4.3.2 Population

The population is currently concentrated in the western portion of the basin (both cities and nearby unincorporated Pierce County). A large portion of the eastern part of the basin is located within Mount Rainier National Park or Mount Baker-Snoqualmie National Forest. However, a small portion of the eastern basin, along the White River, includes Enumclaw and adjacent areas (Figure 4-1).

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 700,820. According to the Puget Sound Regional Council's (PSRC) long-range population forecasts for the forecast analysis zones within Pierce County, the County was expected to increase 16 percent to 812,859 by 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 (PSRC, October 2001):

- 812,859 in 2010
- 892,314 in 2020
- 951,747 in 2030.

Pierce County population projections help predict future populations in the White River Basin. The estimated 2000 population in the White River Basin planning area was 12,881, which is 1.8 percent of the county's total population (700,820) in 2000. Assuming that the planning area will continue to capture at least 2 percent of the county's growth, it is estimated that in 2010, the population residing in the White River Basin planning area is approximately 16,300 and that in 2020, 18,000 people will reside within the basin.

Future population growth is expected to be greater in the western portion of the planning area due to urban influences. The eastern portion of the planning area is expected to retain its rural character.

4.4 GEOLOGY AND SOILS

This section summarizes the geology and soils of the White River Basin planning area, based on reports prepared by the U.S. Army Corps of Engineers (Corps), the U.S. Geological Survey (USGS), and the Upper Puyallup Watershed Committee (UPWC).

4.4.1 General Geology

The geology of the basin is composed of volcanic and sedimentary rocks, a drift plain with glacial till and outwash material, alluvium, and mudflow deposits with various overlying soils (Upper Puyallup Watershed Characterization 2002). Although the entire basin is underlain by bedrock consisting of volcanic and sedimentary rocks, outcrops of bedrock are evident only in the eastern portion of the basin. The volcanic deposits of andesite and basalt are hard and cannot be eroded readily. However, pyroclastic rocks associated with eruptions of Mount Rainier are unstable and tend to erode. Areas where these materials have been deposited in the eastern subbasins are prone to landslides, potentially introducing large volumes of materials to the rivers.

Bedrock in the western portion of the basin is overlain by thick deposits of unconsolidated glacial and fluvial sediments and a mudflow. The glacial deposits forming the current topography were deposited during the most recent glaciation in the region known as the Vashon Stage of the Frasier Glaciation. During the Vashon Glaciation, about 15,000 years ago, a glacial lobe of ice covered the eastern portion of the basin and retreated about 13,500 years ago. The sediments deposited by the glacial advance and retreat of the ice consist of glacial outwash and glacial till (USGS 1963). The outwash gravels deposited during retreat of the ice lobe (recessional outwash) tend to be well-sorted sands and gravels. These deposits can be highly permeable, providing a source of potable groundwater.

During advance of the glacial ice, sand and gravel deposits are formed from meltwaters (advance outwash). As the ice lobe advanced, deposits formed in front of the ice sheet. As the ice sheet advanced further, the advanced outwash was covered. Beneath the ice sheet, deposits composed of sand and gravel with a clay matrix called glacial till (locally known as hardpan) were formed above the advance outwash. Glacial till tends to be dense and has a low permeability.

About 5,700 years ago, a major geologic event called the Osceola mudflow altered the topography. The mudflow originated on the northeast flank of Mount Rainier near the headwaters of the White River (USGS 1963). It flowed down the White River and West Fork White River. East of Buckley the mudflow spread across the Puget Sound lowlands, forming a flat plain extending westward to about the eastern shore of Lake Tapps and occupied the White River Valley. The mudflow varies from about 75 feet thick to a few feet thick at the downstream terminus. The mudflow is composed of an unsorted and unstratified mixture of

subangular stones in a plastic sand-clay matrix. The mudflow has very low permeability, forming an aquitard that tends to impede surface water infiltration.

Starting near the eastern shore of Lake Tapps, the glacial drift plain is evident by the low, rolling glacial hills (drumlins) elongated in an northwest direction. Most of this material is composed of glacial till and has very low permeability.

Since the last period of glaciation, the White River and its tributaries have deposited large quantities of sediments within the floodplains. In the upper reaches of the basin, glacial action, high stream gradients, and erosion combine to produce large volumes of sediment. However, the entire lowlands area has not had time to develop a complex integrated drainage pattern on the drift or Osceola mudflow plain (USGS 1963).

4.4.2 Soils

The Pierce County (USDA SCS 1979) and King County (USDA SCS 1992) soils surveys provide mapping of soils in the western part of the White River Basin. Soils in the eastern mountainous portion of the basin are derived from volcanic materials.

Soil associations present in the western portion of the basin include the Kapowsin association, Alderwood-Everett association, Puyallup-Sultan association, and Buckley association. Much of the soil has poor draining characteristics and tends to retard infiltration of water. This condition, along with the presence of glacial till having low permeability, tends to increase ponding of water and runoff rather than deep infiltration and recharge of deep aquifers. The conditions also create a high potential for on-site sewage system failures.

The National Resource Conservation Service (NRCS) has classified soils into hydrologic soil groups to indicate the rates of infiltration and transmission (NRCS, 1986). Table 4-7 describes the four hydrologic soil groups. Figure 4-7 shows the distribution of hydrologic soil groups in the basin.

In the eastern portion of the basins, the soils are primarily Group B, moderately well-drained loam and Group C, poorly drained sandy clay loam. In the western portion of the basin, soils are primarily Group C and Group D, which have poor drainage characteristics and slow infiltration rates.

Table 4-7
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 to 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 to 0.15 in./hr)
D	Soils are clayey, have a high water table, or are shallow to an impervious layer	Very slow infiltration rates

	(clay loam, silty clay loam, sandy clay, silty clay, or clay)	(0 to 0.05 in./hr)

4.5 NATURAL AND CONSTRUCTED DRAINAGES

Major rivers and streams in the basin include the Greenwater River, White River, West Fork White River, Clearwater River, and Huckleberry Creek. The dominant water bodies in the basin are the Mud Mountain Reservoir (during periods of flood control) east of Buckley and Lake Tapps in the western portion of the basin. The lake has an approximate surface area of 2,296 acres (UPWC 2002). As shown in Figure 4-1, many smaller streams and lakes are present in the basin, especially in the eastern portion.

4.5.1 Natural Drainage System

The White River travels 57 miles and drains 496 square miles of land (Figure 4-1) before entering the Puyallup River at RM 10.5, near the city of Sumner (Corps, 2002). Its headwaters begin where the Emmons and Fryingpan Glaciers meet on the north flank of Mount Rainier. Downstream of the headwaters, the river is joined by many smaller tributaries, including Silver Creek, Huckleberry Creek, and Camp Creek. The west fork of the White River joins the White River just upstream of the confluence of the White and Greenwater Rivers, near the town of Greenwater. The West Fork White River is fed by glacial meltwater whereas Huckleberry Creek and Greenwater River are fed principally by snowmelt. Clearwater River, the southernmost river, is fed by a combination of snowmelt and spring discharge (UPWC 2002).

The White River continues westerly with unconstrained flows until it reaches Mud Mountain Dam. The dam, which began operation in 1948, is a federally authorized flood control project located at RM 29.6. It is operated by the Corps to control flooding in the lower Puyallup floodplain. A trap and haul system is currently being used to transport fish around the dam.

Below Mud Mountain Dam, the White River continues its westerly flow. East of Lake Tapps, the river turns northward toward the city of Auburn. It curves in a southerly direction west of Lake Tapps until reaching the confluence with the Puyallup River. Before 1906, the White River flowed north from Auburn to join the Green River and ultimately discharged into Seattle's Elliot Bay. In 1906, a debris jam blocked the channel of the White River and diverted all the floodwaters away from King County down the Stuck River and south into the Puyallup River. The debris dam was replaced by a permanent diversion wall located at the game farm park in Auburn. The White River remains in this location today.

The White River and its tributaries are listed in Table 4-8. Streams currently affected by urbanization or degradation of water quality were prioritized for characterization in this basin report. These streams are discussed in Section 4.6.

4.5.2 Mud Mountain Dam

Mud Mountain Dam is located on the boundary between King and Pierce Counties (RM 29.6). This is a single-purpose dam providing flood control for the Lower White and Puyallup River valleys. As a single-purpose flood control dam, it passes all inflow, except during times of flood

or maintenance, and does not store water during low flow periods. Minimum instream flow releases have not been set for the dam.

Table 4-8
Prioritized Streams in White River Basin

Priority[a]	Surveyed Phase I	Stream Name[b]	Relationship With River System	Location	Length in Study Area[c] (miles)	Length in Planning Area (miles)	Notes
1	X	Jovita (10.0033)	Direct tributary to WR	Auburn area	1.0	0	Urbanized Lower White River tributary
1	X	Strawberry Creek or Salmon Creek (10.0035)	Direct tributary to WR	Auburn area	1.8	0	Urbanized Lower White River tributary, 303(d) list
1	X	Unnamed (10.0036)	Strawberry Creek	Auburn area	0.2	0	Urbanized Lower White River tributary
2	X	Unnamed (10.0032)	Direct tributary to WR	Auburn area	3.4	0	Urbanized Lower White River tributary
2	X	Unnamed (10.0034)	Jovita	Auburn area	0.5	0	Urbanized Lower White River tributary
2	X	Unnamed (10.0037)	Salmon Springs	Auburn area	1.1	0	Urbanized Lower White River tributary
2	X	Unnamed (10.0038)	Direct tributary to WR	Auburn area	1.4	0	Urbanized Lower White River tributary
2	X	Unnamed (10.0039)	Direct tributary to WR	Auburn area	1.1	0	Urbanized Lower White River tributary
2	X	Unnamed (10.004)	Direct tributary to WR	Auburn area	1.8	1.8	Urbanized Lower White River tributary
2	X	Unnamed (10.0051)	Direct tributary to WR	Auburn area	0.6	0.6	303 list Lower White River tributary
2	X	Unnamed (10.0052)	Direct tributary to WR	Auburn area	1.1	1.1	303 list Lower White River tributary
2	X	Unnamed (10.0053)	Direct tributary to WR	Auburn area	0.4	0.4	303 list Lower White River tributary
3	X	White River (10.0031) RM 0–5.5	N/A	Pierce County	5.5	0	303 list Lower White River in Pierce County
3	X	White River (10.0031) RM 12–24.3	N/A	Pierce/King County border	12.3	10.1	303 list Lower White River in Pierce County
3	X	Greenwater River (10.0122)	Greenwater River	Greenwater River drainage	4.5	4.5	303 list Upper White River tributary
4		Clearwater River (10.008)	Clearwater River	Clearwater area	5.8	5.8	303 list Upper White River tributary
4	X	W. Fork White River (10.0186)	W. Fork White River	West Fork area (below RM 1)	1.0	1.0	303 list Upper White River tributary
5	X	White River (10.0031) RM 5.5–12	N/A	King County	6.5	0	303 list Lower White River in King County
6		Unnamed (10.0116)	Direct tributary to WR	West Fork area	2.1	2.1	Anadromous tributary in forest land

Table 4-8 (Continued)
Prioritized Streams in White River Basin

Priority[a]	Surveyed Phase I	Stream Name[b]	Relationship With River System	Location	Length in Study Area[c] (miles)	Length in Planning Area (miles)	Notes
6		Rocky Run Creek (10.0117)	Direct tributary to WR	West Fork area	1.3	1.3	Anadromous tributary in forest land
6		Canyon Creek (10.0077)	Canyon Creek	Clearwater area	0.7	0.7	Anadromous tributary in forest land
6		Unnamed (10.0081)	Clearwater River	Clearwater area (anadromous reach)	0.7	0.7	Anadromous tributary in forest land
6		Unnamed (10.0082)	Clearwater River	Clearwater area (anadromous reach)	0.3	0.3	Anadromous tributary in forest land
6		Falls Creek (10.0083)	Clearwater River	Clearwater area (anadromous reach)	0.3	0.3	Anadromous tributary in forest land
6		Mineral Creek (10.0085)	Clearwater River	Clearwater area (anadromous reach)	0.7	0.7	Anadromous tributary in forest land
6		Byron Creek (10.0087)	Clearwater River	Clearwater area (anadromous reach)	0.2	0.2	Anadromous tributary in forest land
6		Lyle Creek (10.0088)	Clearwater River	Clearwater area (anadromous reach)	0.5	0.5	Anadromous tributary in forest land, 303(d) list
6		Milky Creek (10.0089)	Clearwater River	Clearwater area (anadromous reach)	0.2	0.2	Anadromous tributary in forest land, 303(d) list
6		Camp Creek (10.0112)	Camp Creek	West Fork area (anadromous reach)	1.0	1.0	Anadromous tributary in forest land
6		Unnamed (10.0187)	W. Fork White River	West Fork area	1.0	1.0	Anadromous tributary in forest land

Table 4-8 (Continued)
Prioritized Streams in White River Basin

Priority[a]	Surveyed Phase I	Stream Name[b]	Relationship With River System	Location	Length in Study Area[c] (miles)	Length in Planning Area (miles)	Notes
6		Unnamed (10.0188)	W. Fork White River	West Fork area	0.2	0.2	Anadromous tributary in forest land
6		Unnamed (10.0189)	W. Fork White River	West Fork area	0.2	0.2	Anadromous tributary in forest land
6		Unnamed (10.019)	W. Fork White River	West Fork area	0.1	0.1	Anadromous tributary in forest land
7		White River (10.0031) RM 24.3–29.5	N/A	Buckley Dam, Mud Mt. Dam	5.2	4.5	Low priority (no 303 list issues)
7		White River (10.0031) RM 29.5–35.4	N/A	Mud Mt. Reservoir Reach	5.9	5.9	Low priority (no 303 list issues)
7		White River (10.0031) RM 35.4–49.2	N/A	Clearwater River, W.F. White River	13.8	13.8	Low priority (no 303 list issues)
7		White River (10.0031) RM 49.2–52.5	N/A	Above W.F. White River	3.3	3.3	Low priority (no 303 list issues)
7		Unnamed (10.0068)	Direct tributary	Buckley area	1.4	1.4	Low priority (no 303 list issues)
7		Unnamed (10.0069)	Direct tributary	Buckley area	2.6	2.6	Low priority (no 303 list issues)
7		Unnamed (10.0106)	Direct tributary	Clearwater area	1.2	1.2	Low priority (no 303 list issues)
7		Rocky Run Creek (10.0117)	Direct tributary	West Fork area	1.8	1.8	Low priority (no 303 list issues)
7		Unnamed (10.0185)	Direct tributary	West Fork area	1.3	1.3	Low priority (no 303 list issues)
7		Old Pond Creek (10.007)	Old Pond Creek	Buckley area	4.8	4.8	Low priority (no 303 list issues)
7		Unnamed (10.0071)	Old Pond Creek	Buckley area	1.2	1.2	Low priority (no 303 list issues)
7		Unnamed (10.0072)	Old Pond Creek	Buckley area	1.9	1.9	Low priority (no 303 list issues)
7		Canyon Creek (10.0077)	Canyon Creek	Clearwater area	4.2	4.2	Low priority (no 303 list issues)
7		Unnamed (10.0078)	Canyon Creek	Clearwater area	0.9	0.9	Low priority (no 303 list issues)
7		Unnamed (10.0081)	Clearwater River	Clearwater area	1.4	1.4	Low priority (no 303 list issues)
7		Unnamed (10.0082)	Clearwater River	Clearwater area	2.1	2.1	Low priority (no 303 list issues)
7		Falls Creek (10.0083)	Clearwater River	Clearwater area	1.8	1.8	Low priority (no 303 list issues)
7		Unnamed (10.0084)	Clearwater River	Clearwater area	1.5	1.5	Low priority (no 303 list issues)

Table 4-8 (Continued)
Prioritized Streams in White River Basin

Priority[a]	Surveyed Phase I	Stream Name[b]	Relationship With River System	Location	Length in Study Area[c] (miles)	Length in Planning Area (miles)	Notes
7		Mineral Creek (10.0085)	Clearwater River	Clearwater area	2.0	2.0	Low priority (no 303 list issues)
7		Unnamed (10.0086)	Clearwater River	Clearwater area	1.2	1.2	Low priority (no 303 list issues)
7		Byron Creek (10.0087)	Clearwater River	Clearwater area	2.3	2.3	Low priority (no 303 list issues)
7		Lyle Creek (10.0088)	Clearwater River	Clearwater area	1.7	1.7	Low priority (no 303 list issues)
7		Milky Creek (10.0089)	Clearwater River	Clearwater area	1.4	1.4	Low priority (no 303 list issues); 2008 Water Quality Assessment 303(d) list
7		Unnamed (10.009)	Clearwater River	Clearwater area	1.3	1.3	Low priority (no 303 list issues)
7		Unnamed (10.0091)	Clearwater River	Clearwater area	1.1	1.1	Low priority (no 303 list issues)
7		Unnamed (10.0092)	Clearwater River	Clearwater area	1.1	1.1	Low priority (no 303 list issues)
7		Camp Creek (10.0112)	Camp Creek	Clearwater area	2.6	2.6	Low priority (no 303 list issues)
7		Unnamed (10.0113)	Camp Creek	West Fork area	1.4	1.4	Low priority (no 303 list issues)
7		Unnamed (10.0114)	Camp Creek	West Fork area	1.4	1.4	Low priority (no 303 list issues)
7		Unnamed (10.0115)	Camp Creek	West Fork area	1.0	1.0	Low priority (no 303 list issues)
7		W. Fork White River (10.0186)	W. Fork White River	West Fork area (above RM 1)	1.0	1.0	Low priority (no 303 list issues)
7		Unnamed (10.0187)	W. Fork White River	West Fork area	0.8	0.8	Low priority (no 303 list issues)
7		Unnamed (10.0188)	W. Fork White River	West Fork area	1.7	1.7	Low priority (no 303 list issues)
7		Unnamed (10.0189)	W. Fork White River	West Fork area	0.4	0.4	Low priority (no 303 list issues)
7		Unnamed (10.019)	W. Fork White River	West Fork area	0.5	0.5	Low priority (no 303 list issues)
7		Unnamed (10.0191)	W. Fork White River	West Fork area	1.4	1.4	Low priority (no 303 list issues)
				Total Length:	138.9		
				Approximate Length Surveyed:	42.0		(Scoped to survey 25–50 miles)
					30%		

Source: Williams et al. (1975), Ames and Bucknell (1981)

Table 4-8 (Continued)
Prioritized Streams in White River Basin

[a] Priorities:

1: Lower White River area tributary streams flowing through developed areas with relatively important salmon habitat.
2: Lower White River area tributary streams flowing through developed areas or listed in one of the 303 list categories.
3: Mainstem White River within Pierce County (303 list issues) and anadromous reach of tributary (in unincorporated Pierce County).
4: Upper White River area (above Mud Mountain Dam) tributary streams on 303 list.
5: Lower White River within King County (303 list issues and flows into lowest portion of river within Pierce County).
6: Anadromous reaches of tributary streams traversing forest lands.
7: Reaches of tributary streams traversing forest lands above the range of anadromy and the mainstem White River above the Buckley diversion dam (not on 303 list).

[b] Unnamed streams listed by Washington Stream Catalog Number (or Stream Number). Example 10.0251: The first two digits (10) represent the WRIA number and the four digits following the decimal point indicate the 251st stream in WRIA 10.

[c] Study area is defined as all parts of the White River Basin in incorporated or unincorporated areas of Pierce County (does not include National Forest or National Park land).

Notes:
Table does not include all streams shown on USGS quadrangle maps.
N/A: not applicable.
RM: river mile.
USGS: U.S. Geological Survey.
W.F.: West Fork.
WR: White River.

The dam has a flood control capacity of 106,275 acre-feet (Corps, 2004). Normally, during non-flood stages the reservoir is empty. Debris transported into the reservoir consists of both drift (trees, logs, and other forest material) and river bedload or sediment. Wood debris is either salvaged for booms, firewood, habitat logs, and other projects or it is ricked into piles and burned.

An estimated 8,000 to 10,000 cords of wood are captured annually behind the dam (WCC 1999). River bedload or sediment deposited while the pool is high is eroded and passed through the outlets by river flow when the pool is evacuated. This is altering the White River's natural sediment transport regime.

The Mud Mountain Dam influences flows in the White River during periods of flood regulation (Corps, 2002). Under the original water control plan, water stored in Mud Mountain Dam was discharged to the White River at up to 17,600 cubic feet per second (cfs). Channel capacity of the White River downstream of Mud Mountain Dam was estimated to be at least 20,000 cfs. Field observations made in the 1970s indicated that flooding in the White River downstream of the dam was occurring with Mud Mountain Dam discharges as low as 12,000 cfs. The reduced flood capacity of the river was attributed to multiple factors including encroachment of development along the channel, accretion of sediments in the channel, and limitations on channel dredging (Corps, 2002). In recent years discharges from Mud Mountain Dam have been limited to 12,000 cfs when feasible. Specific areas with flooding issues mentioned in the Corps report include the Red Creek area just downstream of the dam, MIT fish hatchery, Buckley Meadows subdivision, Sumner golf course, residences near the intersection of 8th Street and 138th Avenue East in Sumner, the Sumner sewage treatment plant. During a storm event in January 2009, Corps released 11,700 cfs from the dam, and unanticipated flooding occurred in the city of Pacific. The apparent cause of flooding was a significantly reduced channel capacity (Corps, 2009).

No complete account of past flood losses is available. It has been estimated (Corps, 2002) that the total damage from floods of December 1917 and January 1919 was $400,000. Although some channel capacity has been lost over the operational history of the dam and some flood damage is likely at flows below 12,000 cfs, flood damage has been significantly reduced. Project operations during the February 1996 flood of record resulted in $146.1 million in damages prevented, accounting for almost half of the total damages prevented during the 50-plus years of operation. Total damages prevented by Mud Mountain Dam through fiscal year 1999 are estimated at $308,152,000.

4.5.3 Lake Tapps and Power Plant

Lake Tapps is the only significant lacustrine water body in the White River Basin. Lake Tapps was built to create storage for the PSE White River hydroelectric project, which came on line in 1912 and suspended operations in January 2004. In 2009, the Alliance purchased Lake Tapps and its water rights for planned use as water supply. Approximately 2.5 miles of earthen dikes and embankments were built around four small natural lakes to create the current Lake Tapps.

The County does not own these dikes. They are owned and maintained by the Alliance to control flooding of water.

A diversion dam on the White River (RM 24.3) is used to fill the lake. The diversion dam is an 11-foot-high structure consisting of a concrete- and rock-filled crib structure 352 feet long and 4 feet high. The structure is topped with 7-foot-high flash boards. The Corps has a cooperative agreement with PSE to maintain the structure. However, flooding in November 2006 damaged the structure and spawning salmon had difficulty using the adjacent fish ladder in the fall of 2007. Corps workers trap spawning salmon at the fish ladder and truck them approximately 5 miles upstream of Mud Mountain Dam.

The 21-mile stretch of White River between the diversion dam and the return canal is referred to as the bypass reach or the reservation reach. Although several minor drainages also feed Lake Tapps, the White River diversion dam is responsible for the vast majority of water supply to the lake.

Water is carried from the lake through a 12-foot-diameter concrete tunnel entering the forebay, then is conveyed via penstocks to the powerhouse. The powerhouse discharges water into the tailrace, and the water is then carried via the Dieringer Canal to the White River. Additional information regarding Lake Tapps is provided in Section 4.7.

4.5.4 White River Flooding Issues

Flooding in the Lower White River Basin is a natural phenomenon that has been mitigated by means of engineered structures (dams and levees) and in some cases exacerbated by development and the increase in impervious surfaces. The discussion of flooding in this section addresses these two types of flooding: riverine and stormwater.

Riverine Flooding

Riverine flooding as used here refers to the flooding that occurs due to the natural hydrology of a river.

The Mud Mountain Dam is the primary flood control structure on the White River, beginning operation in 1942. An informal agreement between the Corps, the MIT, and Pierce and King Counties limits the rate of water release from the dam to 12,000 cfs, when feasible (Corps, 2002).

Due to curtailment of maintenance at Mud Mountain Dam and due to development along the White River below the dam, flood damage in some areas might be expected at flows as low as 6,000 cfs (Corps, 2002). However, a pool evacuation occasioned by the flood of February 1996 resulted in a release from the dam of 13,500 cfs, which caused no “major damage in the reach above the mouth of the White.” Release up to the legal limit of 18,000 cfs (the 100-year flood, estimated by the Corps taking into account the operating rules of the dam [USGS 1988]), if necessary to prevent damage to the dam or catastrophic failure of the dam, could result in severe flooding below the dam.

The Corps (2002) listed the following locations as specific areas threatened by discharges of 12,000 cfs from the Mud Mountain Dam:

- Residences in the Red Creek area just downstream from the dam
- Muckleshoot Tribe fish hatchery
- Buckley Meadows subdivision
- Sumner golf course
- Residences near intersection of 8th Street East and 138th Avenue East in Sumner
- Sumner sewage treatment plant.

In January 2009, flooding occurred in the city of Pacific when the Corps had to release 11,700 cfs of water from the dam during a storm event.

Pierce County participates in the federal flood insurance program. FEMA has produced flood insurance rate maps (FIRMs) for many areas in the basin, which delineate the 100-year and 500-year floodplains (the FIRMs are currently being revised). Current FIRMs are shown on Figure 4-1. Table 4-9 shows the acreage in each subbasin of the White River Basin that falls within the 100-year and 500-year floodplains.

Table 4-9
100- and 500-Year Floodplain Areas by Subbasin

Subbasin	Area in 100-Year Flood Zone (acres)		Area in 500-Year Flood Zone Outside of 100-Year Zone (acres)	
	Total Subbasin	Planning Area	Total Subbasin	Planning Area
Lower White River	4,551	2	459	<1
Lake Tapps	3,146	8	47	<1
Mud Mountain	2,492	1	44	0
Middle White River	1,474	1	1	0
Greenwater River	226	0	0	0
Clearwater River	175	0	34	0
Upper White River	640	0	3	0
West Fork White River	1,337	0	0	0
Huckleberry	15	0	0	0
Fryingpan	658	0	0	0

Pierce County Surface Water Management maintains a system of flood control levees along the White River. According to the 2005 Capital Improvement Program (CIP), prepared by Surface Water Management, 6 percent (1,840 of 29,209 linear feet of levee) on the White River levee system is currently “adequate” (i.e., provides 100-year protection).

Stormwater Flooding

Stormwater flooding can occur when elements of the storm drainage system are blocked or have reduced capacity due to debris or inadequate maintenance, or when conveyance capacity

is no longer adequate due to land use changes. Stormwater flooding is addressed through routine maintenance, response to citizen complaints, and, if necessary, capital improvement projects to provide increased conveyance capacity (e.g., culvert replacement) or enhanced detention storage.

Many of the priority tributaries in the basin are likely to experience flashy hydrology where there has been extensive use of culverts and ditching to straighten channel reaches. Such tributaries have often lost associated wetlands and lost their capacity to temporarily store stormwater runoff. Figure 4-8 shows remaining wetlands east of Lake Tapps that may provide continued flow attenuation in Tributary 0051, but west of Lake Tapps development has substantially reduced the presence of wetlands.

Figures 4-9 and 4-10 show the areas in the White River Basin with the greatest potential to experience stormwater flooding due to changes in percent impervious surface. The tributaries that appear to be most threatened from potential new development are 0032, 0037, and 0038. As described in other sections of this report, many of these tributaries have already experienced habitat degradation due to channel straightening, wetland loss, and changed hydrology. Pierce County manages this flood potential in its Site Development Standards, which specify that peak discharges from new developments must match predeveloped discharge rates. The County may also provide regional stormwater detention for flood control storage on a broader scale.

4.5.5 Constructed Drainage System

In addition to the large diversion of White River flows to create Lake Tapps, the natural drainage system of the White River Basin has been modified substantially due to development. A useful measure of the extent of development is the percentage of impervious surface (shown in Figure 4-5). Development has resulted in an extensive network of stormwater pipes, ditches, detention facilities, and infiltration facilities intended to deal with the changed hydrologic regime created by the development. Some of the natural drainage ways (tributaries to the White River) have been straightened or enlarged to accommodate development. Culverts and bridges have also been constructed throughout the basin at driveway, road, highway, and railroad crossings.

There are multiple segments of levees and revetments along the White River mainstem. They are located on both sides of the White River, from its mouth to where it crosses the Pierce/King county line northwest of Lake Tapps. The levees and revetments were originally constructed to provide flood protection and bank protection (respectively) for public infrastructure and residents along the White River. The levees are approximately 29,200 feet long and are maintained by Surface Water Management. These levees are located in the reach of the river that will be included in the Rivers Flood Hazard Management Plan.

Pierce County also has responsibility on the upper White River for an 800+/- lineal foot segment of levee near the town of Greenwater, which provides a level of flood protection to an area known as Greenwater Village.

4.6 AQUATIC AND RIPARIAN HABITAT

An evaluation of the aquatic and habitat characteristics of streams in the White River Basin is important to develop actions needed to mitigate adverse habitat impacts. To characterize the aquatic and riparian habitat in the basin, the rivers/streams and potential issues were first summarized. URS then worked with Pierce County to rank the streams and prioritize which river or stream would be included in the Phase I characterization (Table 4-8).

This section discusses field observations made during URS field surveys of the prioritized rivers and streams conducted from September 2004 through November 2004. Figures 4-9 and 4-10 show the stream reaches surveyed in the basin. Figure 4-11 shows the stream reaches surveyed in the eastern subbasins. In some cases, such as Tributaries 0052 and 0053, the stream survey found that the GIS map coverage did not match the current stream course. The sections actually surveyed are shown in yellow on all maps. During the Phase I characterization, the following watercourses were inventoried:

- White River mainstem from the confluence with the Puyallup River to the Lake Tapps diversion dam near Buckley (Figure 4-12). The survey included Tributaries 0032 through 0040 and 0051 through 0053 (Figures 4-13 through 4-15) to this section of the White River.
- Lower reach of the Greenwater River mainstem (Figure 4-16)
- Lower reach of the West Fork White River (Figure 4-16).

The Ecosystems Diagnosis and Treatment (EDT) Level 2 parameters (Pierce County 2000) and the Tri-County guidance (Pierce County 2000) as described in Appendix E were used to survey prioritized stream reaches. EDT is a system for rating the quality, quantity, and diversity of habitat along a stream relative to the needs of fish such as coho or Chinook salmon.

The EDT method can be used to identify the potential for a stream under a set of conditions such as those that occur now and help in the assessment of conditions and a prioritization of restoration needs. The Urban Stream Baseline Evaluation Method (USBEM) in the Tri-County guidance provides characterization of the aquatic and riparian habitat and geomorphic channel constraints on watershed or channel alteration.

Detailed stream reach information using the EDT and Tri-County methods is presented in Tables F-1 and F-2 in Appendix F. Photos also are presented in Appendix F along with the physical characteristics of the streams (Table F-3), potential fish barrier measurements (Table F-4), and reach break rationale (Table F-5).

As part of the characterization of tributaries, two stream gauging stations were installed on tributaries in the Lower White River Subbasin. Stream gauges and monitoring instruments were installed and operated on Salmon Creek (0032) (Figure 4-13) and Tributary 0051 (Figure 4-15). Data collected at the gauges from August 2005 through January 2006 is included in Appendix G. Flow information from these stations will be used to assess existing and potential future flooding and water quality issues. Pierce County performed all water quality and benthic macroinvertebrate sampling at the two sites and on three other tributaries. A

preliminary copy of the results of the Pierce County water quality data is included in the Appendix G.

4.6.1 White River Mainstem (0031)

The White River mainstem was surveyed by URS in the fall of 2004. The survey extended from the confluence of the White River with the Puyallup River upstream for a distance of about 24 miles. The White River west and north of Lake Tapps has been channelized in many locations and is affected by agriculture, rural development, and some light industrial activities. The cities of Sumner, Auburn, and Buckley are located within the floodplain of the river. Enumclaw and Greenwater are located on the river but upstream of the Lake Tapps diversion dam. Floodplain width is variable, ranging from less than 100 to 1,000 feet. Bankfull width ranges from 80 to 500 feet, but the bankfull depth is more constant, averaging 5.5 feet.

Riparian cover consists of a hardwood forest with willows, red alder, black cottonwood, black hawthorn, big leaf maple, and Pacific dogwood being the dominant riparian trees west of Lake Tapps. The riparian forest becomes a mix of hardwood and conifer trees, with western hemlock, western red cedar, and Douglas fir being the dominant conifers. Hazelnut, salmonberry, red elderberry, red osier dogwood, and invasive Himalayan and evergreen blackberries are the dominant shrubs.

The White River contains anadromous runs of steelhead and coastal cutthroat trout; fall- and spring-run Chinook, coho, chum, and pink salmon; and a small run of riverine sockeye salmon. Resident coastal cutthroat trout and bull trout also are present and sea-run bull trout may occur in the system. Fall-run Chinook, chum, and pink salmon spawning occurs primarily below the diversion dam; steelhead trout and spring-run Chinook salmon primarily spawn above Mud Mountain Dam. Coho salmon and coastal cutthroat trout spawn and rear primarily in tributary streams throughout the basin. Bull trout spawning occurs only in snowmelt-fed tributaries in the upper White River Basin above Mud Mountain Dam.

Reach observations on the White River mainstem are summarized in this section and reaches are identified in Figure 4-12. Reach lengths, physical features present at reach ends, and overall aquatic and riparian conditions are summarized in Table 4-10, with details of the reach characterizations given in Appendix F.

Reach 01. Reach 01 is between the outlet of the Dieringer Canal and the confluence with the Puyallup River, and located within the city of Sumner. The reach is confined, with very little channel migration. Banks are steep, with little shallow water habitat present. The stream is mostly run habitat (deep, with no pools). The substrate is mostly silt and sand, with some cobble and gravel present. This reach is used primarily as a migration corridor but also provides rearing habitat for cutthroat (all cutthroat trout present in the surveyed portion of the White River are coastal cutthroat trout subspecies) and summer/fall Chinook salmon (WCC 1999). Some rearing of juvenile steelhead trout and coho salmon is likely to occur in the reach. The riparian corridor is narrow and varies between being dominated by shrubs and trees. Most of the land use is agricultural or industrial parks.

Reach 02. Reach 02 is between the outlet of the Dieringer Canal and the Stewart Road Bridge. This reach is located within the City of Sumner. The channel is largely confined as in Reach 01, with similar riparian habitat and land use. However, a few riffles and pools are present as are limited spawning gravels for summer/fall Chinook, chum, and pink salmon (it is unknown whether they are utilized). A golf course is on the left bank in the lower-to-middle part of the reach. Fish use is similar to that of Reach 01, but some spawning may occur in this reach.

Reach 03. Reach 03 is located between the Auburn game farm and Stewart Road Bridge. The first mile of this reach is within unincorporated Pierce County, and then the reach continues into King County. .(Reaches 01, 02, and 03 are also known as the Stuck River). Numerous levees and much residential development are along this reach. Riparian canopy is present through much of the reach's length but is rather narrow in most areas. The channel has a moderate amount of pool and riffle habitat, and much more spawning gravel is present than was observed in Reach 02. Fish use is similar to that of Reach 02, but more spawning by chum, pink, and summer/fall Chinook salmon likely occurs, and yearling steelhead trout are more likely to use this habitat.

Reach 04. Reach 04 is between the Auburn game farm and a major pipeline crossing on the Muckleshoot reservation. This reach starts in King County, and the last 1.5 miles are located within the MIT tribal lands, The reach has fair spawning habitat for steelhead trout, chum, pink, and summer/fall Chinook salmon and rearing habitat for all of the above species, plus cutthroat trout. Most of the floodplain corridor is forested, with the exception of the Auburn game farm park and a small amount of residential land downstream from the diversion levee (1915 diversion dam that stopped the White River from flowing into the Green River). A few side channels are present, and there is a smaller amount of large woody debris (LWD) than upstream in Reach 05.

Reach 05. Reach 05 is located between a pipeline that crosses the river and Muckleshoot tribal land. The first three miles of this reach are located within MIT tribal lands, and the remaining 0.25 mile is within unincorporated Pierce County. This reach has the best spawning and rearing habitat for salmonids available in the White River below the Buckley diversion dam. There are numerous side channels and the river has a relatively normal braided channel typical of a glacial river. Most of the floodplain and the surrounding valley walls are forested with second growth forest, and there is more LWD present than elsewhere below the Buckley diversion dam. Numerous pools occur at the junctures of channels and at bends in the river, as well as near a moderate number of logjams that are present at bends in the river. There are also several areas where ponds and small connecting side channels are present in forested side terraces between the valley walls and the river. Some riffles in this reach of the river may be too shallow for adult salmon (Chinook) spawner passage during periods of low water.

Reach 06. The reach is located along the border of Pierce and King County, and is within unincorporated Pierce County. The first mile of the reach is located within MIT tribal lands. The reach is from RM 14.7 to RM 19.0. This reach has fair spawning gravel and some deep pools where braids in the river join or where the river bends and comes into contact with the valley walls. A few residences are present on the floodplain, but access roads are few and most of the roads are private. Most of the floodplain is forested, but some parts have been clear-cut

recently (away from the river channel). Several small tributaries on the King County side provide spawning and rearing habitat for coho and chum salmon. Fish use is similar to that of Reaches 05 and 07, but there is substantially less side channel habitat present than in Reach 05. Some riffles in this reach of the river may be too shallow for adult salmon spawner passage during periods of low water.

Reach 07. This reach is along the border between Pierce County and King County, and is mostly within unincorporated Pierce County. The last two miles are within the city of Buckley. This reach is from RM 19.0 to the Buckley diversion dam. This reach is similar to Reach 06 but has slightly more gradient and very little side channel habitat. Most of the stream channel consists of runs, with little LWD or pools present. The stream channel does not appear to have any riffle areas wide and shallow enough to create a problem for the passage of Chinook salmon spawners.

Table 4-10
Survey of Stream Reach Conditions, White River Mainstem

Reach Designation	Reach Description	Reach Length (feet)	Channel Type	Percent Gradient	Bankfull Width (feet)	Aquatic Habitat[a]	Riparian Corridor[b]
0031-01	Mouth to confluence with Dieringer Canal	19,500	Large contained	0.75	80	Poor	Fair
0031-02	From confluence with Dieringer Canal to Stewart Rd. Bridge	6,900	Large contained	1	165	Fair	Fair
0031-03	From Stewart Rd. Bridge to bluff at Auburn Game Farm Park	18,600	Floodplain	1.25	200	Fair	Fair
0031-04	From bluff at Auburn Game Farm Park to pipeline crossing on Muckleshoot Indian reservation	12,000	Floodplain	1.75	200	Fair	Fair
0031-05	From pipeline crossing on Muckleshoot Indian reservation to RM 14.7	18,000	Floodplain	1.5	500	Good	Fair
0031-06	From RM 14.7 to RM 19.0	22,800	Floodplain	1.75	300	Fair	Fair
0031-07	From RM 19.0 to Buckley diversion dam	27,600	Floodplain	2	200	Fair	Good

[a] Aquatic habitat condition is based on a numeric average derived from the Tri-County aquatic habitat ratings (see Appendix E) averaged using poor = 1, fair = 2, and good = 3. Average poor ratings were less than 1.67 and average good ratings were greater than 2.33.
[b] Riparian corridor condition is based on a numeric average derived from the Tri-County riparian corridor ratings (see Appendix E) averaged using poor = 1, fair = 2, and good = 3. Average poor ratings were less than 1.67 and average good ratings were greater than 2.33.

Note:
Data are summarized from detailed tables presented in Appendix F.

4.6.2 Tributaries West of Lake Tapps (0035 through 0040)

Six priority streams were surveyed west of Lake Tapps (Figure 4-13): Strawberry Creek (0035), also known as Salmon Creek; Salmon Tributary, also known as Salmon Spring Creek (0036); and Tributaries 0037 through 0040. Tributaries 0037, 0038, and 0039 originate at or near the top of the Lake Tapps plateau, but are either above the range of anadromous fish east of the East Valley Highway or flow through culverts until they reach the White River floodplain. Tributary 0040 originates in the vicinity of Algona, west of the river in the White River floodplain.

The anadromous reaches of Strawberry Creek (0035) and Tributaries 0037, 0038, 0039, and 0040 traverse the White River floodplain. Tributary 0036, however, originates below a series of springs near the top of the Lake Tapps plateau, flows through a ravine, and joins with Strawberry Creek without traversing the White River floodplain. A summary of aquatic habitat and reach corridor conditions by reach is presented in Table 4-11.

Strawberry Creek (0035)

Strawberry Creek, also known as Salmon Creek, originates near a gravel mining operation in the vicinity of 64th Street East and 166th Avenue East (Reach 18 in Figure 4-13). Strawberry Creek is located within the city of Sumner. Strawberry Creek flows along the eastern edge of the White River floodplain in a northwesterly direction. As it flows under the East Valley Highway it turns west and joins the White River. Strawberry Creek derives most of its flow from the Salmon Springs Formation; numerous springs discharge from the steep slopes of the White River valley wall, which feed the creek as it flows along the base of the White River valley wall.

From its origin, the creek flows in a roadside ditch for some distance before entering an open field. Willows and Douglas fir have been densely planted along the stream bank. Further downstream, the creek flows through Sumner, where it is strongly influenced by residential development. The stream flows through several culverts and is piped as it flows underneath a slaughterhouse and parking lot in the vicinity of Elm Street and 160th Avenue East (Reach 12).

Downstream, from the corner of Elm Street and 160th Avenue East to the East Valley Highway, Strawberry Creek flows through an area of mixed residential housing and pastures, with most of the riparian area vegetation on the southwest bank away from the valley wall dominated by reed canary grass along with evergreen and Himalayan blackberry. A short distance from the stream, the riparian vegetation on the northeast bank along the valley wall is dominated by shrubs and hardwood trees, such as salmonberry, red elderberry, red osier dogwood, willow, and red alder. Below the bridge at the East Valley Highway, Strawberry Creek flows west across the White River floodplain and joins with the White River.

Downstream from the East Valley Highway bridge, the streamside trees, dominated by red alder, black cottonwood, and Pacific willow, provide substantial shade. Very little gravel is present in Tributary 0035 upstream from its confluence with Tributary 0036, but gravel spawning riffles are present between the confluence of Tributary 0036 and the White River.

Table 4-11
Survey of Stream Reach Conditions, Tributaries West of Lake Tapps (0035 through 0040)

Reach Designation	Reach Description	Reach Length (feet)	Channel Type	Percent Gradient	Bankfull Width (feet)	Aquatic Habitat[a]	Riparian Corridor[b]
0035-01	From mouth of stream to upstream end of culvert under sod farm road	360	Floodplain	1.5	12.5	Fair	Fair
0035-02	From upstream end of culvert under sod farm road to where dominant riparian vegetation changes from trees to shrubs	600	Floodplain	0.5	14	Fair	Fair
0035-03	From where dominant riparian vegetation changes from trees to shrubs to culvert immediately downstream from railroad tracks	150	Floodplain	0.5	14	Fair	Fair
0035-04	From culvert immediately downstream from railroad tracks to confluence with stream 0037	240	Floodplain	1	8	Fair	Poor
0035-05	From confluence with stream 0037 to bridge at East Valley Highway	240	Floodplain	1	16	Good	Fair
0035-06	From bridge at East Valley Highway to where dominant riparian vegetation changes from grass to trees	405	Floodplain	1	7.5	Fair	Poor
0035-07	From where dominant riparian vegetation changes from grass to trees to confluence with stream 0036	60	Floodplain	1	15	Fair	Poor
0035-08	From confluence with stream 0036 to start of reach dominated by reed canary grass	180	Floodplain	0.5	9	Fair	Fair
0035-09	From start of reach dominated by reed canary grass to start of reach dominated by riparian shrubs	360	Floodplain	0.5	13	Poor	Poor
0035-10	From start of reach dominated by riparian shrubs to upstream end of culvert under North Parker Road	570	Floodplain	0.5	13	Poor	Poor
0035-11	From upstream end of culvert under North Parker Road to culvert under dirt access road	780	Floodplain	0.5	13	Poor	Poor

Table 4-11 (Continued)
Survey of Stream Reach Conditions, Tributaries West of Lake Tapps (0035 Through 0040)

Reach Designation	Reach Description	Reach Length (feet)	Channel Type	Percent Gradient	Bankfull Width (feet)	Aquatic Habitat[a]	Riparian Corridor[b]
	to residence on east side of stream						
0035-12	From culvert under dirt access road to residence on east side of stream to the corner of Elm St. and 160th Ave. E.	1,350	Floodplain	0.5	13	Poor	Poor
0035-13	From corner of Elm St. and 160th Ave. E. to culvert under 52nd St. E	300	Floodplain	1	10	Fair	Poor
0035-14	From culvert under 52nd St. E to upstream end of culvert under meat packing plant and parking lot	330	Floodplain	1	11	Poor	Poor
0035-15	From upstream end of culvert under meat packing plant and parking lot to upstream end of culvert under dirt road	180	Floodplain	1	11	Poor	Poor
0035-16	From upstream end of culvert under dirt road upstream from meat packing plant to upstream end of culvert under 162nd Ave. E	840	Floodplain	0.5	12	Poor	Fair
0035-17	From upstream end of culvert under 162nd Ave. E to upstream end of culvert under 60th St. E.	2,130	Floodplain	1	5	Poor	Poor
0035-18	From upstream end of culvert under 60th St. E. to source of stream near corner of 64th St. E. and 166th Ave. E.	1,050	Floodplain	0.5	8	Poor	Fair
0036-01	From mouth of stream to upstream end of alluvial fan channel and increased gradient	240	Alluvial fan	4	17	Good	Good
0036-02	From beginning of high gradient contained channel to barrier cascade and increased gradient	420	High gradient contained	8	14	Good	Good
0037-01	From mouth of stream to culvert at East Valley Highway	1,500	Floodplain	0.5	9	Fair	Poor
0038-01	From mouth of stream to upstream end of	600	Floodplain	0.5	6	Poor	Fair

Table 4-11 (Continued)
Survey of Stream Reach Conditions, Tributaries West of Lake Tapps (0035 Through 0040)

Reach Designation	Reach Description	Reach Length (feet)	Channel Type	Percent Gradient	Bankfull Width (feet)	Aquatic Habitat[a]	Riparian Corridor[b]
	culvert under sod farm road in turf farm						
0038-02	From upstream end of culvert under dirt farm road in turf farm to upstream end of culvert under railroad tracks	380	Floodplain	0.75	6	Poor	Poor
0038-03	From upstream end of culvert under railroad tracks to upstream end of culvert under dirt road paralleling buried fiber optic cable	700	Floodplain	0.5	16	Poor	Poor
0038-04	From upstream end of culvert under dirt road paralleling buried fiber optic cable to upstream end of palustrine channel	2,200	Palustrine	-1	28	Fair	Poor
0038-05	From upstream end of palustrine channel to upstream end of culvert under East Valley Highway	540	Floodplain	0.5	7	Poor	Poor
0038-06	From upstream end of culvert under East Valley Highway to upstream end of culvert under Forest Canyon Road	1,620	Alluvial fan	3	7	Fair	Fair
003905-01	From confluence of Dieringer Canal with White River to confluence with stream 0039	1,160	Floodplain	0.5	70	Poor	Poor
0039-01	From confluence with Dieringer Canal to upstream end of culvert under East Valley Highway	2,360	Floodplain	0.5	12	Poor	Poor
0039-02	From upstream end of culvert under East Valley Highway to outlet at East Valley Highway of culvert draining ravine	180	Floodplain	0.5	8	Poor	Poor
0040-01	From mouth at White River to control structure that diverts part of flow into upstream end of 0040.5	220	Floodplain	0.5	7	Poor	Fair
0040-02	From control structure at upstream end of 0045.5 to reach where dominant riparian	240	Floodplain	0.5	9	Fair	Fair

Table 4-11 (Continued)
Survey of Stream Reach Conditions, Tributaries West of Lake Tapps (0035 Through 0040)

Reach Designation	Reach Description	Reach Length (feet)	Channel Type	Percent Gradient	Bankfull Width (feet)	Aquatic Habitat[a]	Riparian Corridor[b]
	vegetation changes from trees to shrubs						
0040-03	From where dominant riparian vegetation changes from trees to shrubs to King County Line	260	Floodplain	0.5	12	Poor	Poor
004005-01	From mouth at White River to upstream end of constructed wetland	160	Palustrine	-1	50	Fair	Fair
004005-02	From upstream end of constructed wetland to control structure that diverts part of flow from 0040 into 004005	880	Floodplain	0.5	11	Fair	Fair

[a] Aquatic habitat condition is based on a numeric average derived from the Tri-County aquatic habitat ratings (see Appendix E) averaged using poor = 1, fair = 2, and good = 3. Average poor ratings were less than 1.67 and average good ratings were greater than 2.33.

[b] Riparian corridor condition is based on a numeric average derived from the Tri-County riparian corridor ratings (see Appendix E) averaged using poor = 1, fair = 2, and good = 3. Average poor ratings were less than 1.67 and average good ratings were greater than 2.33.

Notes:
Data are summarized from detailed tables presented in Appendix F.
A percent gradient of -1 signifies a value between 0 and 0.5.

Strawberry Creek is the main salmon spawning creek in the White River Basin on the west side of Lake Tapps. This creek is primarily a chum salmon (occasionally pink salmon) spawning stream, but gets some coho spawning and rearing and contains cutthroat trout. It also supports adult Chinook (Marks, 2009). Large amounts of groundwater (originating from springs) help to moderate the temperature of Strawberry Creek from Reach 16 downstream to the White River. Fish passage is good up to an impassable culvert at 60th Street and the Sumner-Tapps Road (upper end of Reach 16).

During the URS field survey, an adult coho salmon spawner was observed a short distance above the confluence of Strawberry Creek and the White River. A few resident coast cutthroat and rearing coho salmon juveniles were observed in Strawberry Creek, but fish did not appear to be common above the confluence of Tributary 0036. According to the Puyallup Tribe biologist encountered during the URS stream survey, chum and coho salmon are present in Strawberry Creek, with most spawning occurring in Tributary 0036. Chum salmon are the dominant salmon species.

Reach 01. Reach 01 contains poor to fair spawning habitat and fair rearing habitat for coho salmon and some chum salmon spawning. There is a pool and riffle habitat and a good, but narrow, riparian zone. A slight cascade is at the mouth, but connectivity to the river is good. This reach flows through a 4- to 6-foot incision in the floodplain and is fairly confined.

Reach 02. The narrow riparian canopy is poor to fair, with several culverts (passable by fish). There is no spawning gravel and only poor to fair rearing habitat.

Reach 03. Same as Reach 02, but no canopy cover and some ditches from fields flow into the stream channel, transporting fine sediments into the stream.

Reach 04. Similar to Reach 01, but less canopy cover.

Reach 05. Canopy cover is good on the south bank, but an open field is on the north bank. The pool/riffle ratio and habitat are fair to good. Good spawning gravel is present, which is probably used heavily by spawning and rearing coho salmon and cutthroat. Chum salmon also probably use the reach and pinks may spawn in the reach to a limited extent.

Reach 06. This reach flows primarily through a pasture, with some canopy cover by red alder at the upstream end on the north bank. Substrate is primarily gravel within pools. This reach is mostly used by spawning salmon.

Reach 07. This reach has good canopy cover and fair pool and riffle habitat. There is some spawning gravel present for coho and chum salmon spawners, but the reach primarily provides fair to good rearing habitat for coho salmon and cutthroat trout.

Reach 08. Similar to Reach 07, but better canopy cover and much less spawning gravel.

Reach 09. This reach has no LWD, canopy, or channel complexity. The riparian zone is dominated by reed canary grass. The substrate is composed of silt. The channel is fairly deep and has undercut banks providing poor to fair rearing for coho salmon.

Reaches 10, 11, and 12. These reaches are similar to Reach 09, but riparian shrubs dominate a short distance from the bank (which is dominated by reed canary grass).

Reach 13. This reach is a roadside ditch, with little value to salmonids.

Reach 14. This reach, which flows through a short, open, grassy area downstream from a meatpacking plant, has little value to salmonids.

Reach 15. This reach flows primarily through culverts under the packing plant and parking lot and has little value for salmonids.

Reach 16. This reach is similar to Reaches 10, 11, and 12. However, it is separated from spawning habitat (primarily concentrated from Tributary 0036, downstream to the mouth) by a long stretch of poor habitat. A narrow row of young planted trees is alongside much of this reach. It is unlikely that many salmonids use this reach due to the lack of spawning habitat.

Reach 17. Similar to Reach 16, but no riparian canopy is present.

Reach 18. The upper half of this reach is a small roadside ditch with no gravel and a muck bottom. The ditch is shallow, with little flow present. It is doubtful that salmonids or other fish use the roadside ditch portion of this reach. The lower half flows at the base of a steep road embankment, with a narrow but dense planting of both hardwood and Douglas fir along the streambank. An agricultural field borders the riparian trees on the west side of the streambank. The stream channel is wide and shallow and filled with silt. This may be due to former silt runoff from the gravel operation on the hillside above Reach 18. Although the riparian corridor is in fair condition, the location of this reach above an impassable culvert and the poor condition of the aquatic habitat makes it unlikely that fish are present, and no spawning gravel for salmonids is present above the culvert at the head of Reach 17.

Salmon Tributary or Salmon Springs Creek (0036)

Salmon Tributary (0036), a higher gradient tributary of Strawberry Creek, is also within the city of Sumner. Salmon Tributary has a forested riparian buffer dominated by red alder and western red cedar (Figure 4-13). The upper reach contains an 18-foot-high cascade with a 20 to 30 percent gradient, which presents a barrier to fish passage.

Salmon Tributary is the main spawning habitat in the Lower White River Subbasin. Large numbers of chum salmon and fair numbers of coho and cutthroat spawn in the stream. Pinks also probably spawn occasionally in the stream. It is spring fed from sources high on the valley wall or the Lake Tapps plateau. Salmon run as far upstream as a short cascade at the head of Reach 02. The cascade appears to be a barrier, but a Puyallup Tribe biologist has stated that a few occasionally get above the cascade during peak spawning years. The stream was not surveyed above Reach 02 and it is unlikely that any significant salmon use occurs above Reach 02. Resident cutthroat trout were present in the stream above Reach 02 during the URS field survey. Water quality appears to be excellent throughout this stream, and a numerous and diverse benthic macroinvertebrate community is present.

Reach 01. This reach has excellent riparian canopy and a wide riparian zone. Habitat is mostly riffle, with a few small pools. Gravel is the dominant substrate. This section of stream contains the best spawning habitat for coho and chum salmon observed in the lower White River tributaries of Pierce County.

Reach 02. This reach has a much steeper gradient and is more confined the Reach 01, running through a narrow, heavily wooded ravine above the alluvial fan that Reach 01 flows through. A pump station is located near the stream in this reach. The substrate is much coarser than that of Reach 01 and is primarily step-pool habitat. Fish use is similar to that of Reach 01, but less spawning gravel is present.

Tributary 0037

Tributary 0037, a small tributary of Strawberry Creek and also within the city of Sumner, drains from the White River valley wall near the top of the Lake Tapps plateau (Figure 4-13). It flows through a culvert (impassable for fish) under the East Valley Highway and then into a recently constructed wetland and stream channel that drains into Strawberry Creek. During the URS field survey, construction of wetlands for habitat restoration was observed downstream of the East Valley Highway. LWD has been placed alongside the channel but is so high above the bank that it will never be functional for fish habitat.

There is no available perennial stream habitat or fish above the highway. The stream channel below the highway has been constructed and the substrate is fine gravel. It is unlikely that this condition will persist because the stream velocity and flow is very low. The velocity over the gravel is not high enough to attract spawning salmon, but high densities of benthic macroinvertebrates were observed in the stream channel, and it probably provides considerable rearing habitat for coho and cutthroat trout.

Tributary 0038

Tributary 0038 is culverted from Forest Canyon Road to just above the East Valley Highway (Figure 4-13). Below the highway, Tributary 0038 traverses the White River floodplain through shrubby palustrine wetland habitat until it reaches the Burlington Northern railroad tracks, then south along the east side of the tracks for some distance before crossing through a culvert under the tracks and across a cultivated field (turf farm) to the White River. Tributary 0038 is within the city of Sumner.

For most of the distance across the floodplain, the dominant vegetation is reed canary grass and Himalayan blackberry, with willow and hardhack present in wetland areas created by beaver dams. The last few hundred yards before the confluence with the White River has a limited amount of canopy cover provided by red alder, bitter cherry, and black cottonwood. The culvert under the railroad tracks is impassable to fish.

Coho salmon may occasionally use this stream. Spawning and rearing habitat is extremely limited below the railroad tracks (Reaches 01 and 02). Above the railroad tracks there is extensive rearing habitat (and connected open-water wetlands) for coho, but the culvert under the tracks is completely impassable. The upstream habitat is in Pierce County, and the culvert as a fish passage blockage might be a good project to address.

Reach 01. This reach has no spawning gravel but contains a narrow riparian corridor of shrubs and trees and has some pool habitat and undercut banks. No fish were observed during the URS field survey.

Reach 02. This reach flows through a turf farm. It is short but contains spawning gravel and rearing habitat, including a large pool immediately below the culvert that flows under the railroad tracks. A coho salmon carcass was present near the mouth of the culvert at the downstream end of this reach, but the carcass may have been left by a fisherman after butchering a fish caught in the river.

Reach 03. This reach parallels the railroad tracks as a narrow ditched channel. No fish were observed and the substrate is primarily silt and sand, with some gravel present. The gradient is slight and little flow for spawning fish was present during the field survey. Gravels are heavily silted. No riparian trees are present, but the banks are heavily lined with low-growing shrubs.

Reach 04. This reach also parallels the railroad tracks for most of its length, with a short upstream leg that parallels an access road. The channel is a straight ditch that flows alongside the road and railroad tracks. Beaver dams are present throughout the reach, and the channel spreads out into ponded wetland areas. Although the riparian habitat is primarily shrubs, this would be good rearing habitat for coho salmon, but there is no spawning habitat present and the only gravel available is a few patches in Reaches 03 and 05. This reach is also above an impassable barrier culvert under the railroad tracks.

Reach 05. This reach is a short ditched section below the East Valley Highway. There is little pool habitat present or riparian canopy, but there is a limited amount of gravel with suitable spawning flows for salmonids.

Reach 06. With the exception of a few yards of channel that flows through a forest area immediately above the highway, this reach flows through a long culvert that begins at the upper end of the reach where the culvert passes under the Forest Canyon Road. The culvert is not passable and neither is the stream channel immediately upstream of the culvert. Resident cutthroat trout may be present in the unsurveyed reach of the stream above Reach 06.

Tributary 003905

This reach is the Dieringer Canal below the mouth of Tributary 0039 (Figure 4-13) and is located within the city of Sumner. The canal can provide winter refuge habitat, but constitutes a considerable stranding hazard for juvenile salmonids (particularly juvenile summer/fall Chinook).

Tributary 0039

Tributary 0039 is primarily culverted upstream from the East Valley Highway (Figure 4-13) and is also located within the city of Sumner. After crossing under the East Valley Highway, Tributary 0039 flows west as a roadside ditch to the Burlington Northern railroad tracks, then south as a ditch paralleling the railroad tracks until it flows into the Dieringer Canal (Tributary 003905), which is the tailrace (outlet) for the Dieringer power plant below Lake Tapps. Riparian vegetation consists primarily of evergreen and Himalayan blackberry, hardhack, willows, and reed canary grass. No spawning gravel is present in Tributary 003905, but portions of the stream may provide habitat for rearing juvenile coho salmon. If during high water the culvert near the mouth is passable, some winter refuge use may occur by juvenile salmonids seeking to avoid high water in the White River.

Reach 01. This reach is a ditched channel that flows alongside railroad tracks. The culvert at the beginning of the reach is unreachable because of blueberry overgrowth. There is no spawning habitat, but if fish can reach it from the Dieringer Canal, there may be some use as winter refuge habitat. Habitat quality is poor and would take extensive restoration on private land to improve it.

Reach 02. This reach is very short and is contained in a free-flowing ditch. Inflows to the reach come from runoff from seepage next to a homeowner's driveway. A small spring-fed pond is on the south side of the driveway and a small ditch feeds the reach. Most of the tributary above Reach 02 is highly degraded by a culvert network. The terrestrial habitat also has been highly degraded and it is likely that a lot of fine sediments have been delivered to the Dieringer Canal and White River by the land disturbance.

Tributaries 0040 and 004005

Tributary 0040, also known as Government Ditch, originates in the floodplain on the west side of the White River and is a groundwater-fed floodplain stream that flows out of King County (Figure 4-13). This tributary is within unincorporated Pierce County. The tributary was divided into three reaches starting at the White River and ending at the King County Line Road. At the end of Reach 01 is a small diversion structure that diverts a portion of the streamflow southwesterly through a constructed wetland (old gravel pit). This tributary was named 004005 (also known as Government Ditch Tributary) and divided into two reaches, 01 and 02. These reaches are entirely manmade.

Between Reach 02 and Reach 01, the control structure (concrete weirs 1- to 2-feet high) diverts part of the flow into a manmade channel leading to a gravel pit where a wetland has been constructed using three weirs to create shallow impoundments. This manmade channel flowing through the manmade wetland is Tributary 004005, also located in unincorporated Pierce County. The only reach that is accessible by salmonids seeking refuge from winter high water in the White River is Reach 01 below the control structure that diverts water into Tributary 004005. This is likely the only part of this stream used by anadromous salmonids, and it is likely that no salmonids are present above Reach 01.

Rearing habitat for coho salmon is limited and poor to fair; no spawning gravel is available. As a result, it is unlikely that many coho juveniles (that are produced and rear in tributary streams) are present in the stream. Juvenile salmonids would have to jump over the 1- to 2-foot-tall structure, and the additional 16-inch thickness of the structure.

4.6.3 Tributary 0032, Jovita Creek (0033), and Tributary 0034

Jovita Creek and Tributaries 0032 and 0034 drain the western portion of the Lower White River Subbasin in Pierce County. Jovita Creek is connected to the White River by Tributary 0032. Tributary 0034 is a tributary to Jovita Creek. Table 4-12 summarizes aquatic habitat and reach corridor conditions by reach.

Table 4-12
Survey of Stream Reach Conditions, Tributary 0032, Jovita Creek (0033), and Tributary 0034

Reach Designation	Reach Description	Reach Length (feet)	Channel Type	Percent Gradient	Bankfull Width (feet)	Aquatic Habitat[a]	Riparian Corridor[b]
0032-01	From mouth to upstream end of first culvert under State Route 167	1,100	Floodplain	1.5	18	Poor	Fair
0032-02	From upstream end of culvert under State Route 167 to confluence with ditch draining constructed wetland	4,940	Floodplain	1	12	Poor	Poor
0032-03	From confluence with ditch draining constructed wetland to 32nd St. off-ramp	2,540	Floodplain	1	12	Poor	Poor
0032-04	From 32nd St. off-ramp to upstream end of second culvert under Highway 167 (near Tarp World at end of 132nd Ave. E.)	2,960	Floodplain	1.5	18	Poor	Poor
0032-05	From second culvert to confluence with Jovita Creek	4,480	Floodplain	1	12	Poor	Fair
0032-06	From confluence with Jovita Creek to County Line Road	2,400	Floodplain	0.5	12	Poor	Fair
0033-01	From mouth to upstream end of culvert under State Route 167	410	Floodplain	1.5	9.5	Fair	Poor
0033-02	From upstream end of culvert under State Route 167 to upstream end of culvert under West Valley Highway	180	Floodplain	1.1	10	Poor	Poor
0033-03	From upstream end of culvert under West Valley Highway to upstream end of culvert at lowest crossing by Jovita Blvd.	2,060	Moderate gradient mixed control	2	8	Fair	Fair
0033-04	From upstream end of culvert at lowest crossing by Jovita Blvd. to confluence with stream 0034	2,360	Moderate gradient contained	4	5	Poor	Fair
0033-05	From confluence with stream 0034 to culvert at County Line Rd. E.	440	Moderate gradient mixed control	1	4.5	Fair	Fair
0034-01	From mouth to culvert at 114th Ave. E.	700	Moderate gradient mixed control	1	6	Poor	Poor
0034-02	From culvert at 114th Ave. E. to where	200	Moderate gradient	1	5.6	Poor	Fair

Table 4-12 (Continued)
Survey of Stream Reach Conditions, Tributary 0032, Jovita Creek (0033), and Tributary 0034

Reach Designation	Reach Description	Reach Length (feet)	Channel Type	Percent Gradient	Bankfull Width (feet)	Aquatic Habitat[a]	Riparian Corridor[b]
	floodplain narrows		mixed control				
0034-03	From where floodplain narrows upstream from 114th Ave. E. to outlet of private pond (source of stream)	400	Moderate gradient contained	1.5	5	Poor	Fair

[a] Aquatic habitat condition is based on a numeric average derived from the Tri-County aquatic habitat ratings (see Appendix E) averaged using poor = 1, fair = 2, and good = 3. Average poor ratings were less than 1.67 and average good ratings were greater than 2.33.
[b] Riparian corridor condition is based on a numeric average derived from the Tri-County riparian corridor ratings (see Appendix E) averaged using poor = 1, fair = 2, and good = 3. Average poor ratings were less than 1.67 and average good ratings were greater than 2.33.

Note:
Data are summarized from detailed tables presented in Appendix F.

Tributary 0032

Tributary 0032 is essentially a ditched natural watercourse that connects Jovita Creek to the White River (Figure 4-14). The tributary parallels State Route 167 and flows completely within the White River floodplain. Near the upstream end of Reach 01, the tributary flows through large culverts under the highway and Burlington Northern railroad tracks before entering the White River. Tributary 0032 is located entirely in incorporated areas. Reaches 01 through 04 are located within the city of Sumner. Reach 05 crosses from Sumner into the city of Pacific, and Reach 06 is located within the city of Pacific.

The dominant riparian trees in the lower half of Reach 01 consist of red alder, willows, Pacific crabapple, black hawthorn, and black cottonwood. Evergreen and Himalayan blackberry are the dominant shrubs, and reed canary grass is the dominant streamside vegetation. Reach 02 has no riparian trees, and vegetation is dominated by evergreen and Himalayan blackberry and reed canary grass.

Reaches 03 through 06 are dominated by Pacific and Sitka willow, red alder, Pacific crabapple, black hawthorn, and black cottonwood. Evergreen and Himalayan blackberry are the dominant shrubs, and reed canary grass is the dominant grass. Other plants present in the riparian area are salmonberry, red elderberry, nettle, red osier dogwood, and lady ferns. A large constructed wetland is located between Highway 167 and the stream, just south of an on-ramp at 32nd Street. Mallards, green-winged teal, American widgeon, and great blue heron were observed at the wetland during the URS field survey.

Culverts are easily passable for the entire length of Tributary 0032. Except for Reaches 02 and 03, there is a fair to good amount of canopy cover on this stream. Reed canary grass and groundwater tend to moderate temperatures in Reaches 02 and 03. Very little rearing habitat is present, but a minimal amount of use may occur for coho juveniles and cutthroat trout. Summer/fall Chinook juveniles may use lower Reach 01 and possibly Reach 02 for winter refuge habitat. An open-water wetland has been constructed along the lower portion of Reach 03 that drains into Reach 02 through a canal that enters from the right bank at the break between Reaches 02 and 03. It is not known whether this wetland is used by fish; none were observed during the field survey. The wetland is so far removed from spawning habitat that it may not be used by rearing salmonids (or may become too warm in the summer months).

The substrate throughout is dominated by sand and silt. Very little channel complexity is present; the most complexity is in Reach 01 due to beaver activity transporting LWD to the channel.

Reach 01. Reach 01 is deeply incised into the White River floodplain and has good connectivity to the river at its mouth. Small beaver dams are present in this reach. The reach is likely used as winter refuge by summer/fall Chinook and possibly steelhead and coho rearing in the White River.

Reach 02. Habitat is very poor and is likely used primarily for migration. There is no riparian canopy, and riparian vegetation is dominated by thick blackberry hedge and reed canary grass.

Reach 03. Similar to Reach 02.

Reach 04. Similar to Reaches 02 and 03, but with some riparian canopy.

Reach 05. Similar to Reach 04, but better riparian canopy. Reach 05 is basically a reach break because it flows on the east side of State Route 167. Rearing habitat is very poor and there is no spawning habitat. The reach is used as a migration corridor.

Reach 06. The reach, which is above the confluence with Jovita Creek, is similar to Reach 05 but with more open canopy. There appears to be a considerable amount of iron precipitates in the groundwater feeding into the stream channel, causing precipitates to form on the substrate. The survey of this reach ended just above the King County Line Road.

Jovita Creek (0033)

Jovita Creek (0033) is a tributary to Tributary 0032 and contains the only real salmon spawning habitat in the Tributary 0032 drainage (Figure 4-14). Jovita Creek, the outlet of Trout Lake (in King County), flows south to Jovita Boulevard and then down Jovita Canyon to the West Valley Highway, where it crosses through multiple culverts under both the West Valley Highway and State Route 167 (including both on- and off-ramps from State Route 167 to Stewart Street). A small falls is immediately downstream of the West Valley Highway that seems to have been created by backcutting the stream channel to a lower gradient (Appendix F, Table F-4). Willows, red alder, and black cottonwood are the dominant riparian trees, with western red cedar, western hemlock, and Douglas fir also present. Other plants present in the riparian area are salmonberry, red osier dogwood, sword ferns, and lady ferns.

Jovita Creek contains cutthroat trout and some coho are present during years when adults can access the creek through the culverts under Interstate 5 (I-5) and the West Valley Highway. During years when coho cannot get past the highway culverts, they probably use the short (about 50 to 100 feet) reach between the mouth of Jovita Creek and the first culvert under the I-5 on-ramp. The stream is accessible to anadromous salmonids (if they can get past I-5 and West Valley Highway, up to the confluence of Tributaries 0034 and 0033). There is resident salmonid habitat in Reach 05 of Jovita Creek and in Reaches 01 through 03 of Tributary 0034. The uppermost Jovita Boulevard culvert (below the confluence of Tributary 0034) may be impassable to anadromous salmonids.

Reach 01. Fairly good spawning gravel is available between the creek mouth and first culvert (about 50 to 100 feet). There are an undetermined number of culverts (or perhaps one very long culvert) under the two lanes of State Route 167 and its on- and off-ramps. A Puyallup Tribes fisheries technician interviewed in the field during the URS field survey said that salmon usually cannot pass through the freeway culverts and often cannot get past a small barrier falls just downstream from the West Valley Highway culvert. Most of Reach 01 consists of culvert, with very little riparian cover present in the short free-flowing reach near the mouth of the stream. Reach 01 is located within the city of Pacific.

Reach 02. The culvert at the West Valley Highway appears to be passable by fish. There is only a short reach between the West Valley Highway and the entrance to the culvert/culverts under the freeway. This reach is poor to fair spawning and rearing habitat for salmonids. A small falls

(less than 3 feet high) is about 15 feet below the highway culvert that may be a partial barrier to anadromous salmonids. Reach 02 is located within the city of Pacific.

Reach 03. This reach has fair to good riparian habitat and the floodplain is not confined by Jovita Boulevard. Stream habitat is moderate-gradient pool and riffle, with good spawning substrate. Riparian cover is fair to good, and buffer width is good with a wide floodplain. This reach provides fair to good habitat for spawning and rearing coho salmon and cutthroat trout. Reach 03 is located within the city of Edgewood.

Reach 04. This reach is primarily step-pool habitat and is fair to good habitat for coho salmon and cutthroat trout. Riparian cover is fair to good, but not as good as in Reach 03. The stream channel is generally confined to one side of the valley or the other, depending on which side of the boulevard the stream is on. This reduces available habitat and habitat quality by restricting stream meanders to a narrower floodplain than was present before construction of the boulevard. The culverts all appear to be easily passable, with the possible exception of the uppermost culvert. Reach 04 is located within the city of Edgewood.

Reach 05. This reach is low-gradient pool and riffle habitat with fair spawning gravel and rearing habitat present. Most of this reach flows through landscaped yards, and the riparian canopy is only fair. The culvert under the King County Line Road is not passable by fish. Reach 05 starts in the city of Edgewood, and continues north into King County.

Tributary 0034

Tributary 0034 is a small tributary of Jovita Creek that originates in a wetland area and feeds a small pond next to Jovita Boulevard (Figure 4-14). Tributary 0034 flows alongside Jovita Boulevard, flowing into Jovita Creek in the vicinity of 114th Avenue East. This tributary is located within the city of Edgewood. Tributary 0034 may contain cutthroat trout, but the presence of other salmonids is unknown. The riparian area is forested, with red alder being the dominant tree, followed by willow and black cottonwood. Himalayan and evergreen blackberry are the dominant shrubs, with salmonberry, red osier dogwood, sword fern, and lady fern also present.

Jovita Creek and Tributary 0034 are mostly natural stream channels (although the channel was probably moved to one side or the other by the road through Jovita Canyon and is not completely natural). The floodplain is constrained in width by Jovita Boulevard. Fish were not observed during the URS survey, but resident cutthroat trout may be present throughout the stream. There are no barriers to fish passage throughout the length of the stream, with culverts passable by fish.

Reach 01. This reach flows through open yards and pastures, with little riparian cover present. The substrate is mostly silt and sand, but some pools are present.

Reach 02. This reach flows through a forest area. The forest is dominated by young red alder and the understory by blackberry bushes. The substrate is composed of gravel and cobble, but there is very little structure (channel primarily riffle habitat).

Reach 03. This reach is fed by a small artificial pond located just upstream from a residential driveway. The pond is fed by springs and marshy areas and a channel is not present above the

pond. The pond drains through a channel in the driveway and over a drop of more than 6 feet to the stream channel below, with no upstream fish passage available between the pond and the stream. This reach of the stream is slightly higher gradient and is highly confined in an incised channel, with good riparian canopy and cover. This reach also has fair pool and riffle habitat and gravel for salmonids if they are present. There are virtually no side channels in Reach 03.

4.6.4 Tributaries East of Lake Tapps (0051 through 0053)

Tributaries 0051, 0052, and 0053 are all located within unincorporated Pierce County. These tributaries are slightly disturbed as a result of previous logging activities. Tributary 0051 originates in a wetland area on the Lake Tapps plateau and flows through a forested ravine to the White River (Figures 4-12 and 4-15). Tributaries 0052 and 0053 originate in side terraces of the White River floodplain. A summary of aquatic habitat and riparian conditions for these tributaries by reach is presented in Table 4-13.

Tributary 0051

Tributary 0051 originates in a wetland area on the Lake Tapps plateau (Figure 4-15). Reaches 04 and 05 upstream of 230th Avenue East (North Lake Tapps Highway) are mostly channelized and overgrown with blackberry bushes. Reaches 04 and 05 have no LWD or riparian cover. The tributary flows through a culvert under 230th Avenue East and then down a ravine to the White River floodplain. In the upper end of Reach 02 a barrier falls presents a complete barrier to fish passage. However, below the barrier falls the tributary has good spawning gravel and rearing habitat for coho and cutthroat.

Through Reach 01, the tributary flows close to the west bank of the floodplain, eventually wandering further into the floodplain. In the floodplain the tributary also becomes a losing stream (water flows into the subsurface and flow is diminished) as it flows through an abandoned side channel of the White River. There is evidence of a small seasonal discharge channel to the White River, but the channel is perched about 6 feet above the White River and the discharge channel would be very steep cascade or falls if water was present.

The ravine in Reach 02 is heavily forested, with red alder, big leaf maple, western hemlock, and western red cedar being the dominant trees. Evergreen and Himalayan blackberry are the dominant shrubs, with red elderberry, salmonberry, lady fern, and sword fern also present. At the White River floodplain (Reach 01), the streamside vegetation is dominated by reed canary grass, with evergreen and Himalayan blackberry the dominant understory vegetation a short distance from the stream. There is a forested canopy, with red alder and black cottonwood being the dominant trees, with some western hemlock present.

The stream channel is passable to salmonids below the barrier falls at the head of the ravine. Coastal cutthroat trout were observed in the stream channel flowing through the ravine. However, anadromous salmonids do not have access to Tributary 0051, and even though there is abundant suitable rearing habitat for coho salmon juveniles in the lowest reach, none were observed during the field survey.

Tributaries 0052 and 0053

Reach 03 in both Tributaries 0052 and 0053 has intermittent flow. The dominant trees are red alder, black cottonwood, and big leaf maple. Reach 02 in both tributaries traverses similar hardwood forest with patches of Douglas fir, western hemlock, and western red cedar.
Reach 01

Table 4-13
Survey of Stream Reach Conditions, Tributaries East of Lake Tapps (0051 through 0053)

Reach Designation	Reach Description	Reach Length (feet)	Channel Type	Percent Gradient	Bankfull Width (feet)	Aquatic Habitat[a]	Riparian Corridor[b]
0051-01	From mouth of stream to start of mixed control moderate gradient reach	1,340	Floodplain	0.5	12	Fair	Fair
0051-02	From start of mixed control moderate gradient reach to start of high gradient contained reach	260	Moderate gradient mixed control	6	18	Good	Fair
0051-03	From start of high gradient contained reach to start of palustrine reach at culvert under 230th Ave. E.	1,900	High gradient contained	11	17	Good	Fair
0051-04	From culvert under 230th Ave. E. to culvert where dominant riparian vegetation changes from trees to shrubs	1,540	Palustrine	-1	10	Fair	Fair
0051-05	From culvert where dominant riparian vegetation changes from trees to shrubs to source of stream	1,360	Palustrine	-1	10	Poor	Poor
0052-01	From mouth of stream to end of coniferous forest and beginning of hardwood forest	940	Palustrine	-1	12	Good	Fair
0052-02	From beginning of hardwood forest to beginning of coniferous forest	2,240	Palustrine	-1	12	Good	Fair
0052-03	From beginning of coniferous forest to source of stream	1,400	Palustrine	-1	10	Good	Fair
0053-01	From mouth of stream to end of coniferous forest and beginning of hardwood forest	340	Palustrine	-1	12	Good	Fair
0053-02	From beginning of hardwood forest to beginning of coniferous forest	1,880	Palustrine	-1	10	Good	Fair
0053-03	From beginning of coniferous forest to source of stream	2,140	Palustrine	-1	9	Good	Fair

[a] Aquatic habitat condition is based on a numeric average derived from the Tri-County aquatic habitat ratings (see Appendix E) averaged using poor = 1, fair = 2, and good = 3. Average poor ratings were less than 1.67 and average good ratings were greater than 2.33.

Table 4-13 (Continued)
Survey of Stream Reach Conditions, Tributaries East of Lake Tapps (0051 Through 0053)

[b] Riparian corridor condition is based on a numeric average derived from the Tri-County riparian corridor ratings (see Appendix E) averaged using poor = 1, fair = 2, and good = 3. Average poor ratings were less than 1.67 and average good ratings were greater than 2.33.

Notes:
Data are summarized from detailed tables presented in Appendix F.
A percent gradient of -1 signifies a value between 0 and 0.5.
Based on field observations, there is good rearing habitat in Reach 0501-01.

in both tributaries also flows through hardwood forest. Riparian shrubs in Reach 01 of the tributaries include Himalayan and evergreen blackberry, and some salmonberry, red elder, and red osier dogwood also are present. Reach 01 of both Tributaries 0052 and 0053 are flowing through old river side channels. Both tributaries terminate in the White River floodplain at a high-gradient falls, which drops at least 6 feet to the current channel of the White River.

Beaver ponds were observed throughout the basin of both tributaries. However, no fish were observed in the tributaries. In Tributary 0053, Reach 02 is dry most of the year and contains no spawning gravel. Coastal cutthroat trout may be present, despite the very limited spawning habitat (no spawning gravel was observed).

4.6.5 Greenwater River

The Greenwater River (Stream 0122) is located at the border of the Mount Baker-Snoqualmie National Forest (Figure 4-16). Because most of the Greenwater River is beyond the boundaries of the planning area, only the lower reaches were inventoried. The surveyed reaches are located within unincorporated Pierce County. A summary of aquatic habitat and riparian conditions by reach is presented in Table 4-14.

The Greenwater River is contained within a wide floodplain and bounded by steep bluffs (Figure 4-16). The surveyed reaches of the river have an average bankfull width of 80 feet and an average depth of 4.5 feet. The lowest surveyed reach has a contained channel with a higher gradient and a much narrower floodplain. The river system is fed primarily by snowmelt from late spring through mid-summer. Spring discharges along some creeks also feed streamflows.

The riparian forest is dominated by red alder, black cottonwood, Douglas fir, western hemlock, and western red cedar, with abundant willows on stream gravel bars. Other vegetation present included Pacific yew, grand fir, sword fern, vine maple, red elderberry, and salmonberry. A few invasive scotch broom plants were present on drier gravel bars. Timber harvest has been extensive within this area of the basin.

The river provides good to excellent spawning and rearing habitat for salmonids. Numerous coho salmon were observed during the inventory survey, along with resident coastal cutthroat trout and juvenile steelhead trout. Several bull trout spawners also were observed. The inventoried reaches of the river are spawning and rearing habitat for spring-run Chinook salmon and winter-run steelhead trout. Tribal, federal, and state biologists have observed pink salmon spawners on occasion. Pools in the stream reaches surveyed occur mostly at bends where the river is forced to change direction (up to 90 degrees) by steep bank walls.

Reach 01. Reach 01 is between the confluence with the White River to a bridge near residential properties where the channel changes type from large contained to floodplain. No salmon were observed, but several coastal cutthroat trout were seen holding in pools. In the upper portion of the reach, the river channel is more confined in a relatively narrow floodplain.

Reach 02. Reach 02 is short and lies at a point where the channel changes from large contained to floodplain and the river divides into two channels around a large island. A few scotch broom

plants are present on drier gravel bars. A few coho salmon carcasses were observed. There was a large recent clearcut a short distance south of the river.

Table 4-14
Survey of Stream Reach Conditions, Greenwater River (0122)

Reach Designation	Reach Description	Reach Length (feet)	Channel Type	Percent Gradient	Bankfull Width (feet)	Aquatic Habitat[a]	Riparian Corridor[b]
0122-01	From mouth to bridge near most upstream residential properties where channel changes from large contained to floodplain	6,000	Large contained	2.5	85	Fair	Good
0122-02	From where channel changes from large contained to floodplain, to where river divides into 2 channels around large island	2,320	Floodplain	1.5	80	Good	Good
0122-03	From downstream end of large island dividing river into 2 channels to upstream end of island	520	Floodplain	1	95	Fair	Good
0122-04	From upstream end of island that divides river into 2 channels to confluence with stream 0125	4,080	Floodplain	2.5	80	Good	Good
0122-05	From confluence with stream 0125 to where substrate changes from predominantly gravel and cobble to cobble and boulders	1,800	Floodplain	1.5	70	Good	Good
0122-06	From where substrate changes to cobble and boulders to confluence with stream 0126 (change from floodplain to contained channel)	8,080	Floodplain	1.75	80	Good	Good
0122-07	From confluence with stream 0126 to change from large contained to floodplain channel	600	Large contained	3	70	Fair	Good
0122-08	From where floodplain widens and gradient decreases to National Forest boundary	2,720	Floodplain	2	92	Good	Good

[a] Aquatic habitat condition is based on a numeric average derived from the Tri-County aquatic habitat ratings (see Appendix E) averaged using poor = 1, fair = 2, and good = 3. Average poor ratings were less than 1.67 and average good ratings were greater than 2.33.
[b] Riparian corridor condition is based on a numeric average derived from the Tri-County riparian corridor ratings (see Appendix E) averaged using poor = 1, fair = 2, and good = 3. Average poor ratings were less than 1.67 and average good ratings were greater than 2.33.

Note: Data are summarized from detailed tables presented in Appendix F.

Reach 03. Reach 03 starts at the downstream end of the large island dividing the river into two channels to the upstream end of the island. A few coho salmon were observed in this reach. Of the two channels, the northeast channel provides better holding habitat. The gravels in the southwest channel are slightly embedded.

Reach 04. Reach 04 starts at the upstream end of the island to the confluence with Stream 0125. During the field survey, larger pools were observed to contain 3 to 20 coho salmon. Four bull trout between about 14 and 20 inches in length were seen in several of the deeper pools, holding beside logs that were parallel to the flow of water.

Reach 05. Reach 05 is between the confluence with Stream 0125 to where substrate changes from predominantly gravel and cobble to cobble and boulders. A few scotch broom plants were present on drier gravel bars. About 50 coho salmon were observed spawning in riffles.

Reach 06. Reach 06 is between where the substrate changes to cobble and boulders to the confluence with Stream 0126 (change from floodplain to contained channel). A few scotch broom plants are present on drier gravel bars. A few live post-spawn coho salmon were observed along with several coho salmon carcasses.

Reach 07. Reach 07 is between the confluence with Stream 0126 and the change from large contained to floodplain channel. A few coho salmon carcasses were observed, particularly near the confluence with Stream 0126.

Reach 08. Reach 08 is between where the floodplain starts to widen and the gradient decreases to the National Forest boundary. No fish were observed in this reach.

4.6.6 West Fork of the White River

The West Fork of the White River has features similar to the Greenwater River, but the mainstream is glacial in origin. Because most of the upper reaches of the West Fork extend beyond the Pierce County boundaries, only the lower reaches were inventoried (Figure 4-16 and Table 4-15). The surveyed reaches are located within unincorporated Pierce County.

The surveyed reaches have an average bankfull width of 140 feet and depth of 6.5 feet. The West Fork flows through a wide floodplain, averaging 450 feet for most of the inventoried length, and the valley is surrounded by steep slopes. Like the Greenwater River, it meanders substantially within the floodplain. Reach 01 has a contained channel with a higher gradient and a much narrower floodplain. Salmonid habitat is fair to good with deep runs and riffles, but little LWD is present. Reach 02 also has very little LWD present in the river and only a few deep pools. Most of the river channel consists of deep runs and riffles. Willows and red alders dominate many areas in the vicinity of the river bank.

The West Fork of the White River is used by winter-run steelhead, spring-run Chinook salmon, and coho salmon. Coastal cutthroat trout and bull trout also are present. During the late fall/early winter period of the inventory, coastal cutthroat trout and juvenile steelhead trout were observed in the river, which was running low and relatively clear during a period of little precipitation. Riparian habitat is dominated by conifers on the steep slopes and black cottonwood and red alder in the floodplain.

Table 4-15
Survey of Stream Reach Conditions, West Fork White River (0186)

Reach Designation	Reach Description	Reach Length (feet)	Channel Type	Percent Gradient	Bankfull Width (feet)	Aquatic Habitat[a]	Riparian Corridor[b]
0186-01	From mouth of river to change from large contained to floodplain channel	2,480	Large contained	1.75	125	Fair	Good
0186-02	From floodplain channel to upstream end of surveyed reach	0	Floodplain	2	150	Fair	Good

[a] Aquatic habitat condition is based on a numeric average derived from the Tri-County aquatic habitat ratings (see Appendix E) averaged using poor = 1, fair = 2, and good = 3. Average poor ratings were less than 1.67 and average good ratings were greater than 2.33.
[b] Riparian corridor condition is based on a numeric average derived from the Tri-County riparian corridor ratings (see Appendix E) averaged using poor = 1, fair = 2, and good = 3. Average poor ratings were less than 1.67 and average good ratings were greater than 2.33.

Note:
Data are summarized from detailed tables presented in Appendix F.

The riparian forest is dominated by red alder, black cottonwood, Douglas fir, western hemlock, and western red cedar, with abundant willows on stream gravel bars. Other vegetation present includes Pacific yew, grand fir, sword fern, vine maple, red elderberry, and salmonberry. The riparian habitat in the lower, more contained reach was dominated by conifers, with grand fir the dominant species.

4.7 LAKES

4.7.1 Lake Tapps Background

Lake Tapps is the only sizable lake in the White River Basin planning area. It is a man-made reservoir that was built for hydroelectric power generation. Water is diverted from the White River and conveyed in a canal to Lake Tapps. The lake discharges through a tailrace that enters the White River near Dieringer, just upstream form the confluence of the White and Puyallup rivers. Originally, PSE owned and maintained the lake, diversion canal, and hydropower facilities. PSE's water right allows for diversion of up to 2,000 cfs for power generation. The White River Basin has been closed to new water rights appropriations since 1980.

The south shore of Lake Tapps is in the city of Bonney Lake. The rest of the lake lies within unincorporated Pierce County. Residential land uses dominate the shorelines and islands; more than 3,000 houses are located near the lake. Lake Tapps is heavily used for boating, water skiing, swimming, and other recreational activities. Many of the shoreline residences have private docks. Public parks and boat ramps allow general public access to the lake.

Traditionally, PSE tried to maintain high lake water levels during the summer recreation season and draw down the lake during the winter to facilitate inspection and maintenance of berms and other structures around the lake. This annual drawdown may have helped reduce the growth of aquatic weeds in the lake by exposing the weeds to desiccation cold temperatures.

The Alliance purchased the lake and the water rights of surface water that flows through Lake Tapps. The Alliance is a nonprofit corporation comprising eight municipalities (Bellevue, Issaquah, Kirkland, Redmond, Tukwila, Covington, the Sammamish Plateau, and Skyway Water Districts) in the Puget Sound region. The Alliance plans to use Lake Tapps as a source of potable water, and to construct the necessary water treatment and delivery systems to transport water from the lake to its members.

In August 2008, the Alliance entered into the 2008 White River Management Agreement (WRMA) with both the PTI and the MIT and a separate agreement with each tribe. One of the central features of the WRMA is the Agreed Flow Regime for the White River, under which the Alliance agreed to limit diversion from the White River into Lake Tapps Reservoir in accordance with the Diversion Optimization Plan and the Ramping Rates to achieve or exceed specified minimum flows in the White River downstream of the diversion dam. Provisions of the WRMA include enhanced streamflow monitoring; enhanced funding for replacement, maintenance, and operation of gauging equipment; enhanced project maintenance including fish screen maintenance in the diversion canal; outlet modifications to avoid introducing predatory or

exotic species from Lake Tapps Reservoir into the White River; sediment trapping; and a tailrace study and plan to improve water quality discharge from Lake Tapps Reservoir and to prevent entry, delay, and/or stranding of salmonids in the tailrace canal (Cascade Water Alliance Lake Tapps Water Rights and Supply Project Draft Environmental Impact Statement, January 2010).

Ecology reviewed the proposed water supply project proposal and released a draft Report of Exam (ROE) in September 2006 and revised draft ROEs in May 2010. The draft ROE indicates that Ecology is considering a variety of measures to mitigate for the transfer of water to the Alliance customers outside of the White River basin:

- Increase the minimum instream flows in the White River to improve water quality and enhance salmon habitat.
- Set aside streamside or adjacent lands in the White River watershed to support salmon and other wildlife.

The future operating rules for the lake may include an annual drawdown to reduce aquatic weed growth. The retardation of milfoil growth is a valued quality to the residents and recreational users of Lake Tapps.

Pierce County and the Alliance signed a non-binding agreement in August 2005. The County and the Alliance agreed to investigate the best practicable method of establishing Lake Tapps as a public water supply reservoir, as well as to coordinate protection and monitoring of water quality in Lake Tapps and the White River Basin.

4.7.2 Lake Tapps Water Quality

Lake Tapps has been the subject of several recent water quality studies. Ecology monitored water quality regularly between August 2004 and September 2005 at up to 11 stations (Figure 4-2).

The following bullets summarize the key findings:

- The lake was thermally stratified most of the year (Ecology 2006). Figure 4-17 shows the temperature profile in the deepest portion of the lake. Stratification prevents the deeper lake water (hypolimnion) from mixing with the water near the lake surface (epilimnion).
- Surface water temperatures ranged from 9°C (48°F) at the end of March to 23°C (75°F) in late July, with relatively little variability among stations.
- Ratios of total nitrogen to total phosphorus (TP) concentrations were consistently high, indicating that phosphorus is the primary nutrient limiting algal growth in Lake Tapps (Ecology 2006).
- Nitrate and ammonia concentrations in the lake were relatively low.
- TP concentrations in the lake were generally less than 0.010 mg/L, which Ecology considers to be in the oligotrophic range. Figure 4-18 shows the median TP

concentrations measured in water samples collected at various locations in the lake and diversion canal.

- Water diverted from the White River had very high TP concentrations at times. TP concentrations near the lake inlet were generally lower. The apparent decrease is probably due to removal of particulate P in the settling basins located along the diversion channel (Ecology 2006).
- TP concentrations in the epilimnion in the embayments were relatively low (see Figure 4-18). This suggests that eutrophication is not currently a problem despite the shallow depths and reduced water circulation in these areas (Ecology 2006).
- Total phosphorus concentrations at the diversion and the inlet were highly correlated with turbidity, but not with the diversion flow rates (Ecology 2006).
- Dissolved oxygen met the water quality criterion in the epilimnion but fell below the criterion in the hypolimnion. Oxygen concentration approached 0 mg/L near the bottom of the lake during some months. The low DO in the hypolimnion is likely due to thermal stratification which prevented vertical mixing and re-aeration of the hypolimnion.
- Most of the pH measurements were within the criteria (6.5 to 8.5), but several were slightly above or below criteria.
- Hypolimnetic anoxia and subsequent elevated concentrations of phosphorus, nitrogen, and ammonia in the hypolimnion indicated mesotrophic conditions (Ecology 2006).
- Median chlorophyll-a concentrations were in the mesotrophic range at all locations.
- Abundant filamentous algae growth near Lake Tapps North Park was observed during winter drawdown.
- Fecal coliform bacteria concentrations were generally low, even in the embayments with numerous shoreline septic systems. The highest median concentrations were observed near the lake inlet.
- Flows through the lake during the 2004–2005 sampling period were low compared to flows that occurred during hydropower operations. Overall water quality in the lake was good despite the relatively low flows.

The data summarized above indicate that Lake Tapps had generally good water quality during 2004–2005. As discussed in Section 4.7.1 above, the operating rules for the lake may change due to the cessation of hydropower generation and the potential future use of the lake as a potable water source. Changes in the operating rules could affect diversion and discharge rates as well as lake water surface elevations, which in turn could affect lake water quality.

4.7.3 Lake Tapps Pollutant Source Survey

A shoreline survey was conducted to identify existing non-point pollutant sources affecting the water quality of Lake Tapps. Lake Tapps has approximately 46 miles of shoreline. Sections of

shoreline having the highest potential for pollutant loading sources were prioritized. Priority areas were defined after reviewing data available from the following sources:

- Pierce County Unified Sewerage Plan, Lake Tapps Service Area
- Pierce County GIS data: stormwater drainage systems and Service Response System (SRS) requests for flooding and on-site sewage concerns (active problems) overlaid with pre-1970 parcel development
- Tacoma Pierce County Health Department Permitted On-Site Sewage System Repairs Map generated February 15, 2005
- June 2002 Inspection of Project Works for the White River Hydroelectric Project (FERC No. 2494) available at the Washington Department of Ecology, Office of Dam Safety
- Natural Resource Conservation Service Soil Survey for Pierce County Area, Washington (1979).

A series of phone interviews with staff from Pierce County, the City of Bonney Lake, and PSE conducted in February and March 2005 provided additional information that further defined the priority pollutant survey area. The names, affiliations, and dates of those interviewed are as follows:

- Bill Creveling, Tacoma-Pierce County Health Department, February 24, 2005
- John Woodcock, City of Bonney Lake, February 24, 2005
- Bruce Gould, City of Bonney Lake, February 28, 2005
- Gene Galloway, Puget Sound Energy, February 2005
- Bob Barnes, Puget Sound Energy, February 25, 2005
- Kip Julin, Pierce County Environmental Services—Utilities, February 28, 2005.

After the background data described above for the Lake Tapps plateau was reviewed, the Lake Tapps shoreline was divided into five priority areas (Figure 4-19):

1. The city of Bonney Lake, an incorporated area of Pierce County that did not require surveying.
2. The sections of Lake Tapps that are uphill of the surrounding landscape and are not likely to have pipes in the embankment or groundwater discharge to the lake, which also did not require surveying.
3. The eastern edge of the lake, which is considered to be a low priority survey area. It contains the most recent development, and more stringent building and on-site sewage setback regulations were implemented here than in the other four priority areas.
4. Lake Tapps Island, identified as a secondary priority. Soil and hydrologic conditions match those of the highest priority area, but development occurred in this area after 1970. Some flooding events have been identified in the SRS active problems data.

5. The northwest and west shores of Lake Tapps, from north of Tacoma Point to Jenks Park, which was identified as the highest survey priority. This section of the lake contains the oldest development, where construction occurred prior to building and on-site sewage system setback regulations. These properties have septic systems that are reaching or have exceeded their estimated lifespans. A search of the County's SRS data also identified this area as containing a high frequency of historical and active flooding problems. Soils along this section of shoreline are dominated by Alderwood gravelly sandy loams that contain shallow, moderately well-draining soils over a weakly cemented glacial till. Water infiltrates to the till layer, then moves horizontally downslope and discharges as seeps along the shoreline.

This highest priority survey area includes approximately 15 miles of shoreline. Within this subsection of Lake Tapps, the survey focused on Tacoma, Driftwood, and Deer Island Points, where the greatest concentration of aging development and identified flooding problems have occurred.

Field Survey

The Lake Tapps pollutant source survey was conducted on March 25, 2005, using a global positioning system (GPS). This day offered ideal conditions for performing the field survey. The previous several days experienced warm, breezy weather that dried out the lake sediments and storm drain systems, making clear identification of seeps and unidentified outfall pipes more rapid.

The survey proceeded from near the corner of 182nd Avenue East and 9th Street East at the north end of Lake Tapps and finished at the causeway to Interlake Island, the northwest border of the city of Bonney Lake (Figure 4-20). The field survey crew completed approximately 11 miles of shoreline from the corner of 182nd Avenue East and 9th Street East to the cove between Deer Island Drive East and 184th Avenue East (Bankers Island).

Results

Significant potential discharge locations were found at 22 sites and one seep (Table 4-16). All pipes were dry except one. Most had eroded drainage channels leading from the pipe to the lake. Most pipes ended at the lot retaining walls. Except as described below, most of the pipes are likely roof drains.

- One 9-inch and five 12- to 18-inch pipes were identified that correspond to mapped County stormwater outfalls. One County mapped stormwater outfall at the north end of Driftwood Point was not located during the survey.
- One 12-inch corrugated plastic pipe at the northeast end of Tacoma Point (SP-13) had a trickle of water draining from it. This pipe is not depicted on the County's stormwater drainage maps. The water emptying from this pipe was clear with no odor and had a conductivity of 120 microSiemens per centimeter (µS/cm) and a temperature of 10°C. A dark-orange- or rust-colored slime was present in the small puddle below the outfall. An additional unidentified stormwater outfall was located on the north side of the lake

outlet canal (SP-2). The owner explained that he had installed two nested pipes (SP-2) to drain stormwater that had started collecting on his lot some years back.

- One small concrete canal (SP-16) was located along the southwest edge of Driftwood Point and measured 18 inches wide by 18 inches deep. There is a significant drainage pattern in the sediment from the ditch to the current lake level. This canal corresponds with a mapped County stormwater outfall.

Almost every lot had several small drainholes in the retaining walls and anywhere from no to five pipes draining into the lake. These pipes typically were 3- to 5-inch plastic corrugated or polyvinyl chloride (PVC) material ending nearly flush with the retaining wall. Several owners we spoke with explained these pipes drained stormwater from their properties.

One seep (SP-17) was located along a manmade channel cut deep into the southwestern tip of Driftwood Point. The seep was about 15- to 20-feet wide exiting the sediment about 25 feet from the shoreline. No odor was detected. Bittercress (Cardamine sp.) and water chickweed (*Montia fontana*) were growing at the seep.

Further Observations

Other items of interest were not located using the GPS because almost every property had one or more of the following:

- Many dock repairs and dock expansions
- Dumping of building and construction materials off dock ends
- General household debris
- to 2-inch intake pipes in almost every yard.

One landowner in the vicinity of mapped points SP-19 and SP-20 built a wall of tires in the lake. The wall of tires extends about 30 feet from the shoreline retaining wall. It appears to represent their swimming area.

Table 4-16
Potentially Significant Discharge Locations Identified during the March 25, 2005, Lake Tapps Field Survey

Site	Type	Size	Wet/Dry	Source	Comments
SP-1	Pipe	Unknown	Unknown	Shed on dock	Pipe outlet extends below current waterline. Wiring conduit extends length of pipe.
SP-2	Pipe	Two 6″ or 6″ and 8″	Dry	Stormwater from uphill streets and school	18102 17th St. E. – Alice Whitley stated she was required to install these pipes to drain stormwater from her front yard and street front after school reconstruction for buses several years ago.
SP-3	Ditch	Unknown	Dry	Unknown	
SP-4	Pipe	4″	Dry	Unknown	
SP-5	Pipe	Two 4″	Dry	Unknown	
SP-6	Pipe	Four 4″	Dry	Roof drains per owner	Small trickle from one pipe, not enough to sample.
SP-7	Pipe	Two 4″	Dry	Unknown	
SP-8	Pipe	8″ or 9″	Unknown	Unknown	Pipe dives underground about 25 feet from the shoreline.
SP-9	Pipe	6″	Dry	Unknown	
SP-10	Pipe	Unknown	Dry	Unknown	
SP-11	Pipe	12″ or 14″	Dry	Unknown	RCP possibly municipal outfall at the park.
SP-12	Pipe	2″	Dry	Unknown	Area downgradient of pipe outfall was recently filled and graded.
SP-13	Pipe	12″	Wet (trickle)	Unknown	Trickle of water with small puddle. No odor. Conductivity 120 mS/cm. Temperature 10°C. Orange bacteria or precipitate.
SP-14	Pipe	2″ and two 6″	Dry	Unknown	2″ iron pipe ends 50 feet from the shoreline. Two 6″ pipes end at retaining wall.
SP-15	Pipe	6″	Dry	Unknown	Per property owner, pipe flows a full 6″ during storms.
SP-16	Ditch	18″ x 18″	Dry	Unknown	Ditch possibly draining road.
SP-17	Seep	15′ x 20′	Wet	Unknown	No odor. Bittercress and water chickweed present.
SP-18	Pipe	6″	U/K	Unknown	Outfall not visible.
SP-19	Pipe	18″	Dry	Unknown	
SP-20	Pipe	14″	Dry	Unknown	
SP-21	Pipe	Two 2″ and two 4″	Dry	Buildings on property?	Small pipes originate from the boathouse.
SP-22	Pipe	One 9″ and three 4″	Dry	Unknown	
SP-23	Pipe	14″	Dry	Unknown	Per adjacent property owner, pipe installed by County.

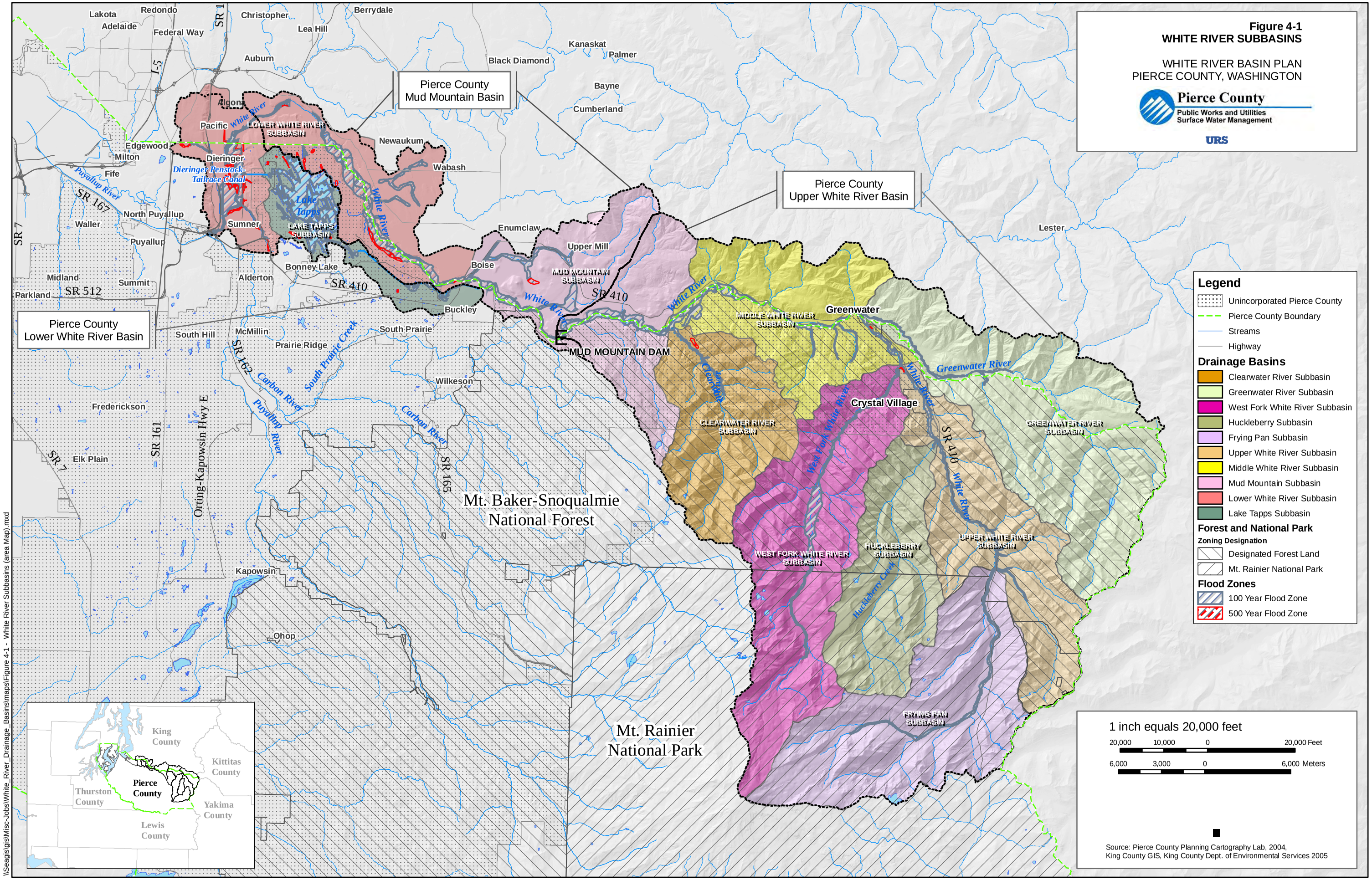
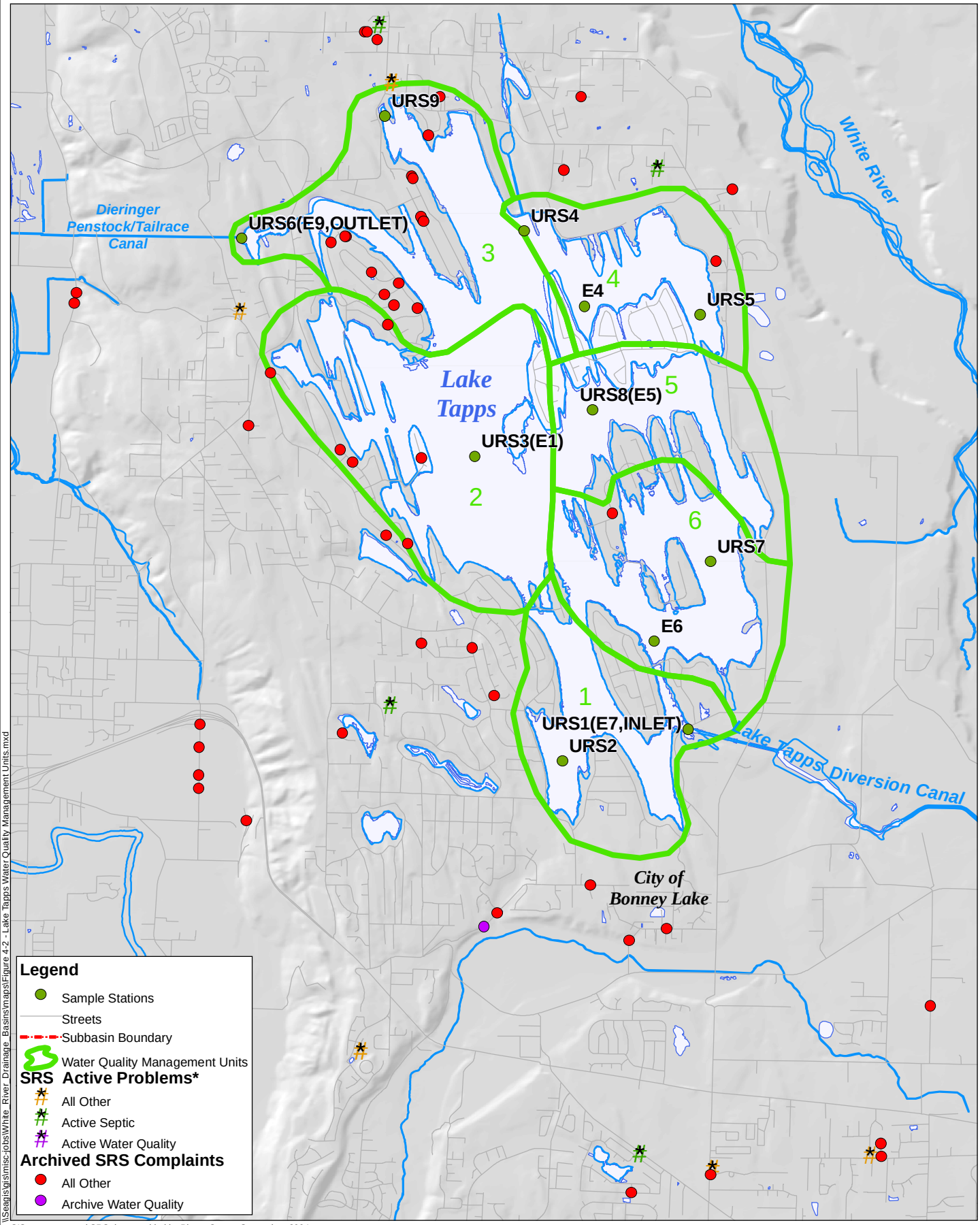


Figure 4-1
WHITE RIVER SUBBASINS
WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON
Pierce County
Public Works and Utilities
Surface Water Management
URS
Pierce County
Mud Mountain Basin
Pierce County
Upper White River Basin
Pierce County
Lower White River Basin
Mt. Baker-Snoqualmie
National Forest
Mt. Rainier
National Park
Lakota
Redondo
Adelaide
Federal Way
Christopher
Lea Hill
Berrydale
Auburn
Black Diamond
Kanaskat
Palmer
Bayne
Cumberland
Algona
Pacific
Edgewood
Milton
Fife
Dieringer
Newaukum
Wabash
Puyallup River
Dieringer Penstock-
Tailrace Canal
Lake
Tapps
Sumner
LOWER WHITE RIVER
SUBBASIN
LAKE TAPPS
SUBBASIN
Waller
North Puyallup
Puyallup
Enumclaw
Upper Mill
Boise
Bonney Lake
Alderton
Midland
Summit
Parkland
Buckley
MUD MOUNTAIN
SUBBASIN
MUD MOUNTAIN DAM
South Hill
McMillin
Prairie Ridge
South Prairie
Wilkeson
Carbon River
South Prairie Creek
Fredrickson
Elk Plain
Ortung-Kapowsin Hwy E
Kapowsin
Ohop
Lester
Greenwater
MIDDLE WHITE RIVER
SUBBASIN
Greenwater River
Crystal Village
CLEARWATER RIVER
SUBBASIN
GREENWATER RIVER
SUBBASIN
WEST FORK WHITE RIVER
SUBBASIN
HUCKLEBERRY
SUBBASIN
UPPER WHITE RIVER
SUBBASIN
FRYING PAN
SUBBASIN
Legend
Unincorporated Pierce County
Pierce County Boundary
Streams
Highway
Drainage Basins
Clearwater River Subbasin
Greenwater River Subbasin
West Fork White River Subbasin
Huckleberry Subbasin
Frying Pan Subbasin
Upper White River Subbasin
Middle White River Subbasin
Mud Mountain Subbasin
Lower White River Subbasin
Lake Tapps Subbasin
Forest and National Park
Zoning Designation
Designated Forest Land
Mt. Rainier National Park
Flood Zones
100 Year Flood Zone
500 Year Flood Zone
1 inch equals 20,000 feet
20,000 10,000 0 20,000 Feet
6,000 3,000 0 6,000 Meters
Source: Pierce County Planning Cartography Lab, 2004,
King County GIS, King County Dept. of Environmental Services 2005
King County
Kittitas County
Thurston County
Pierce County
Yakima County
Lewis County
\\Seagis\gis\Misc-Jobs\White_River_Drainage_Basins\maps\Figure 4-1 - White River Subbasins (area Map).mxd



\\Seagis\gis\misc-jobs\White_River_Drainage_Basins\maps\Figure 4-2 - Lake Tapps Water Quality Management Units.mxd

GIS coverages and SRS data provided by Pierce County September, 2004

* SRS = Service Response System

Pierce County
Public Works and Utilities
Surface Water Management

URS

1 inch equals 4,000 feet

0 2,000 4,000 Feet

0 500 1,000 Meters

Figure 4-2
Lake Tapps Water Quality Management Units

White River Basin Plan
Pierce County, Washington

Figure 4-3
EXISTING LAND USE

WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON

Pierce County
Public Works and Utilities
Surface Water Management

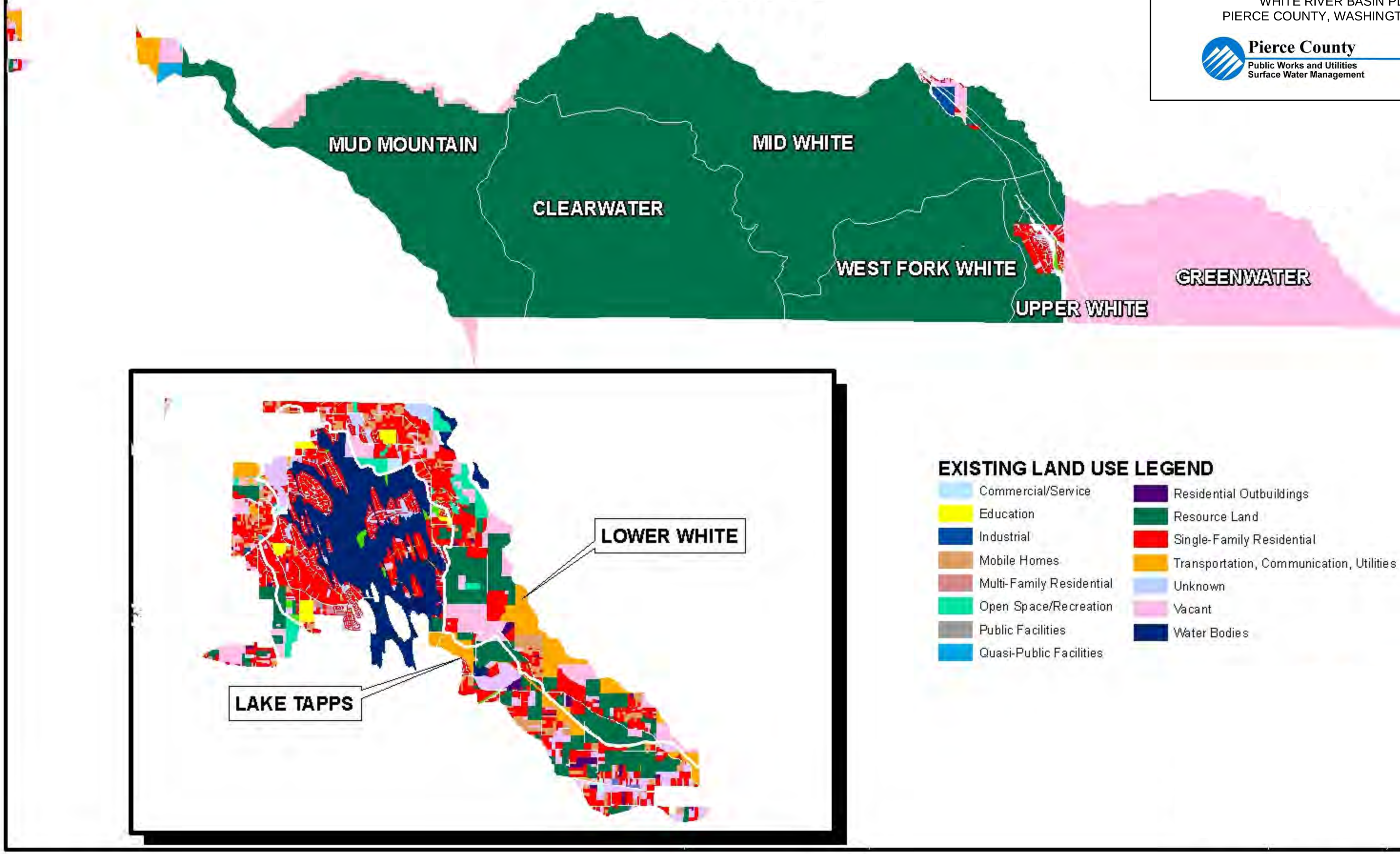
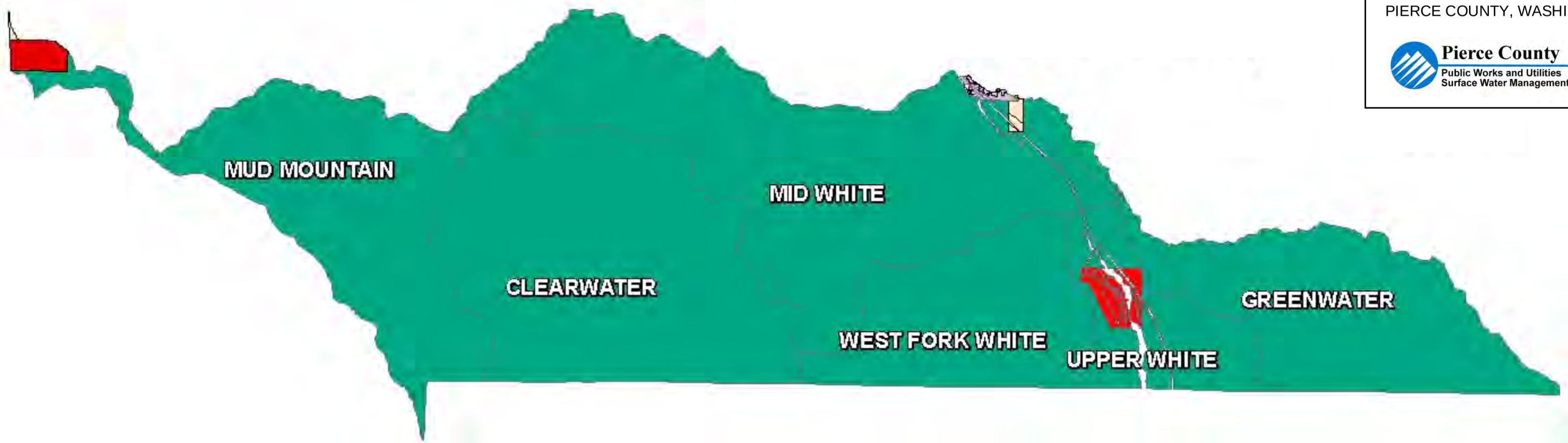
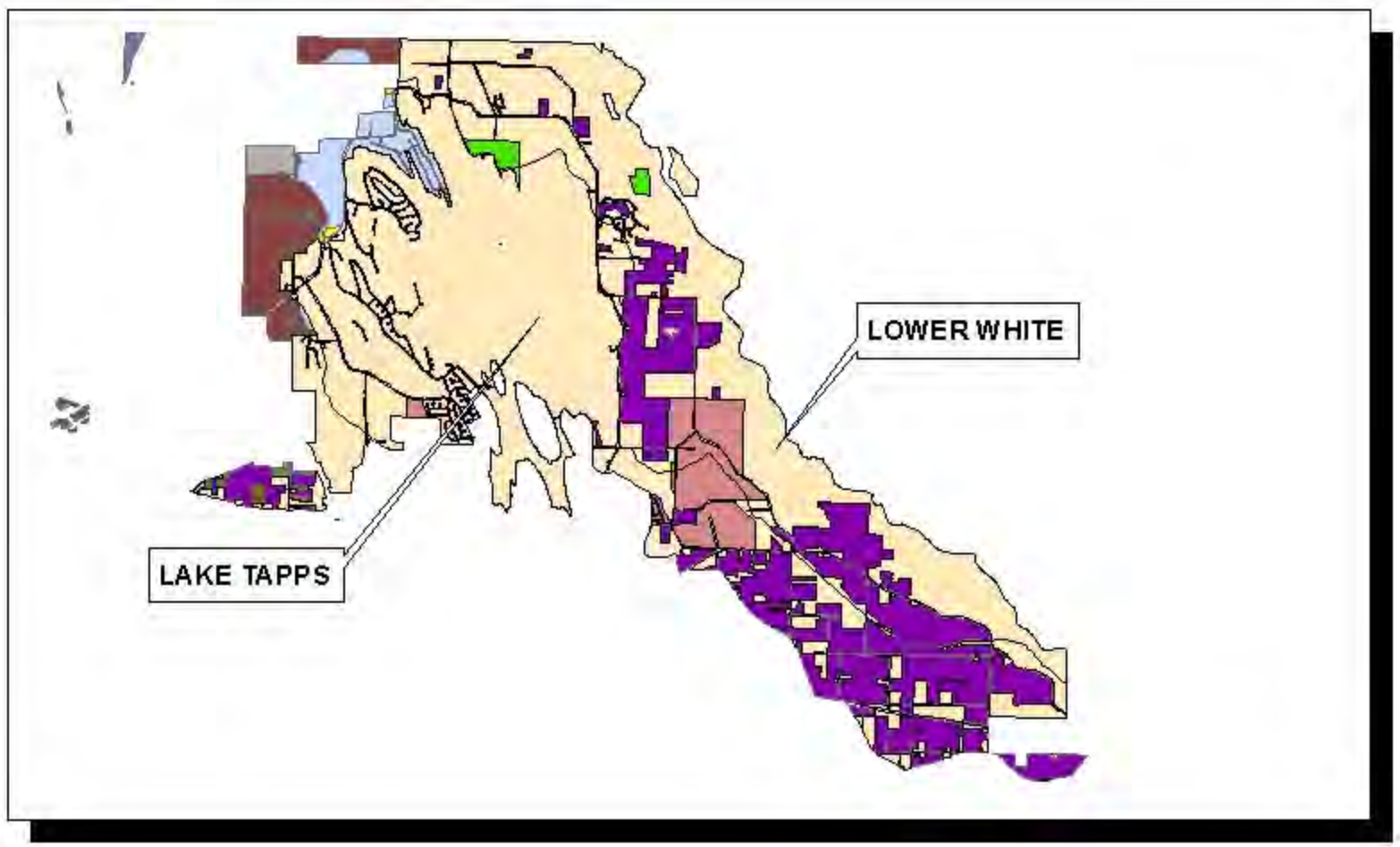


Figure 4-4
ZONING

WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON

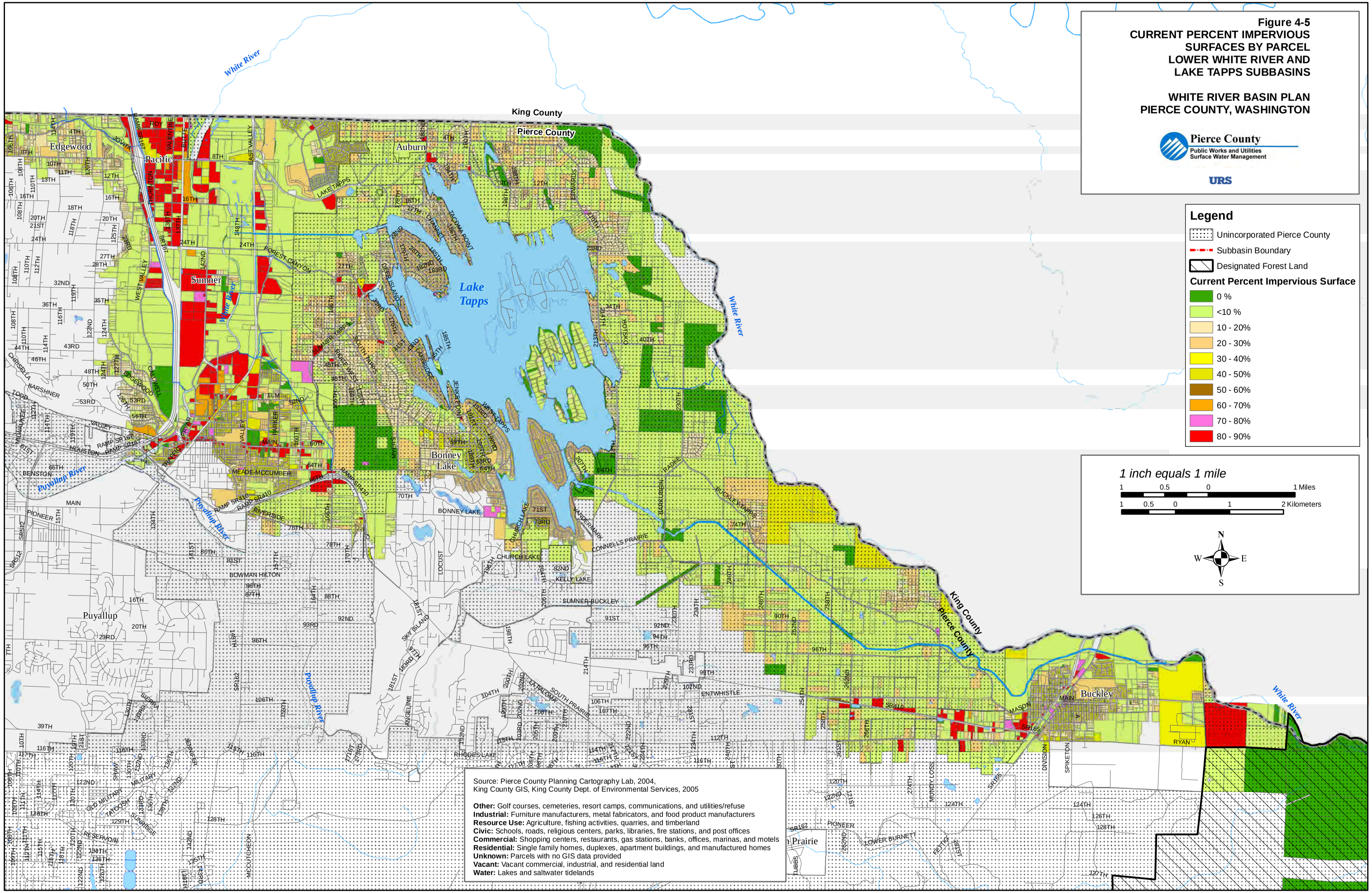
Pierce County
Public Works and Utilities
Surface Water Management



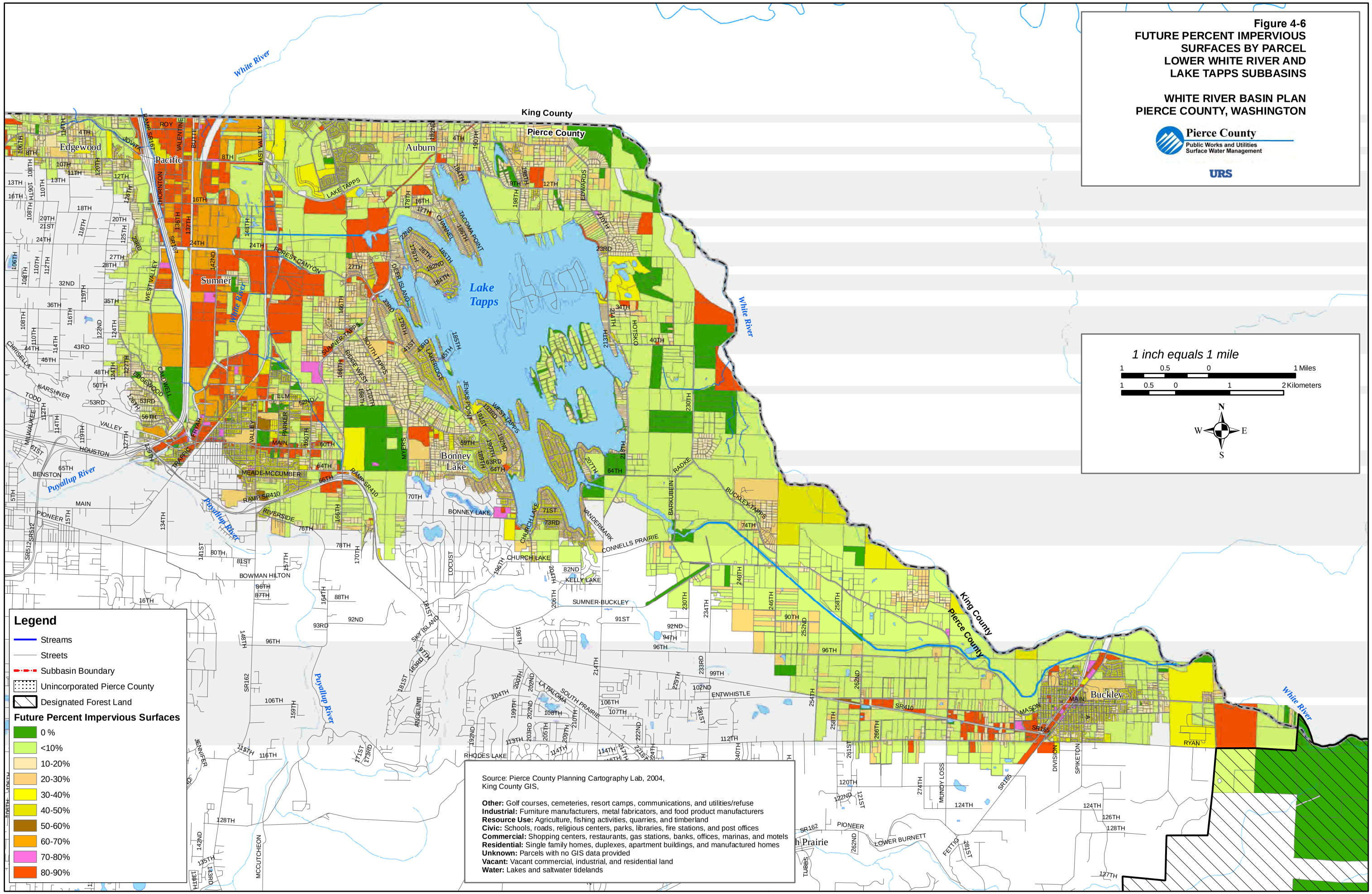


ZONING LEGEND

- Agricultural Resource Land
- Community Center
- Designated Forest Land
- Employment Center
- Gateway Community
- Master Planned Resort
- Moderate Density Single Family
- Neighborhood Center
- Park & Recreation
- Public Institutional
- Reserve 5
- Rural 10
- Rural 20
- Rural Farm



\\Seagis\gis\Misc-Jobs\White_River_Drainage_Basins\maps\Figure 4-9 - Current Impervious Surfaces by Parcel - Lower White River and Lake Tapps Subbasins.mxd



\\Seagis\gis\Misc-Jobs\White_River_Drainage_Basins\maps\Figure 4-10 - Future Impervious Surface - Lower White River and Lake Tapps Subbasins.mxd

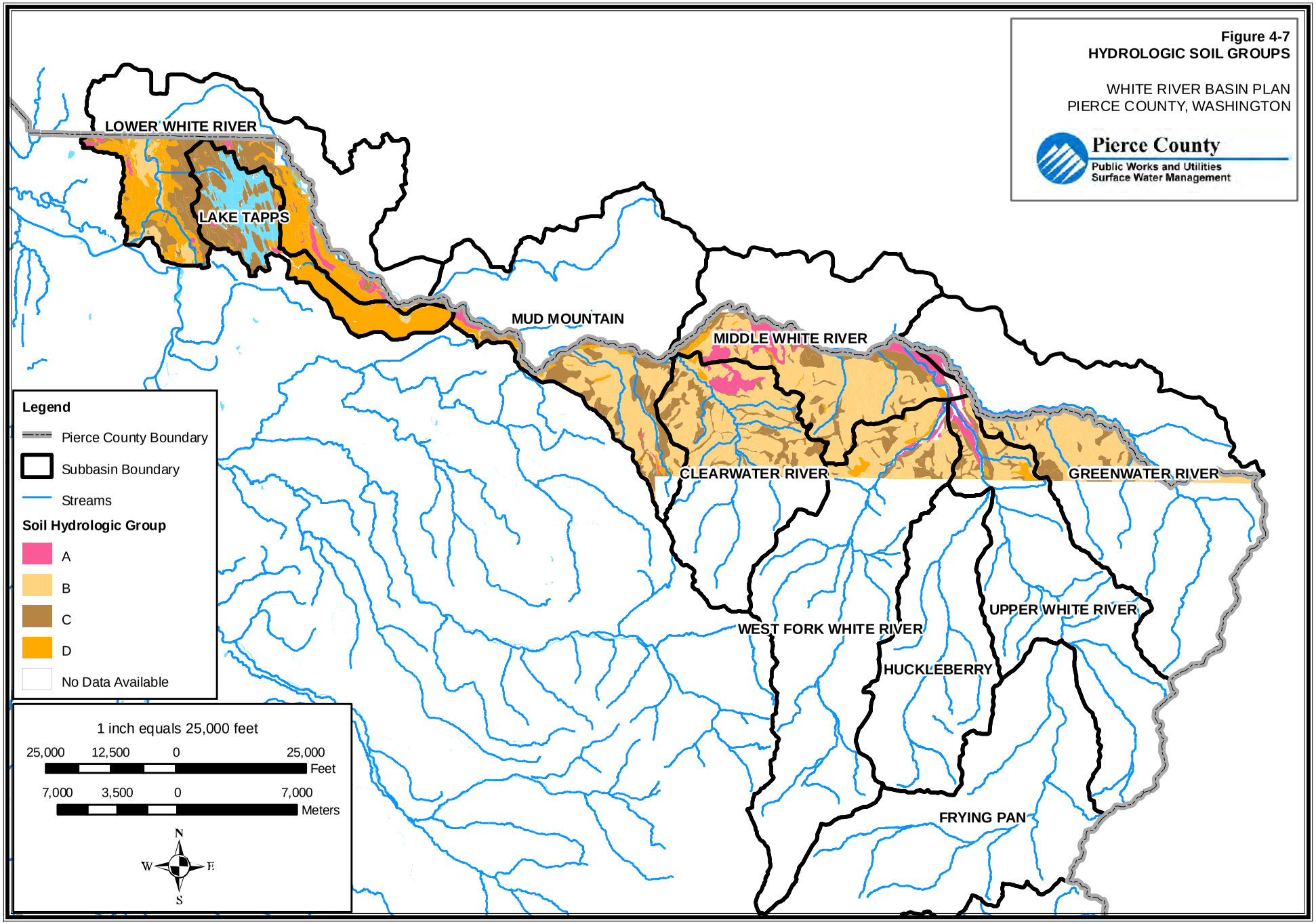


Figure 4-7
HYDROLOGIC SOIL GROUPS
WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON
Pierce County
Public Works and Utilities
Surface Water Management
LOWER WHITE RIVER
LAKE TAPPS
MUD MOUNTAIN
MIDDLE WHITE RIVER
CLEARWATER RIVER
GREENWATER RIVER
UPPER WHITE RIVER
WEST FORK WHITE RIVER
HUCKLEBERRY
FRYING PAN
Legend
Pierce County Boundary
Subbasin Boundary
Streams
Soil Hydrologic Group
A
B
C
D
No Data Available
1 inch equals 25,000 feet
25,000 12,500 0 25,000 Feet
7,000 3,500 0 7,000 Meters
N
W
E
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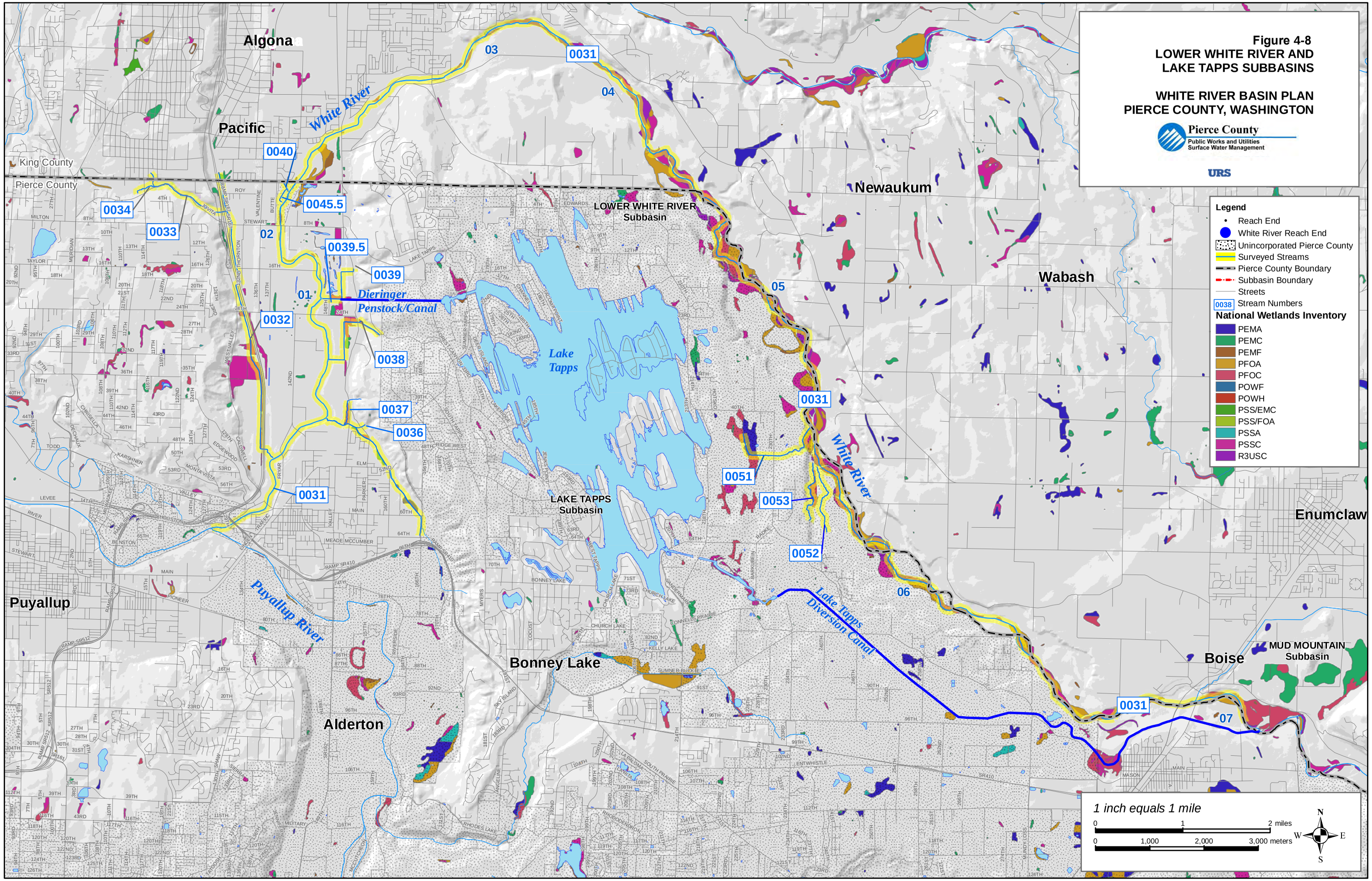


G:\projects\WhiteRiver\maps\Figure 4-11 - Wetlands - Lower White River and Lake Tapps Subbasins.mxd

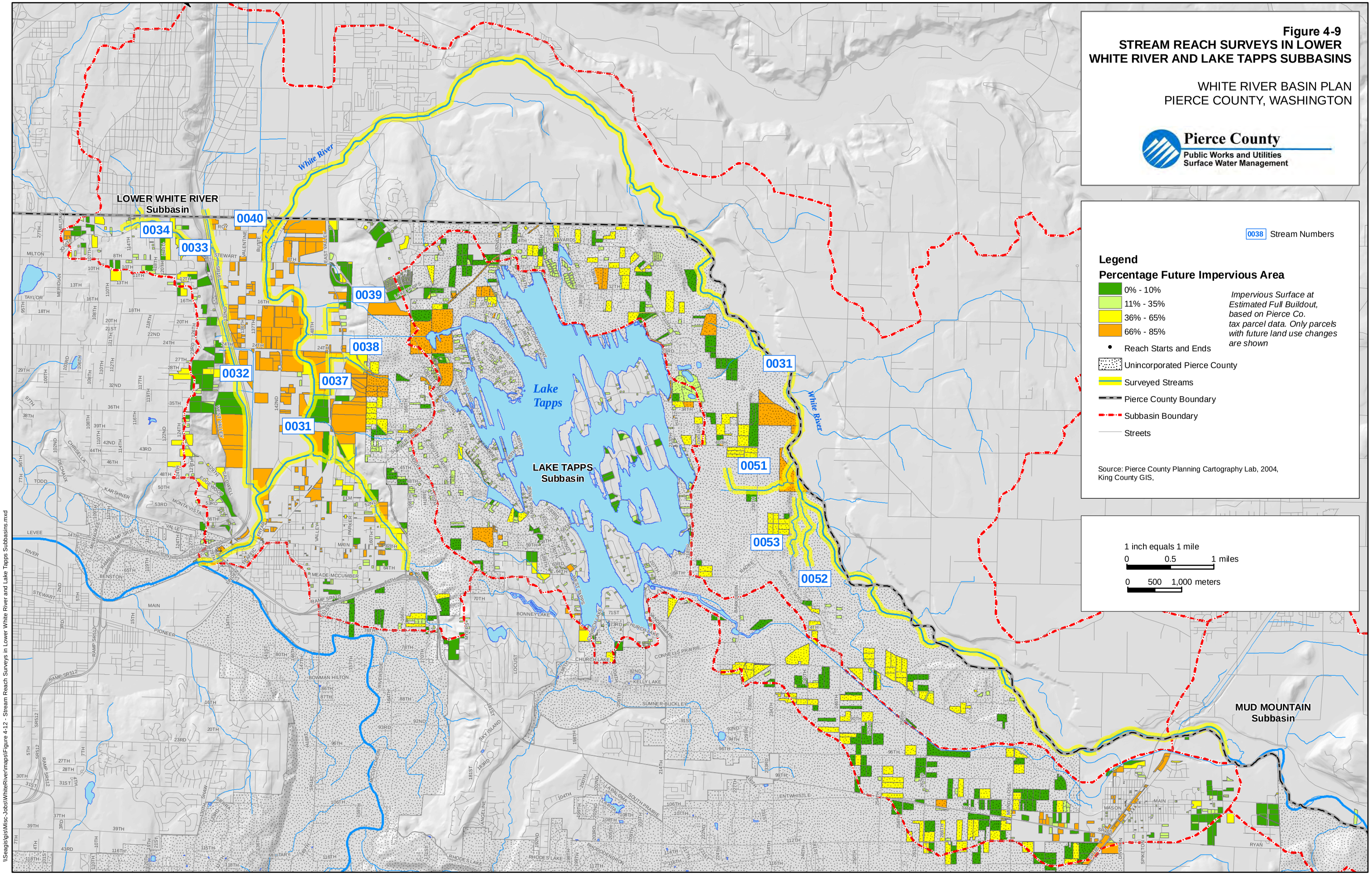


Figure 4-9
STREAM REACH SURVEYS IN LOWER WHITE RIVER AND LAKE TAPPS SUBBASINS
WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON
Pierce County
Public Works and Utilities
Surface Water Management
0038 Stream Numbers
Legend
Percentage Future Impervious Area
0% - 10%
11% - 35%
36% - 65%
66% - 85%
Impervious Surface at Estimated Full Buildout, based on Pierce Co. tax parcel data. Only parcels with future land use changes are shown
Reach Starts and Ends
Unincorporated Pierce County
Surveyed Streams
Pierce County Boundary
Subbasin Boundary
Streets
Source: Pierce County Planning Cartography Lab, 2004, King County GIS,
1 inch equals 1 mile
0 0.5 1 miles
0 500 1,000 meters
LOWER WHITE RIVER Subbasin
LAKE TAPPS Subbasin
MUD MOUNTAIN Subbasin
Lake Tapps
White River
0040
0034
0033
0039
0038
0032
0037
0031
0051
0053
0052
\\Seagis\gis\Misc-Jobs\WhiteRiver\maps\Figure 4-12 - Stream Reach Surveys in Lower White River and Lake Tapps Subbasins.mxd

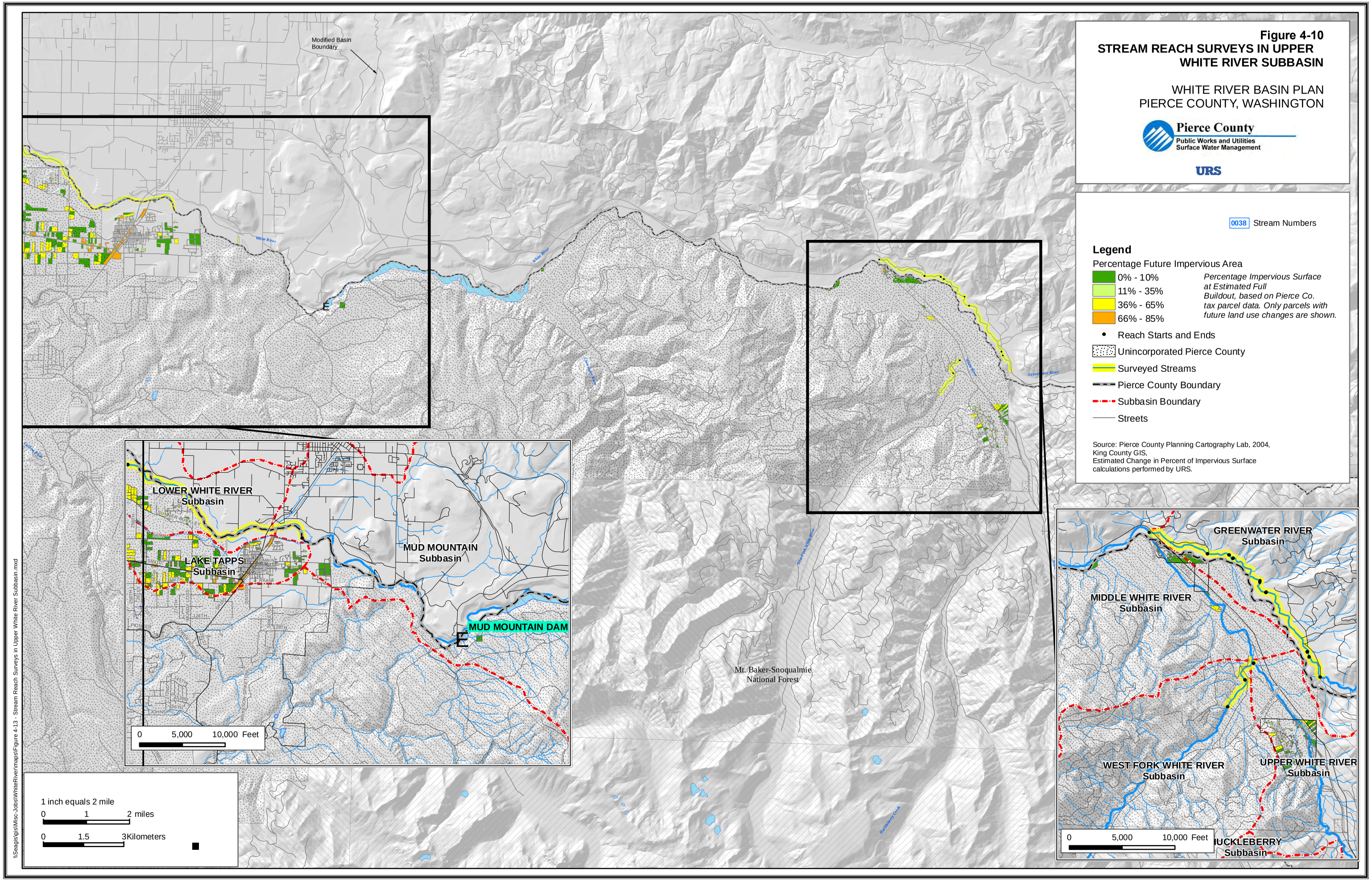
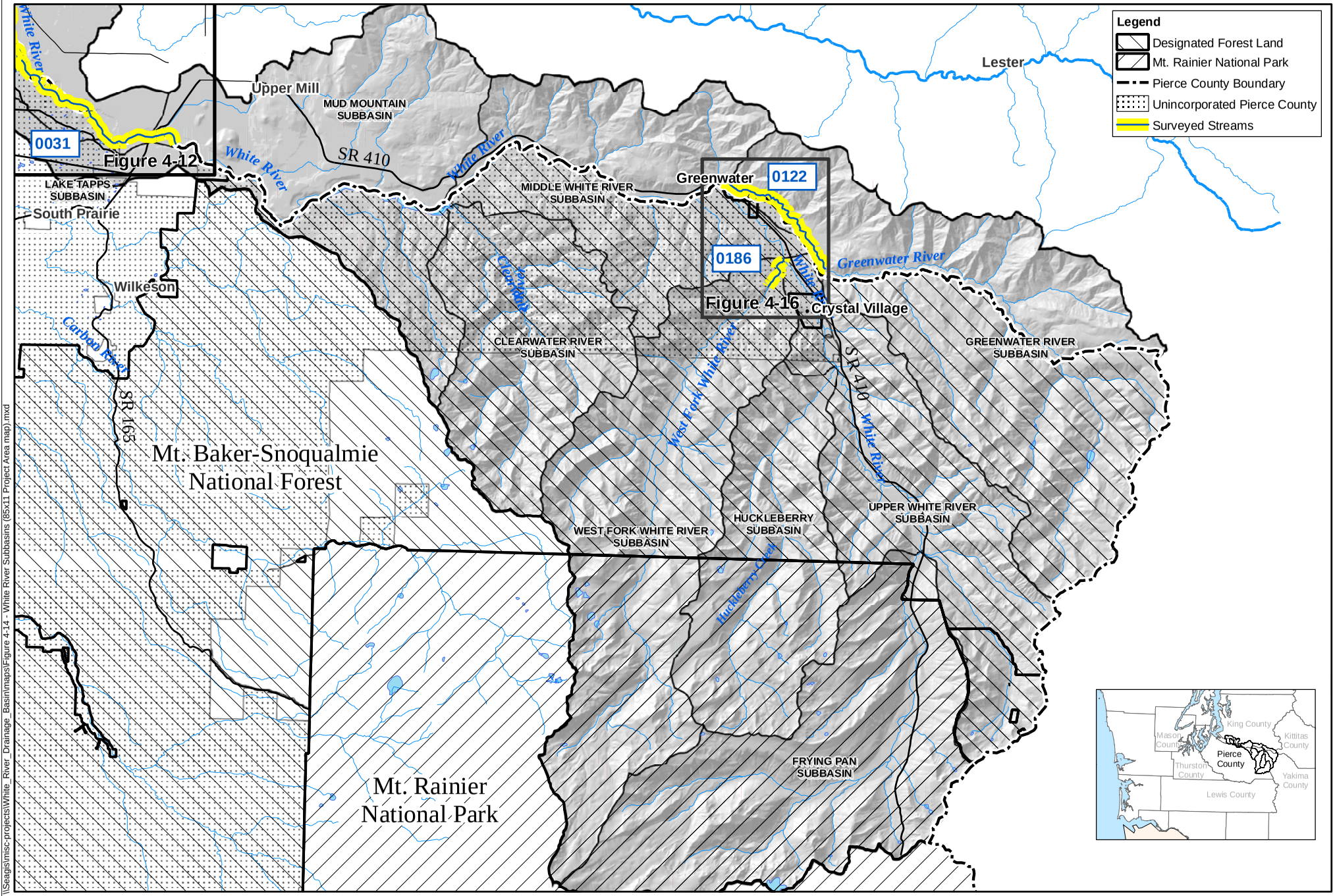


Figure 4-10
STREAM REACH SURVEYS IN UPPER WHITE RIVER SUBBASIN

WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON



Pierce County
Public Works and Utilities
Surface Water Management

1 inch equals 20,000 feet

0 10,000 Feet

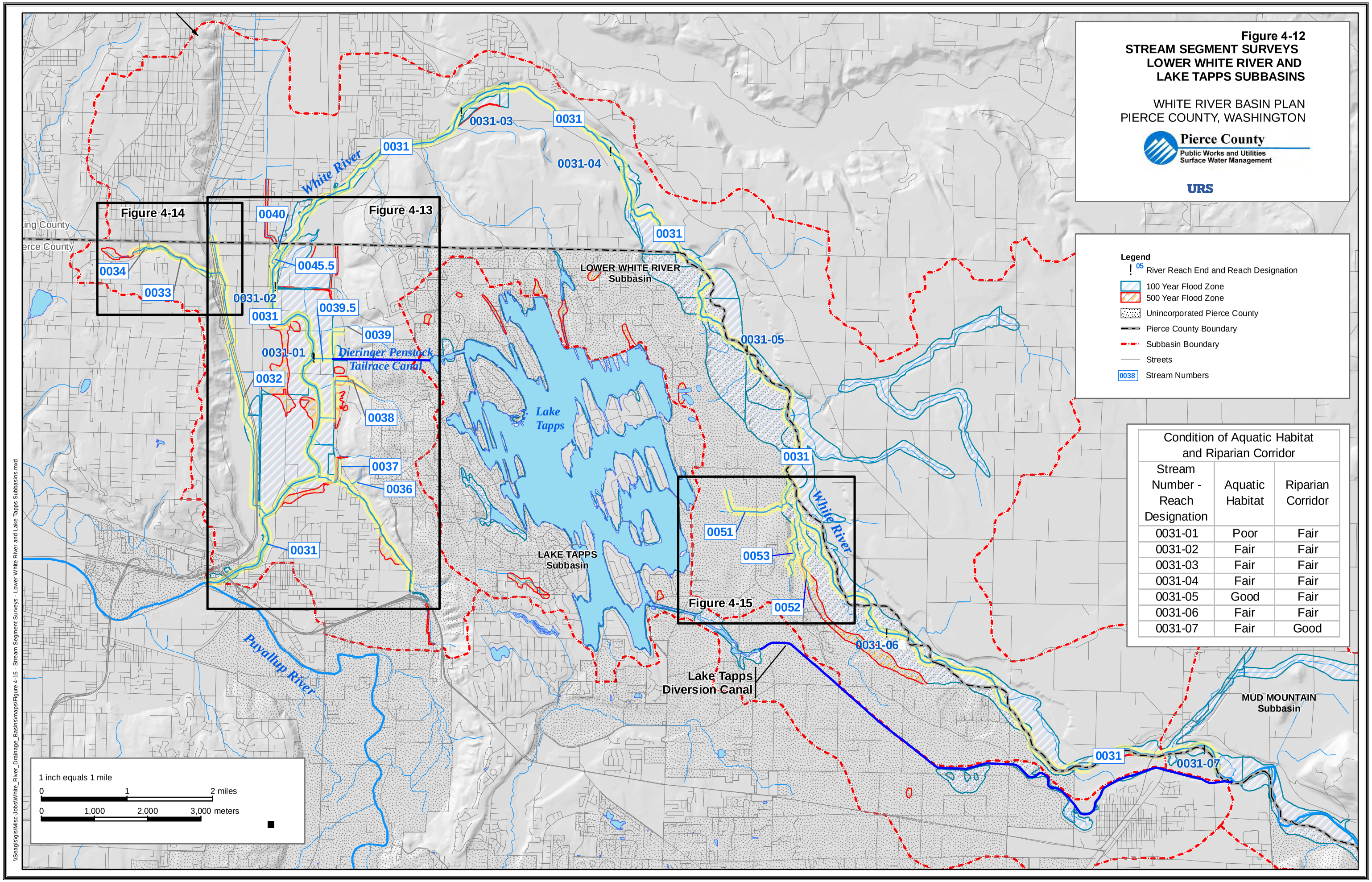
0 3,000 Meters

N W E S

Figure 4-11. STREAM SURVEYS, EASTERN SUBBASINS

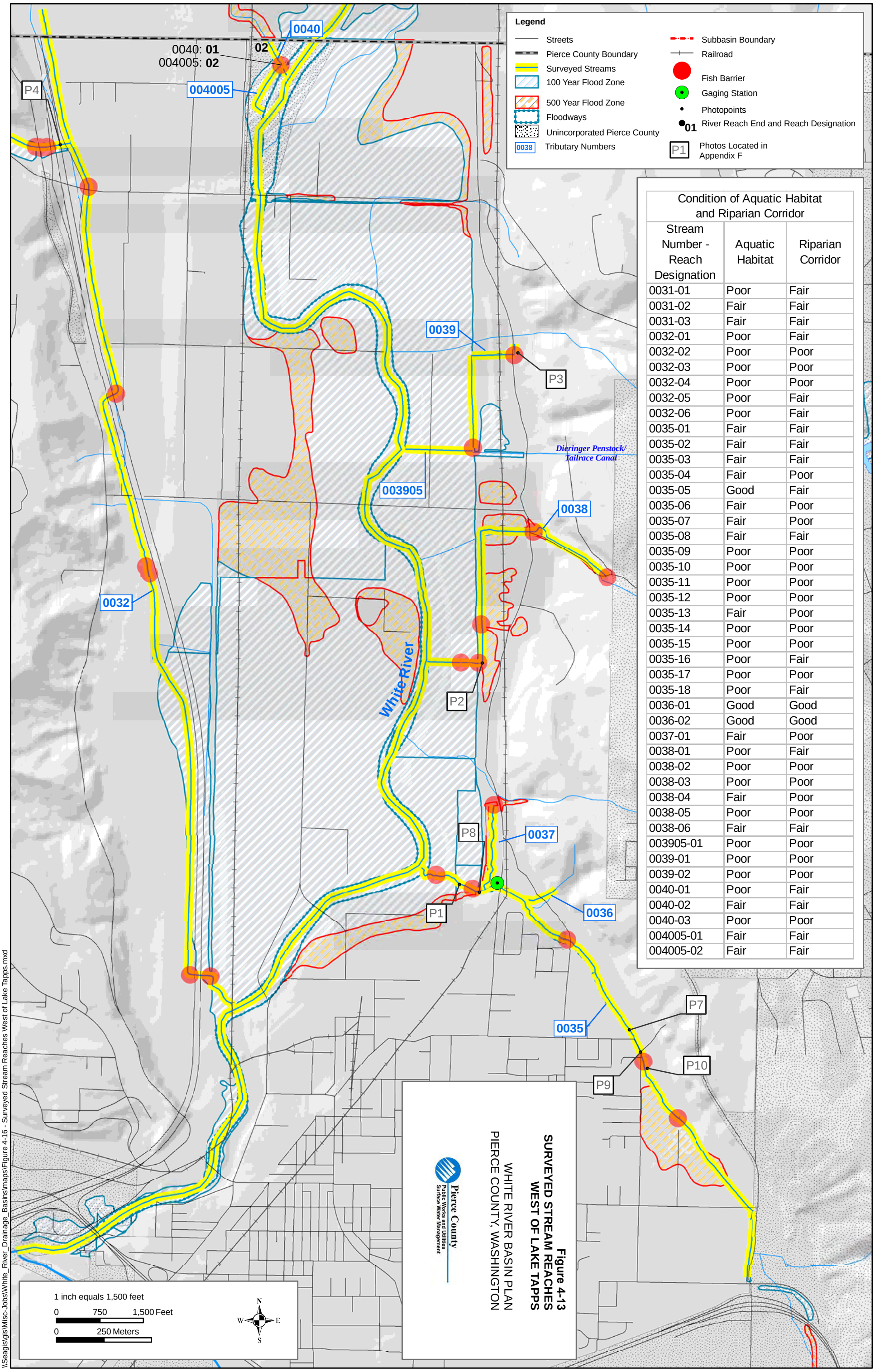
WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON

\\Seagis\misc-projects\White_River_Drainage_Basin\maps\Figure 4-14 - White River Subbasins (85x11 Project Area map).mxd

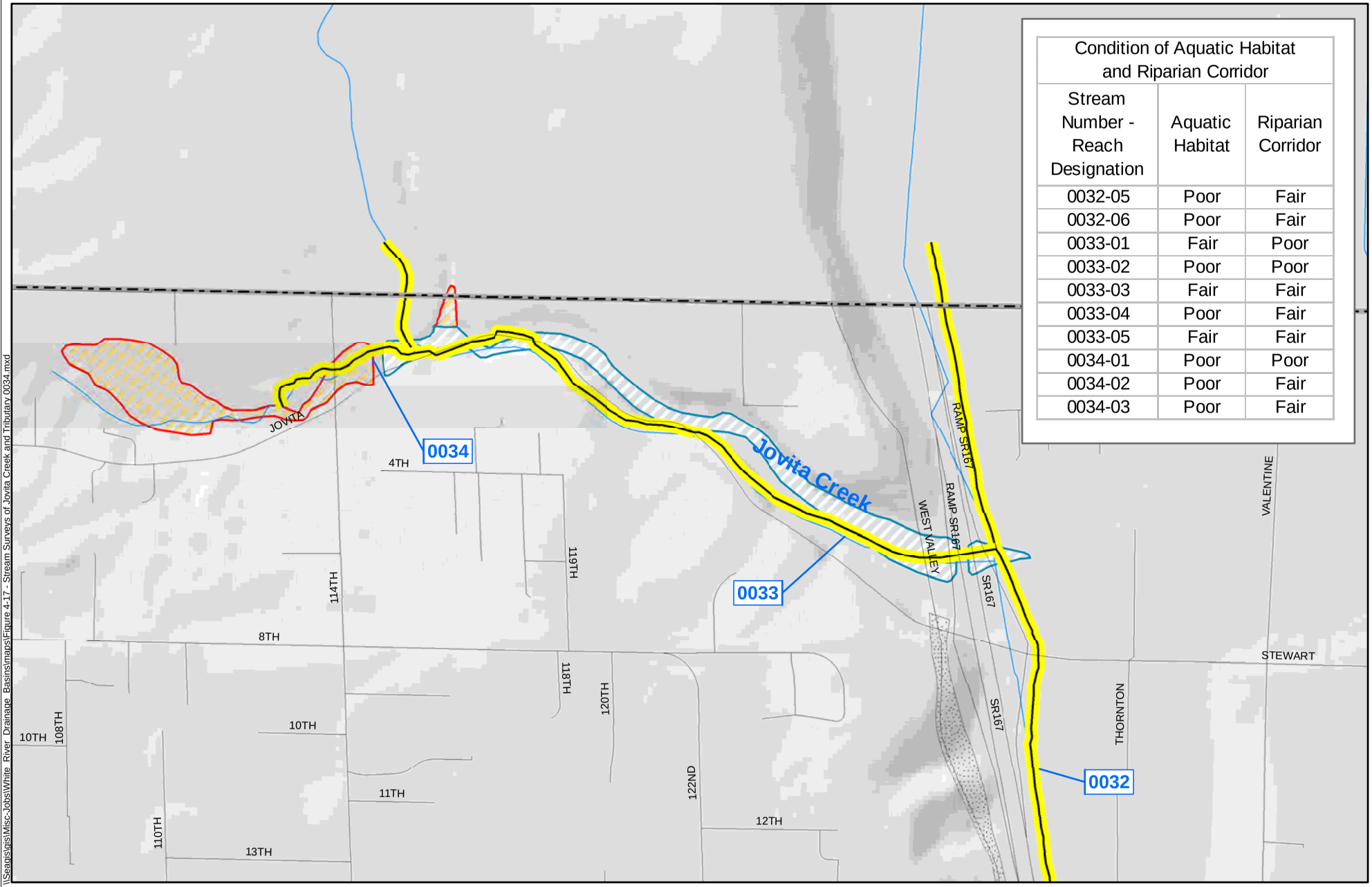


Condition of Aquatic Habitat and Riparian Corridor

Stream Number - Reach Designation	Aquatic Habitat	Riparian Corridor
0031-01	Poor	Fair
0031-02	Fair	Fair
0031-03	Fair	Fair
0031-04	Fair	Fair
0031-05	Good	Fair
0031-06	Fair	Fair
0031-07	Fair	Good



Condition of Aquatic Habitat and Riparian Corridor		
Stream Number - Reach Designation	Aquatic Habitat	Riparian Corridor
0031-01	Poor	Fair
0031-02	Fair	Fair
0031-03	Fair	Fair
0032-01	Poor	Fair
0032-02	Poor	Poor
0032-03	Poor	Poor
0032-04	Poor	Poor
0032-05	Poor	Fair
0032-06	Poor	Fair
0035-01	Fair	Fair
0035-02	Fair	Fair
0035-03	Fair	Fair
0035-04	Fair	Poor
0035-05	Good	Fair
0035-06	Fair	Poor
0035-07	Fair	Poor
0035-08	Fair	Fair
0035-09	Poor	Poor
0035-10	Poor	Poor
0035-11	Poor	Poor
0035-12	Poor	Poor
0035-13	Fair	Poor
0035-14	Poor	Poor
0035-15	Poor	Poor
0035-16	Poor	Fair
0035-17	Poor	Poor
0035-18	Poor	Fair
0036-01	Good	Good
0036-02	Good	Good
0037-01	Fair	Poor
0038-01	Poor	Fair
0038-02	Poor	Poor
0038-03	Poor	Poor
0038-04	Fair	Poor
0038-05	Poor	Poor
0038-06	Fair	Fair
003905-01	Poor	Poor
0039-01	Poor	Poor
0039-02	Poor	Poor
0040-01	Poor	Fair
0040-02	Fair	Fair
0040-03	Poor	Poor
004005-01	Fair	Fair
004005-02	Fair	Fair



Condition of Aquatic Habitat and Riparian Corridor		
Stream Number - Reach Designation	Aquatic Habitat	Riparian Corridor
0032-05	Poor	Fair
0032-06	Poor	Fair
0033-01	Fair	Poor
0033-02	Poor	Poor
0033-03	Fair	Fair
0033-04	Poor	Fair
0033-05	Fair	Fair
0034-01	Poor	Poor
0034-02	Poor	Fair
0034-03	Poor	Fair

\\Seagis\sis\Misc-Jobs\White_River_Drainage_Basins\maps\Figure 4-17 - Stream Surveys of Jovita Creek and Tributary 0034.mxd

Pierce County
Public Works and Utilities
Surface Water Management

1 inch equals 1,000 feet
0 500 Feet
0 150 300 Meters

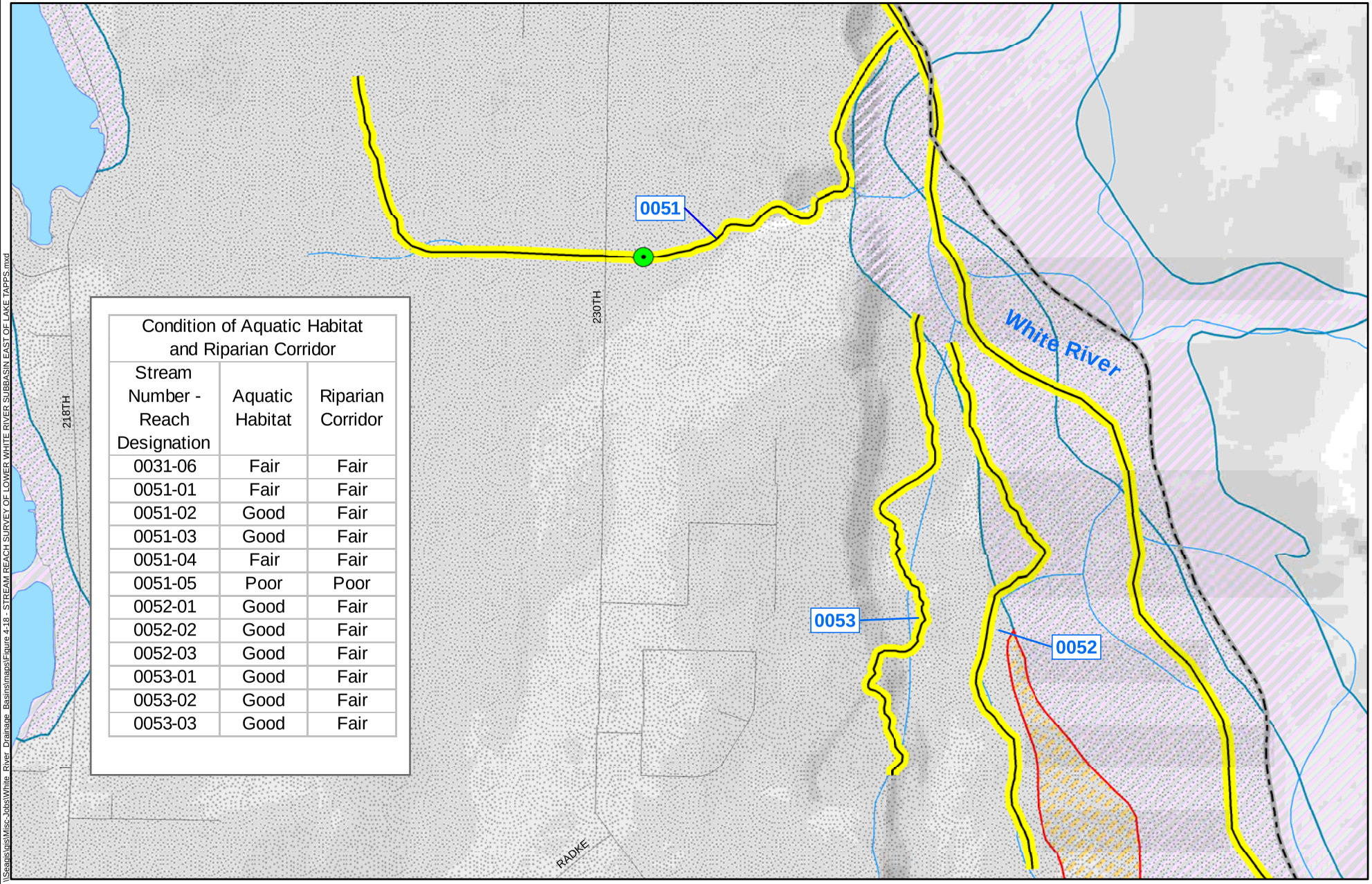
N W E S

Legend

04 River Reach End and Reach Designation
Fish Barrier
Surveyed Streams
Pierce County Boundary
Subbasin Boundary
0038 Tributary Numbers
100 Year Flood Zone
500 Year Flood Zone
Unincorporated Pierce County

Figure 4-14
STREAM SURVEYS OF JOVITA CREEK AND TRIBUTARY 0034

WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON



Condition of Aquatic Habitat and Riparian Corridor		
Stream Number - Reach Designation	Aquatic Habitat	Riparian Corridor
0031-06	Fair	Fair
0051-01	Fair	Fair
0051-02	Good	Fair
0051-03	Good	Fair
0051-04	Fair	Fair
0051-05	Poor	Poor
0052-01	Good	Fair
0052-02	Good	Fair
0052-03	Good	Fair
0053-01	Good	Fair
0053-02	Good	Fair
0053-03	Good	Fair

Pierce County
Public Works and Utilities
Surface Water Management

1 inch equals 1,000 feet
0 500 1,000 Feet
0 150 300 Meters

N W E S

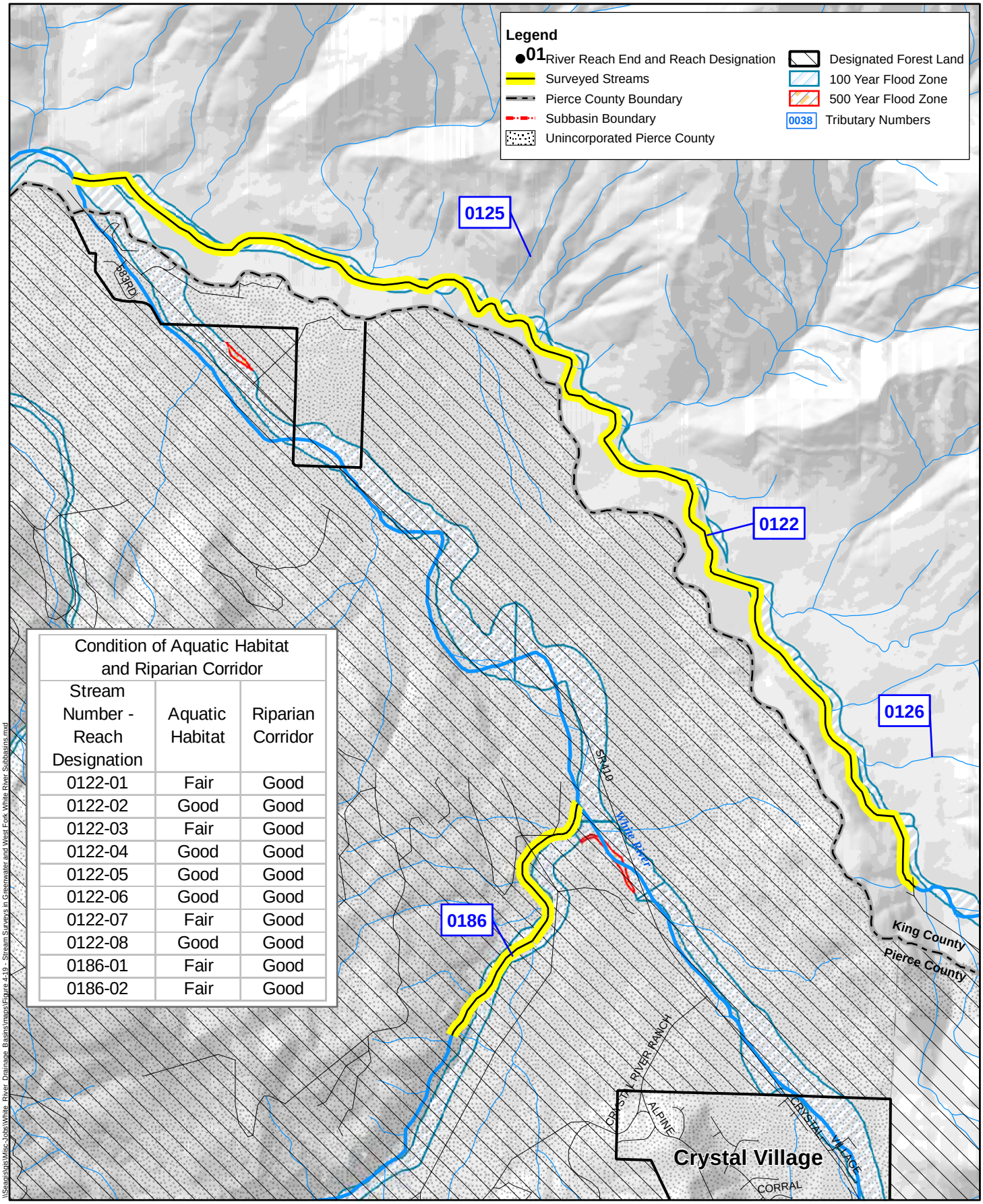
Legend

03● River Reach End and Reach Designation
Fish Barrier
Surveyed Streams
0038 Tributary Numbers
Gaging Station
Pierce County Boundary
Subbasin Boundary
100 Year Flood Zone
500 Year Flood Zone
Unincorporated Pierce County

Figure 4-15
STREAM REACH SURVEY OF LOWER WHITE RIVER SUBBASIN EAST OF LAKE TAPPS

WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON

\\Seaqis\gis\Misc-Jobs\White_River_Drainage_Basin\maps\Figure 4-18 - STREAM REACH SURVEY OF LOWER WHITE RIVER SUBBASIN EAST OF LAKE TAPPS.mxd



Condition of Aquatic Habitat and Riparian Corridor		
Stream Number - Reach Designation	Aquatic Habitat	Riparian Corridor
0122-01	Fair	Good
0122-02	Good	Good
0122-03	Fair	Good
0122-04	Good	Good
0122-05	Good	Good
0122-06	Good	Good
0122-07	Fair	Good
0122-08	Good	Good
0186-01	Fair	Good
0186-02	Fair	Good

\\Seaplis\gis\Misc-Jobs\White River Drainage Basins\maps\Figure 4-19 - Stream Surveys in Greenwater and West Fork White River Subbasins.mxd

Pierce County
Public Works and Utilities
Surface Water Management

1 inch equals 2,500 feet

0 1,250 2,500 Feet

0 150 300 600 Meters

N W E S

Figure 4-16. STREAM REACH SURVEYS FOR GREENWATER AND WEST FORK WHITE RIVER SUBBASINS

WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON

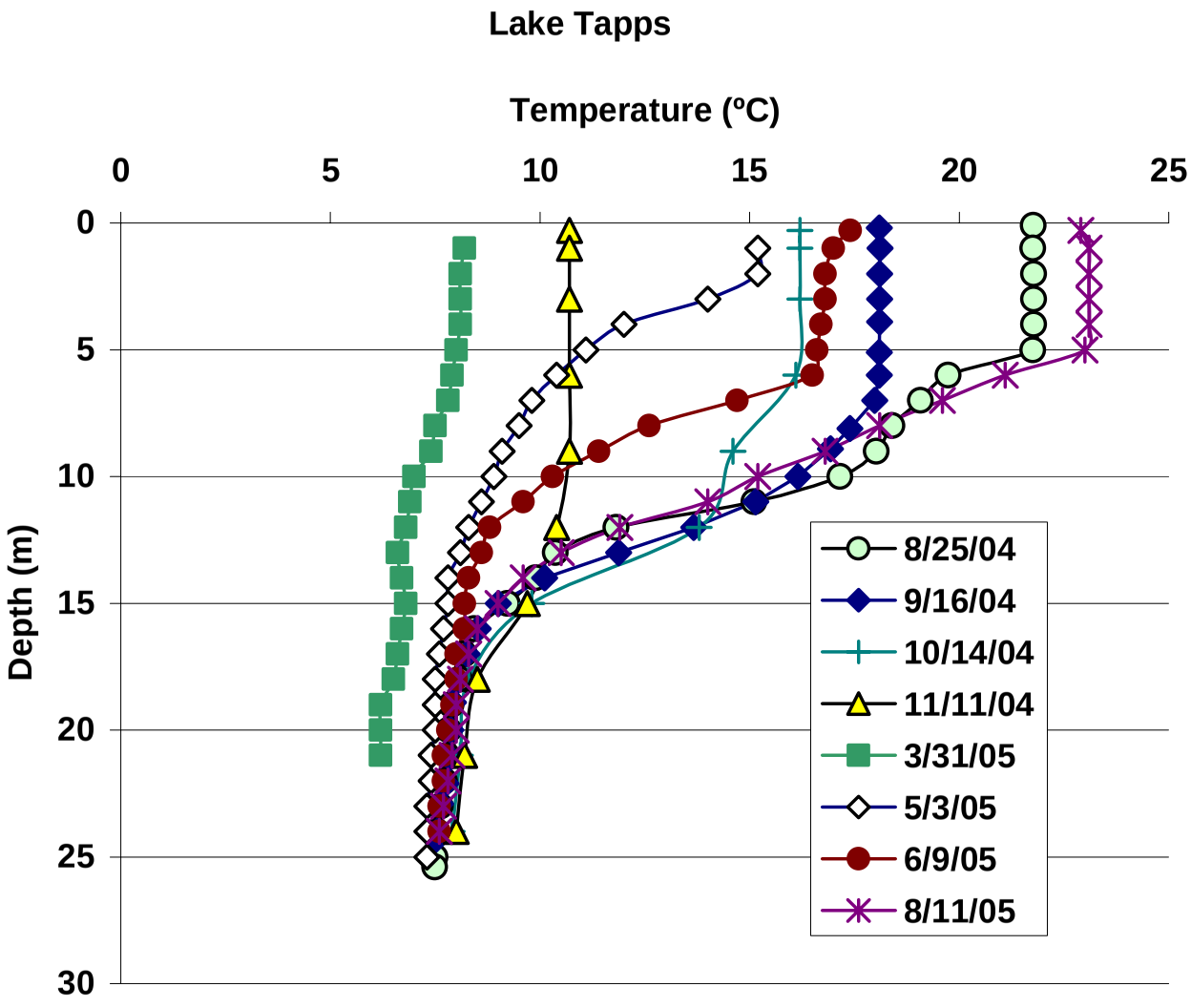
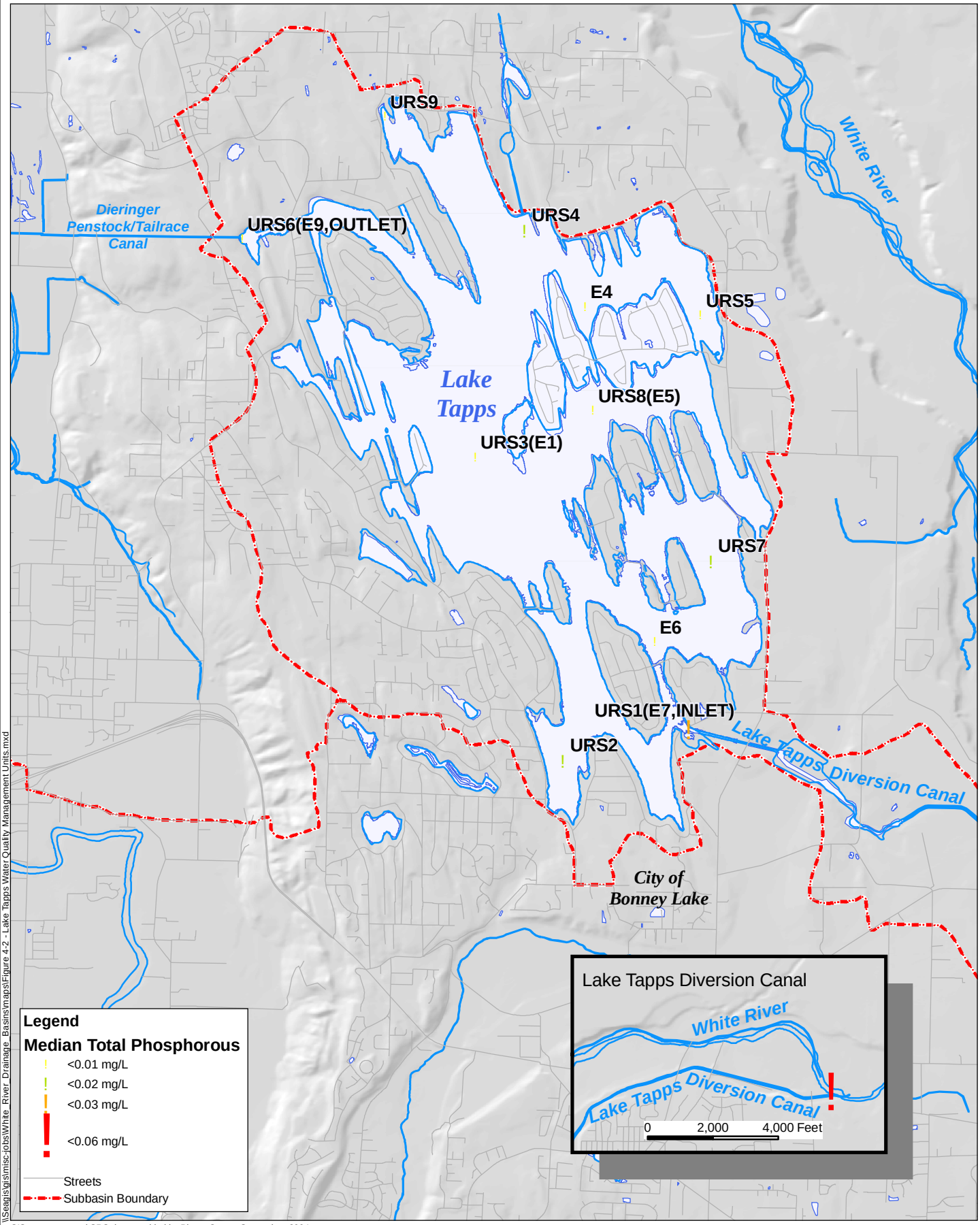


Figure 4-17 Temperature Profiles in West Main Basin of Lake Tapps



\\Seaqis\gis\misc-jobs\White_River_Drainage_Basins\maps\Figure 4-2 - Lake Tapps Water Quality Management Units.mxd

GIS coverages and SRS data provided by Pierce County September, 2004
* SRS = Service Response System

Pierce County
Public Works and Utilities
Surface Water Management

URS

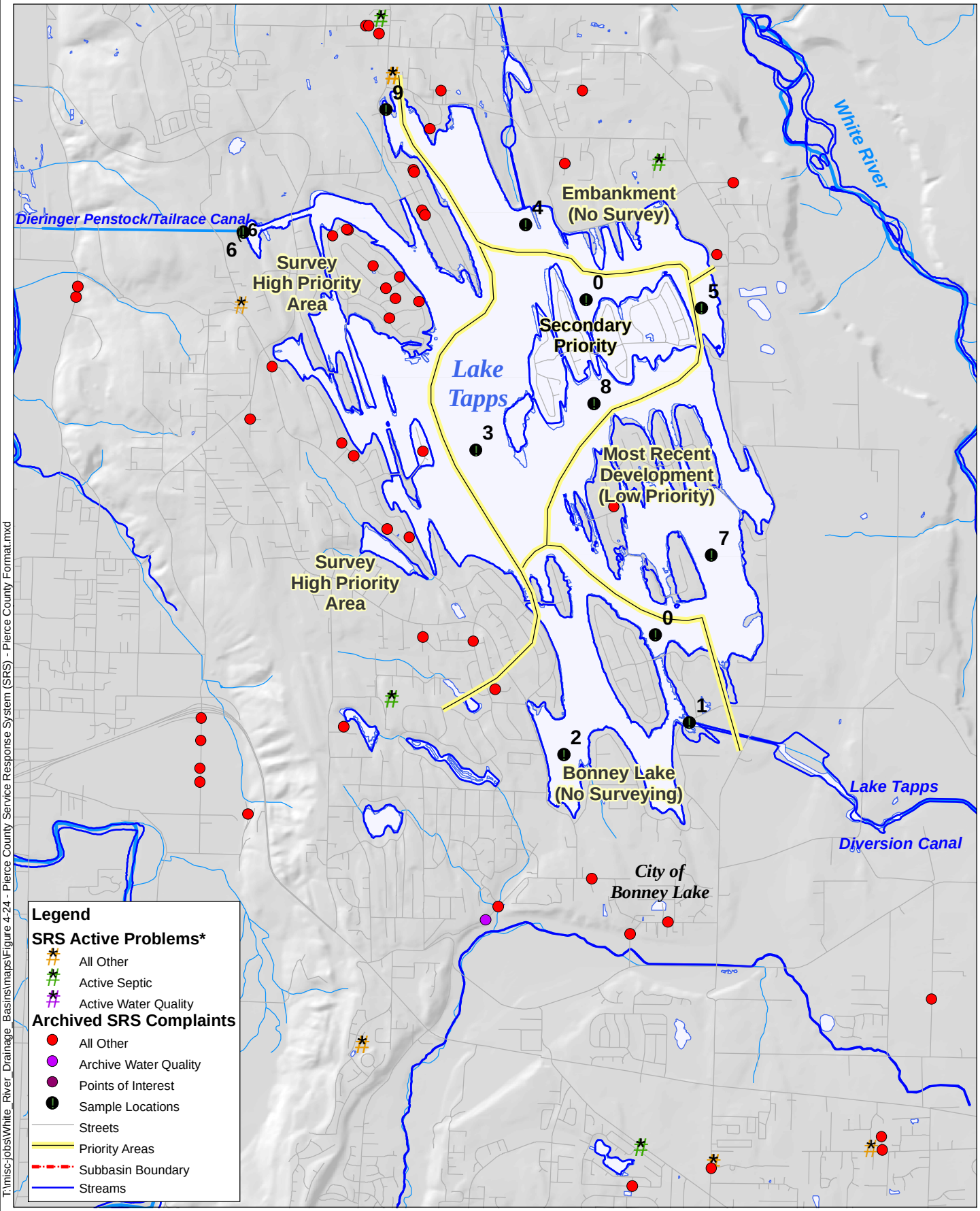
1 inch equals 4,000

0 2,000 4,000 Feet

0 500 1,000 Meters

Figure 4-18
Lake Tapps Median Total Phosphorous

White River Basin Plan
Pierce County, Washington



T:\misc-jobs\White_River_Drainage_Basins\maps\Figure 4-24 - Pierce County Service Response System (SRS) - Pierce County Format.mxd

GIS coverages and SRS data provided by Pierce County September, 2004

* SRS = Service Response System

1 inch equals 4,000 feet

0 2,000 4,000 Feet

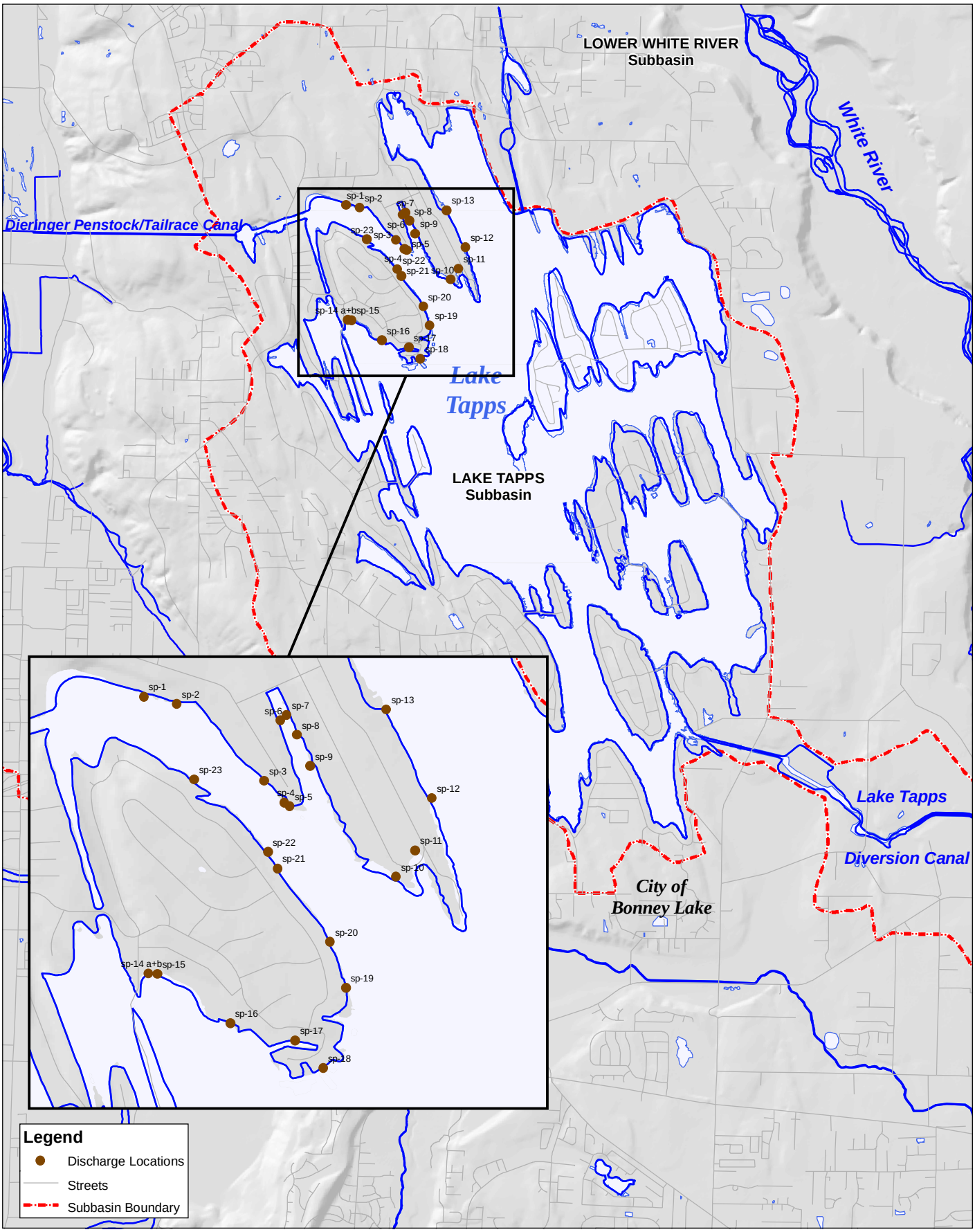
0 0.5 1 Kilometers

Pierce County
Public Works and Utilities
Surface Water Management

URS

Figure 4-19
Pierce County Service Response System and Lake Tapps Pollutant Source Survey Priority Designation

White River Basin Plan
Pierce County, Washington



\\Seagis\gis\misc-jobs\White_River_Drainage_Basins\maps\Figure 4-25 - Lake Tapps Pollutant Source Survey.mxd

GIS coverages and SRS data provided by Pierce County September, 2004

Pierce County
Public Works and Utilities
Surface Water Management

URS

1 inch equals 4,000 feet

0 2,000 4,000 Feet

0 0.5 1 Kilometers

Figure 4-20
Lake Tapps Pollutants Source Survey

White River Basin Plan
Pierce County, Washington

CHAPTER FIVE
IDENTIFICATION OF PROBLEMS

Pierce County is responsible for addressing flooding and stormwater quality problems, as well as aquatic/riparian habitat impacted by stormwater runoff and stormwater facilities. This chapter describes existing and potential surface water management problems within the White River Basin planning area. Problems identified in this chapter fall into three general categories: flooding /drainage, water quality, and aquatic/riparian habitat.

5.1 FLOODING

Flood hazard mitigation planning in Pierce County takes place within the context of the Puyallup River Basin Comprehensive Flood Control Management Plan. One goal of the flood control management plan is to establish a more comprehensive approach to flood control management than the strictly structural approach characteristic of prior times. Structural and nonstructural recommendations of the plan include the following:

- Coordinate and standardize floodplain regulations for all municipalities in the basin
- Regulate floodplain development
- Develop a flood warning system
- Begin a public awareness program
- Construct setback levees and other structural alternatives further away from the river to allow a more natural riverine environment.

These broad goals are reflected in the 2005 CIP plan (for the 2006–2011 period) for river improvement, which contains the following noncapital improvement project alternatives for achieving the river improvement level of service (LOS) (100-year flood recurrence interval):

- Alternative 1: Land acquisition program (606 acres purchased through 2004)
- Alternative 2: Flood warning program
- Alternative 3: Public awareness program
- Alternative 4: Revision of existing floodplain regulations to prohibit development in the 100-year floodplain areas by revising definitions and reviewing the “zero-rise” criterion
- Alternative 5: Mud Mountain Dam operations modification (would require act of Congress to change operation of dam, which could reduce the size of the floodplain)

For capital facilities, the CIP plan identifies improving an additional 0.95 levee miles (in Pierce County as a whole, not just the White River Basin) to the 100-year LOS, at a cost of $1.52 million, which would bring the total number of levee miles at the LOS to 10.6 out of 45.8 miles.

The following levee segments on the White River have been identified for inclusion in the levee setback project and have been assigned priority values (list provided by Pierce County, priority value in parentheses):

- County Line Site (55)
- Pacific Avenue setback (53)
- 24th Street East Pointbar (47)
- Pacific Pointbar (45)
- Interurban-White Site (43)
- 8th Street East Setback (29).

Flood hazard reduction for the White River Basin should focus on the following key areas:

1. Continuance of the floodplain property acquisition program to reduce potential flood damage.
2. Identification of further opportunities to combine flood protection with habitat and stream rehabilitation through the levee setback program.

5.2 WATER QUALITY DEGRADATION

Recent water quality complaints in Lake Tapps are few. The SRS had three septic service calls in the Lake Tapps region during 2004 and an additional three septic complaints in Greenwater and along Mountain Beaver Drive (east of the West Fork of the White River). In addition, during URS's windshield survey, sewage was observed in Salmon Creek near 162nd Avenue East, and the odor of sewage was noted in Tributary 0040 at 136th Avenue East.

Water quality degradation requiring action can result from local pollution (stormwater non-point pollution and on-site sewage systems) and basin-level conditions. The current overall water quality in the White River is generally good (WCC 1999), except for pH and temperature. Water quality in the tributaries is variable and marginal for parameters such as temperature, turbidity, and dissolved oxygen, as shown by recent measurement and samples analysis Pierce County did on selected tributaries (Appendix G).

5.2.1 Lake Tapps

Water quality monitoring conducted during 2004–2005 found that water quality in Lake Tapps was generally good. Nitrogen-to-phosphorus ratios indicate that phosphorus is the key nutrient limiting algal growth in the lake. The total phosphorus and chlorophyll-a values were relatively low, indicting that the lake was not eutrophic. Lake water quality was generally good even though flows through the lake were low compared to historical flows.

During the 2004–2005 monitoring, the White River appeared to be the main source of phosphorus entering the lake. TP and fecal coliform concentrations in the embayments were relatively low despite the numerous septic systems and stormwater outfalls along their

shorelines. This suggests that septic systems and stormwater discharges are not major sources of TP or bacteria at present. However, septic system effluent and urban stormwater runoff often contain elevated concentrations of TP, bacteria, and other pollutants. Consequently, septic systems and stormwater discharges could affect lake water quality in the future.

There are more than two thousand septic systems around Lake Tapps. Septic system effluent typically contains high concentrations of phosphorus and 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 the lake, with little contaminant removal en route. In general, the risk of failures is generally greater for older systems.

Septic systems can also contribute phosphorus to the lake via groundwater. Phosphorus usually moves very slowly in soil and groundwater because it adsorbs on soil particles and forms chemical complexes with low solubilities. It is possible that phosphorus plumes from shoreline drainfields exist but have not reached the lake yet. If these septic systems remain in use, phosphorus plumes could eventually reach the lake via groundwater.

Water quality in Lake Tapps may be affected by operations of the diversion dam and lake outlet. As discussed in Section 4, the "operating rules" for Lake Tapps are the subject of ongoing negotiations involving multiple parties. Pierce County Surface Water Management (SWM) does not own the lake and does not have authority over its operation. However, SWM can perform water quality management activities, such as non-point pollution source control, water quality monitoring, and implementation of stormwater quality best management practices (BMPs). SWM's activities will need to be tailored to the lake operating rules that result from the negotiations cited above.

Additional monitoring of Lake Tapps would help SWM gain a better understanding of its existing water quality and the potential effects of changes in lake operations. Monitoring would also help SWM identify source control needs and evaluate water quality trends over time. Monitoring Lake Tapps as operational parameters are changed would determine whether water quality remains within the criteria for human and environmental health.

5.3 HABITAT AND FISH PASSAGE

Habitat and fish passage assets and problems vary according to the location and the conditions in the White River Basin. Issues as they relate to current conditions and areas of opportunity are discussed below. The potential restoration opportunities presented here describe the types of actions that could be implemented by the jurisdiction responsible for the surface water features. Many of the streams in the lower White River Basin are within the incorporated cities of Sumner and Auburn as well as King County, and most of the streams in the upper White River Basin are within federal lands or commercial forest lands. There are opportunities for Pierce County to work in partnership with these other jurisdictions to address water resources issues in the Basin.

5.3.1 White River Mainstem

The primary fisheries issues on the White River mainstem are related to low stream flows in the bypass reach (reach between the Buckley diversion canal and the Dieringer Canal). Elevated stream temperatures in the bypass reach may be a result of low flows and have the potential to limit rearing capacity for bull trout and juvenile anadromous salmonids. Low flows resulting from the Buckley diversion and Mud Mountain Dam also have the potential to create both temperature and physical barriers to fish passage.

Low flows and elevated water temperatures in late summer can delay the upstream migration of adult salmon spawners (particularly chinook salmon) and result in the mortality of mature adults prior to spawning. Low flows and elevated water temperatures can also reduce available rearing habitat for both bull trout and chinook salmon, particularly spring-run chinook that have extended freshwater juvenile rearing periods. Smolt mortality during downstream passage through the dams can also be an issue, although recent modifications to the dams have improved this situation. Because bull trout and anadromous salmonids are trapped below the Buckley diversion and trucked above Mud Mountain Dam, the use of the reach between the two dams by salmonids is limited to juveniles and smolts that were produced in the watershed above Mud Mountain Dam and that have migrated downstream. This reach is no longer used by spawning salmonids (other than resident trout).

Elevated summer water temperatures also have a negative impact on bull trout rearing in the mainstem of the Lower White River. Rearing bull trout avoid water temperatures in excess of 15°C to 16ºC. Bull trout spawners in the lower river are trapped below the Buckley diversion dam and transported above Mud Mountain Dam. All bull trout spawning occurs in headwater tributaries above Mud Mountain Dam, and smolts migrate downstream to rear to maturity in the mainstem, possibly entering saltwater during the spring and early summer on foraging migrations. The reach of the White River between the Buckley diversion dam and Mud Mountain Dam is not accessible to upstream bull trout migrants, and bull trout that rear to maturity in the reach between the two dams do not have access to spawning habitat above Mud Mountain Dam.

Other fisheries issues on the mainstem related to the two dams on the White River include the loss of pool habitat, recruitment of spawning gravels, and the lack of LWD recruitment. Urbanization along Reaches 01 through 03 of the White River has also reduced the potential for recruitment of LWD into the mainstem.

Types of Restoration Opportunities

- Where possible, pullback levees could be installed to permit more lateral channel migration and create forested buffers with the potential to eventually provide recruitment of LWD to the stream channel.
- Engineered logjams and other structures in the White River mainstem have the potential to increase channel diversity and pool frequency. This would increase rearing capacity for juvenile salmonids and provide refuge to juvenile salmonids from high flows and summer low flows and elevated temperatures.

- In many areas of Reaches 01 though 03, agricultural fields, industrial parks, or (in one case) a golf course extend all the way to the top edge of the incised river channel. This leaves only a few yards of low-growing shrubs along the steep bank of the incision as riparian cover. Even a narrow row of trees planted along the river would contribute greatly to bank stability, canopy cover, and potential LWD recruitment.
- Numerous pipes in fields and industrial parks channel untreated stormwater runoff directly into the river. Agricultural and residential runoff increases nutrient loading of the lower river and contains pesticides and herbicides that potentially impact salmonids and their ability to navigate during migrations. Runoff from roads and parking lots includes dissolved metals and other chemical that are toxic to salmonids and other fishes. This is particularly an issue during the first heavy stormwater runoff in the fall. Increased detention and new methods of treatment for pollutants would reduce impacts to fish and aquatic wildlife.
- Connectivity with side channel habitat has been reduced as has the amount of available side channel habitat within the White River floodplain. Restoration of connectivity and the creation of new side channel habitat have the potential to increase rearing capacity for juvenile anadromous salmonids.

5.3.2 Tributaries to White River Mainstem

Many of the channels of the larger tributaries west of Lake Tapps have been channelized into straight ditches with no channel complexity. Untreated runoff from pastures, failing septic fields, and roadside ditches probably contributes to nutrient loading of these streams, and runoff from roads may contain pollutants that impact fish when stormwater runoff occurs during the first fall freshets.

Types of Restoration Opportunities

- Increasing the sinuosity of these streams would increase the amount of available fish habitat and result in increased channel complexity due to the formation of pools at bends in the stream channels.
- Establishing buffers of streamside trees along these streams would help to stabilize banks, provide cover for rearing salmonids, increase the delivery of organic nutrients through leaf fall, and increase the recruitment of LWD. Increased channel complexity also has the potential to increase available spawning gravels at the tailouts of new pools. Forested buffers as little as 50 feet wide or a single row of streamside trees can make a significant difference in aquatic habitat quality.
- Increased detention and treatment of stormwater runoff from fields, residences, parking lots, and roads would reduce impacts to fish and aquatic wildlife from nutrient enrichment and pollutants such as dissolved metals, solvents, pesticides, and herbicides.
- The constructed wetland on Tributary 004005 is not accessible to rearing juvenile salmonids. Several other wetlands on tributaries of the Lower White River are not

accessible to rearing juvenile salmonids. Increasing the accessibility of suitable coho salmon-rearing habitat in wetlands would benefit coho salmon populations.

- Many of the tributaries west of Lake Tapps have suitable habitat for rearing salmonids (particularly coho salmon) but either lack suitable spawning gravel or culverts prevent access to upstream spawning gravels. Restoring higher gradient reaches of streams with the potential to provide spawning gravel, in close association with suitable accessible rearing habitat in lower gradient stream reaches and connected wetlands, is essential to fully using available rearing habitat.
- All of the tributaries east of Lake Tapps have nonstructural passage barriers (drops up to 6 feet) into the White River, which preclude anadromous fish population use of these streams. Removal of these short cascades has the potential of creating new coho spawning and rearing habitat. However, it may be beyond Pierce County jurisdiction to remove natural fish passage barriers.
- A number of drain pipes extend from the horse pasture bordering Reach 04 of Tributary 0052. Drainage from this and other developments along Reaches 04 and 05 likely increases the nutrient loading in this stream. Increased detention, infiltration, and treatment of stormwater runoff from pastures and residential yards would reduce nutrient enrichment.
- Jovita Creek (0033) has the potential to provide better rearing habitat for coho salmon and other salmonids if channel complexity is increased. The placement of physical structures to create pools and better hydraulic conditions to maintain spawning gravels have the potential to significantly increase salmonid production (particularly coho salmon).

5.3.3 Culvert Issues

Priority tributaries were surveyed to identify potential physical blockages to fish passage (Section 4.6). The following are specific blockages in the priority tributaries.

- Artificial passage problems exist at the culvert under the Burlington Northern railroad tracks (Tributary 0038) and at the concrete control structure diverting water to constructed wetlands (Tributary 0040). The latter barrier could be considered a Pierce County responsibility.
- Jovita Creek, a tributary to 0032, contains the only salmon spawning habitat in the Lower White River Subbasin. Much of Jovita Creek can be characterized as natural. Fish passage through several culverts under State Route 167 is questionable, but Pierce County culverts all appear to be passable. Downstream of the West Valley Highway, an active headcut caused by increased flow rates may create a fish passage barrier.
- Along the surveyed reaches of the Greenwater River, no Pierce County drainage facilities create limitations for support of anadromous and resident fish populations.

- Along the surveyed reaches of the West Fork of the White River, no Pierce County drainage facilities create limitations for support of anadromous and resident fish populations.

5.3.3 Data Gaps

Phase I surveys evaluated stream channel habitat and barriers to fish passage but did not evaluate water quality requirements for salmonids, such as summer water temperatures and dissolved oxygen. Fish presence was evaluated visually and from the available literature, but data gaps exist, particularly concerning life-history forms present. Stream surveys were conducted primarily during a period of low precipitation and low flows during the late fall and provided less than optimum information about seasonal connectivity between the White River mainstem and side- or off-channel habitat. Additional data could be collected by Pierce County and other responsible jurisdictions to address these data gaps.

CHAPTER SIX
STORMWATER DRAINAGE AND FLOODING ANALYSIS

Chapter Six provides an overview of flooding and drainage problems in the White River Basin. Section 6.1 presents an overall flood risk assessment for the basin. Section 6.2 describes the analytical methods used to evaluate the flooding and drainage problems identified. Section 6.3 summarizes existing flooding and drainage problems and the results of the analyses. Section 6.4 discusses potential future problems. Section 6.5 makes recommendations for addressing each of the problems; recommendations include capital improvement projects, maintenance activities, programmatic measures, and additional studies. Specific recommendations for this White River Basin Plan (Basin Plan) are described in Chapter Nine.

6.1 FLOOD RISK ASSESSMENT

Pierce County Surface Water Management (SWM) completed a Flood Risk Assessment that covers all 10 of the County's basin planning areas (Pierce County, 2008a). The Flood Risk Assessment was prepared to achieve the following objectives:

- Ensure 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's Flood Risk Assessment report contains separate assessments for each basin planning area. The Flood Risk Assessment for the White River Basin included text from Chapter Four of this Basin Plan. The complete Flood Risk Assessment for the White River Basin planning area is provided in Appendix H.

6.1.1 Causes of Flooding

According to FEMA's 1987 Flood Insurance Study, 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 snowpack 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.

Types of flooding observed in the White River Basin are riverine and stormwater flooding. Riverine flooding refers to the flooding that occurs due to the natural hydrology of a river. Stormwater flooding refers to the flooding resulting from the changed hydrology of a river or stream due to changes in the stream or in land use and impervious area in a basin. It can also be referred to as "nuisance flooding" that occurs when elements of the storm drainage system are blocked or have reduced capacity temporarily due to debris or inadequate maintenance, or when conveyance capacity is no longer adequate.

Riverine Flooding

Flooding in the Lower White River Basin is a natural phenomenon that has been mitigated by means of engineered structures (dams and levees). The months of November, December, and January have very high stream flows due to winter rainfall. The mountain snowpack plays a strong role in controlling summer flow conditions. The lowest-flow month generally is August because most of the snow has melted and, usually, very little rain falls in July and August.

The Mud Mountain Dam, which began operation in 1942, is the primary flood control structure on the White River. Under the original water control plan, channel capacity of the White River downstream of Mud Mountain Dam was estimated to be at least 20,000 cubic feet per second (cfs). However, flooding has occurred downstream of the dam at discharges well below the original estimated channel capacity. The reduced flood capacity of the river was attributed to multiple factors including encroachment of development along the channel, channel aggradation, and limitations on channel dredging (U.S. Army Corps of Engineers [Corps], 2002).

Field observations made as far back as the 1970s indicated that flooding downstream of the dam was occurring with dam discharges as low as 12,000 cfs. During a more recent storm event in January 2009, the Corps released 11,700 cfs from the dam, and unanticipated flooding occurred in the city of Pacific. The apparent cause of flooding was a significantly reduced channel capacity (Corps, 2009).

An informal agreement between the Corps, the Muckleshoot Indian Tribe (MIT), and Pierce and King Counties limits the rate of water release from the dam to approximately 12,000 cfs, when feasible (Corps, 2002). However, the maximum authorized outflow from Mud Mountain Dam is 17,600 cfs (Corps, 2009), which can be maintained up to approximately the 100-year flood event. Release rates could be increased if necessary to prevent damage to the dam or catastrophic failure of the dam, which could result in severe flooding below the dam.

Pierce County (River Improvement Division) maintains a system of flood control levees along the White River. According to the 2005 Capital Improvement Program (CIP), prepared by SWM (formerly Water Programs), 6 percent (1,840 of 29,209 linear feet of levee) of the White River levee system is currently "adequate" (i.e., provides 100-year protection).

Stormwater Flooding

Nuisance flooding is addressed through routine maintenance, response to citizen complaints, and, if necessary, capital projects to provide increased conveyance capacity (e.g., culvert replacement) or enhanced detention storage.

Many of the priority tributaries in the basin are likely to experience flashy hydrology where there has been extensive use of culverts and ditching to straighten channel reaches. Such tributaries have often lost associated wetlands and their capacity to store stormwater runoff temporarily. Remaining wetlands east of Lake Tapps may provide continued flow attenuation in Tributary 0051, but west of Lake Tapps development has substantially reduced the presence of wetlands.

The tributaries that appear to be most threatened from potential new development are 0032, 0037, and 0038. Many of these tributaries have already experienced habitat degradation due to channel straightening, wetland loss, and changed hydrology. Pierce County manages this flood potential in its Site Development Standards, which specify that peak discharges from new developments must match predeveloped discharge rates. The County may also provide regional stormwater detention for flood control storage on a broader scale.

A summary of existing riverine and stormwater flooding problems is provided in Section 6.3.

6.1.2 Flood Hazard Impacts

Flooding in the White River Basin can have numerous impacts on the way of life within this basin, and Pierce County in general. Under this section, we will assess the vulnerability of the basin's improved property and critical facilities, and assess the impact of flooding on the basin's population and economy.

Public Safety and Health

No reported losses of life have been attributed to flooding within this basin, but damage and disruption cased by flooding has been a 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 700,820. According to the Puget Sound Regional Council's (PSRC) long-range population forecasts for the forecast analysis zones within Pierce County, the county population is expected to increase 16 percent to 812,859 by 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 (PSRC, October 2001):

- 812,859 in 2010
- 892,314 in 2020
- 951,747 in 2030.

Pierce County population projections help predict future populations in the White River Basin. The estimated 2000 population in the White River Basin planning area was 12,881, which is 1.8 percent of the county's total population of 700,820 in 2000. Assuming that the planning area will continue to capture at least 2 percent of the county's growth, it is predicted that in 2020, the population residing in the White River Basin planning area will be approximately 18,000.

Based on these projections, the assumptions for the potential impacts of flooding are as follows:

- Pressures to develop floodplains within this basin may increase 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, development in response to this growth would be directed away from known flood hazard areas within this basin.

There is real-time flood warning capability within the White River Basin. U.S. Geological Survey (USGS) real-time gauges are installed at the following locations:

- The Greenwater River at Greenwater
- Mud Mountain Lake near Buckley
- The White River near Buckley
- The White River Canal at Buckley
- The White River at Boise Creek near Buckley
- Lake Tapps near Sumner
- Lake Tapps Diversion

One additional stream flow gauge is available for flood threat recognition. This gauge is located on the White River near the confluence with the Clearwater River near Buckley. This is not a real-time gauge. The approximate lead time for flood warning is 24 to 48 hours based on the flood threat recognition 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. Local factors can also 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.

Critical Facilities

Using the parameters to define “Critical Facilities” discussed in Chapter 1 of the Flood Risk Assessment and coordinating with Pierce County Emergency Management, SWM has found no critical facilities that are likely to be impacted by flooding within the White River Basin. The basis for this determination is physical location within a mapped or known floodplain, known history of flooding, and lack of flood protection.

The Pierce County Natural Hazard Mitigation Plan (2005) included a list of critical facilities. This plan used a different set of parameters to define critical facilities and identified three critical facilities within the basin planning area; two of these facilities are dams and one is a County Sheriff detachment. According to the hazard mitigation plan, the County Sheriff detachment and one of the dams is located in an area that is outside of a floodplain or flood-prone area. The other dam facility has a flood vulnerability classification of “low: the facility is in a floodplain or flood-prone area but has no prior history of flood damage.”

Two facilities in this basin are worth noting: Mud Mountain Dam and Lake Tapps. Mud Mountain Dam is vital to flood protection within this basin. Neither of these facilities are owned, operated, or maintained by the County. These facilities are described below.

Mud Mountain Dam

Mud Mountain Dam is located on the boundary between King and Pierce Counties, at river mile (RM) 29.6. This is a Corps single-purpose dam providing flood control for the lower White and Puyallup River valleys. As a single-purpose flood control dam, it passes all inflow, except during times of flood or maintenance, and does not store water during low-flow periods. Minimum in-stream flow releases have not been set for the dam.

The dam has a flood control capacity of 106,275 acre-feet (Corps, 2004). Normally, during non-flood stages the reservoir is empty. Debris transported into the reservoir consists of both drift (trees, logs, and other forest trash) and river bedload or sediment. Wood debris is either salvaged for booms, firewood, habitat logs, or other projects or it is ricked into piles and burned. An estimated 8,000 to 10,000 cords of wood are captured annually behind the dam (WCC, 1999). River bedload or sediment deposited while the pool is high is eroded and passed through the outlets by river flow when the pool is evacuated.

Lake Tapps, Power Plant, and Associated Infrastructure

Lake Tapps is the only significant lacustrine water body in the White River Basin. Lake Tapps was built to create storage for the Puget Sound Energy (PSE) White River hydroelectric project, which came on line in 1912 and suspended operations in January 2004. In 2009, the Cascade Water Alliance (Alliance) bought Lake Tapps and intends to eventually use it as a potable water source. Approximately 2.5 miles of earthen dikes and embankments were built around four small natural lakes to create the current Lake Tapps. The dikes are maintained to control flooding.

A diversion dam on the White River (RM 24.3) is used to fill the lake. The diversion dam is an 11-foot-high structure consisting of a concrete- and rock-filled crib structure 352 feet long and 4 feet high. The structure is topped with 7-foot-high flash boards. The 21-mile stretch of the White River between the diversion dam and the return canal is referred to as the bypass reach. Although several minor drainages also feed Lake Tapps, the White River diversion dam is responsible for the vast majority of water supply to the lake.

Structures Impacted

Table 6-1 shows an estimate of the number of structures on parcels in the floodplain within the White River Basin. 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 the preparation of the Flood Risk 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 6-1
Structures within the 100-Year Floodplain White River Basin

Subbasin	Structure Type				Market Improvement Value (in millions)
	Commercial	Dwelling	Other	Total	
Lower White River	13	26	2	**41**	$41.6
Lake Tapps	9	18	1	**28**	$28.7
Mud Mountain	7	14	1	**22**	$22.8
Middle White River	4	8	1	**13**	$12.9
Greenwater River	1	1	0	**2**	$3.0
Clearwater River	0	1	0	**1**	$0.2
Upper White River	2	4	0	**6**	$6.3
West Fork White River	4	7	1	**12**	$12.7
Huckleberry	0	0	0	**0**	$0
Fryingpan	2	4	0	**6**	$6.0
Total	**42**	**83**	**6**	**131**	**$ 134.20**

Repetitive Loss Areas

Utilizing the FEMA definition of "repetitive loss" defined under the CRS, no repetitive loss properties are identified within this basin.

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 6-2 summarizes vital insurance statistics that can be used to help identify vulnerability within the White River Basin. The locations of these policies are identified in Figure 1-2 of the Flood Risk Assessment.

Table 6-2
Flood Insurance Statistics for the White River Basin

Number of flood insurance policies in force within the basin (as of May 1, 2007)	81
Number of policies within a mapped floodplain (FIRM)	9
Number of policies outside of a mapped floodplain	72
Number of claims filed within the basin	6
Number of claims filed for losses outside the 100-year floodplain	3
Estimated number of insurable, primary structures in mapped floodplains	125
Estimated % of at risk structures with flood insurance coverage	4.6%
% of current flood insurance coverage outside of a mapped floodplain	89%

Based on a review of these 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 percent of single-family homes in special flood hazard areas (SFHAs) are covered by flood insurance.
- With 89 percent of the current policies in force located outside of a mapped floodplain, some flooding issues appear to be occurring within this basin that are 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.
- The majority of historical claims filed within this basin have been outside of a mapped floodplain. Once again, this suggests that there are flooding issues within this basin not addressed through flood hazard mapping.
- The small policy base within this basin makes it very difficult to establish trends or correlations to identify risk exposure within this basin.
- The low policy counts within this basin suggest that land has been used wisely 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 methods used to evaluate the flooding and drainage problems within the White River Basin. Flooding and drainage problems were identified in the following three ways:

- Review of Section 905(b), General Investigational Reconnaissance Study, Puyallup/White River Watershed, Washington (Corps, 2002)
- Review of Pierce County Levee Setback Project, Prioritization Matrix (GeoEngineers, 2007)
- A residential questionnaire.

Flooding and drainage problems were grouped into the following general categories:

- Riverine flooding
- Stormwater or local flooding.

Flooding issues on portions of the White River mainstem and the Greenwater River will be addressed in the *Pierce County Rivers Flood Hazard Management Plan* (see Section 2.4.4). All

problems identified in the basin are presented on Table 6-3. However, analyses were completed only for problems located within the basin planning area. Table 6-3 includes descriptions of the problems and problem locations.

6.2.1 Riverine Flooding Analysis Methods

Riverine flooding analyses targeted specific flooding problem sites, as well as general flood hazard reduction through property acquisition. The first section below examines the specific problems identified in earlier sections of the Basin Plan. The second section below looks at property acquisition opportunities. As noted in Section 6.1, no repetitive loss properties were identified within this basin.

Riverine Flooding Problem Sites

Riverine flooding problems were initially screened to determine whether they are located inside or outside of the basin planning area. For example, the White River mainstem from the mouth to the county line and the sections that flow through King County are outside of the basin planning area. The reach from the mouth to the county line is to be covered by the *Pierce County Rivers Flood Hazard Management Plan* (see Section 2.4.4 for a complete description). Problems found to be outside the planning area were not analyzed.

According to the Corps, the following seven areas are threatened by a White River discharge of 12,000 cfs (Corps, 2002 and 2009):

- Residences in the Red Creek area just downstream from the dam (problem MMT-02)
- MIT fish hatchery (problem MMT-03)
- Buckley Meadows subdivision (problem TAP-24)
- Sumner golf course (problem TAP-21)
- Residences near intersection of 8th Street East and 138th Avenue East (problem TAP-23)
- Sumner Sewage Treatment Plant (problem TAP-22)
- Portions of the city of Pacific (problem LWR-78).

Of the seven areas described above, six were determined to be outside the County's jurisdiction. The seventh problem location could not be determined based on the information provided.

Floodplain Property Acquisition

As mentioned in Chapter Five, flood hazard reduction for the White River Basin should focus on the floodplain property acquisition program. Acquiring and maintaining undeveloped properties preserves flood storage, preserves natural hydrology, and reduces the potential for future flood damages. Property acquisition can also preserve riparian areas containing high-quality habitat. An analysis of potential property acquisitions focused on parcels in the 100-year floodplain of the lower White River, in the basin planning area.

PSE owned much of the undeveloped land along the bypass reach of the White River. The bypass reach is the section of river between the Lake Tapps diversion and outlet. Part of this reach is in King County and also flows through the Muckleshoot Indian Reservation. Of the sections within Pierce County, the reach from the Lake Tapps diversion downstream to the county line is within the basin planning area. In 2009, PSE sold Lake Tapps to the Alliance. It also sold many of its properties along the bypass reach. Properties along the bypass reach, on the Muckleshoot Indian Reservation side of the river (right bank), went to the MIT. PSE also placed 500 acres, in the riparian areas of the bypass reach, into restrictive covenant.

Current tax parcel data were reviewed using geographic information system (GIS) tools to determine if there are opportunities to purchase undeveloped properties along the bypass reach.

SWM maintains a system of flood control levees along the White River. Six potential levee setback sites were identified along the lower White River (GeoEngineers, 2007). Setting back existing levees to sites farther away from the river provides an opportunity to increase the flood storage capacity of the river, potentially reducing downstream effects of flooding. All six of the levee setback sites identified are located west and northwest of Lake Tapps. Flooding problems and projects along this reach of the White River are included in the *Pierce County Rivers Flood Hazard Management Plan*; therefore, they are not addressed in the Basin Plan.

6.2.2 Local Flooding Analysis Methods

In fall 2007 questionnaires were sent out to 2,400 property owners in the White River Basin. Questionnaires were sent to all properties within 150 feet of Lake Tapps and all properties in the town of Greenwater. The questions focused on land use, septic system use, use of pesticides and fertilizers, water quality, flooding, and habitat issues. Property owners returned 375 completed questionnaires to Pierce County.

Results from the questionnaire indicate the following trends regarding stormwater flooding and drainage:

- Almost all of the respondents own a single-family, lakefront residence.
- Most respondents were not aware of specific flooding problems in the basin area; 12 percent of respondents (44 respondents) identified past road or driveway flooding problems.
- Eight percent of respondents (31 respondents) experienced problems at their residence due to flooding.

In January 2011, a resident reported a local flooding problem in the Upper White River subbasin in Crystal River Ranch Estates. This problem was a late addition to the plan brought to the County's attention during completion of the plan.

Local flooding problems were evaluated by mapping the problem locations along with available information from the County's GIS data library. Sufficient information was available for 35 problems to determine an approximate location within the planning area. Site visits were

conducted for each of these 35 problems to observe and document drainage conditions, as well as to determine jurisdictional status (i.e., if the problem is under SWM jurisdiction.) After the site visits, the problems were screened and categorized as follows:

- Problems located on private property or private roads and eliminated from further evaluation
- Problems located in incorporated areas to be referred to the appropriate city
- Maintenance issues to be referred to the appropriate maintenance department
- Problems located in unincorporated Pierce County.

For problems located in unincorporated Pierce County, the County's GIS drainage inventory was reviewed to understand drainage conditions better. In most instances, the source and the extent of the problem could not be determined from the single site visit and GIS data review. However, additional site visits could not be performed within the schedule and budgetary constraints of the Basin Plan.

Hydrologic and hydraulic analyses were performed for two local flooding problems (problems TAP-15 and UWR-06, Table 6-3) where the problem could be defined well. These analyses are described in the following sections.

Hydrologic and Hydraulic Analyses

The following sections describe the hydrologic and hydraulic analyses conducted for developing drainage improvements at the TAP-15 problem location. First, the rational method was used to calculate a conservative estimate of the peak design discharge to the storm drainage system. Second, Manning's equation was used to verify the conveyance capacity of the system is adequate to collect and convey runoff.

Peak Design Discharge

According to Pierce County's *Stormwater Management and Site Development Manual* (SWM Manual, Pierce County, 2008b), storm drainage infrastructure at the problem site needs to be designed for a 25-year event. A preliminary look at the problem area found that the runoff catchment leading to the drainage infrastructure is less than a few acres. Therefore, the rational method was selected for estimating the peak design discharges. Although the SWM Manual does not contain a description of the rational method, it does contain a provision for its use in cases where runoff drainage areas are 25 acres or less.

Advantages to the rational method are (a) peak discharge estimates tend to be conservative, and (b) it is simple and time-efficient. The rational method provides reasonable results for drainages with high imperviousness, small areas, and short times of concentrations. The Washington State Department of Transportation Hydraulics Manual (WSDOT Manual, WSDOT, 2010) contains guidelines for using the rational method. Peak discharge is calculated using the following equation:

Where Q = runoff in cubic feet per second, C = runoff coefficient in dimensionless units, I = rainfall intensity in inches per hour, and A = drainage area in acres.

$$Q = CIA \qquad \text{Equation 1}$$

Runoff coefficient. The runoff coefficient represents the percentage of rainfall that becomes runoff, and is dependent upon the land use/land cover. Based on GIS data, the drainage catchment was divided into two different land uses: pavement/roofs (impervious) and lawn (impervious). The percentage of each land use within the basin was determined using GIS tools. This percentage was used to calculate an area-weighted runoff coefficient. Runoff coefficients were obtained from the WSDOT Manual:

- $C_{pavement/roofs} = 0.90$
- $C_{lawn} = 0.10$

Rainfall Intensity. Rainfall intensity can be calculated based on the time of concentration for the catchment and region-specific coefficients as presented in the WSDOT Manual:

$$I = \frac{m}{(T_c)^n} \qquad \textit{Equation 2}$$

Where I = rainfall intensity in inches per hour, T_c = time of concentration in minutes, and m and n = coefficients in dimensionless units. Coefficients m and n developed for major cities in Washington are contained in the WSDOT Manual, and vary depending on the selected recurrence interval. The nearest city with coefficients is Tacoma; for the 25-year event m and n are 6.93 and 0.533, respectively.

Drainage Area. The runoff catchment was delineated in GIS using a combination of aerial photographs and 2-foot contours. The time of concentration for the catchment is based on the estimated travel time of runoff, from the hydraulically most distant point of the tributary area. Travel times for individual flow paths can be calculated using the following equation from the WSDOT Manual:

$$T_t = \frac{L}{K\sqrt{S}} \qquad \textit{Equation 3}$$

Where T_t = travel time of flow segment in minutes, L = length of segment in feet, K = ground cover coefficient in feet, and S = slope of segment. Segment lengths along the longest flow path were estimated using GIS tools.

The WSDOT Manual provides a table of values for ground cover coefficients, with values of 420 and 1,200 listed for grass and paved areas, respectively. The slopes of each flow path segment were estimated using GIS topographic data.

Conveyance Capacity

The SWM Manual allows for the use of the Uniform Flow Analysis Method (i.e., Manning's Equation) for designing stormwater pipes and open conveyances. A standard step backwater analysis is typically only required for scenarios where tailwater conditions can affect conveyance capacity. The downstream outlet of the system for this site, however, is assumed to be a free outfall, and tailwater effects are assumed to be negligible. Manning's equation can be written as shown in Equation 4 below:

$$Q = \frac{1.49}{n} A \cdot R^{2/3} \cdot S^{1/2}$$ *Equation 4*

Where n = Manning's coefficient, A = cross-sectional area of flow in square feet, R = hydraulic radius in feet, and S = hydraulic energy slope in feet/feet.

Conveyance capacity calculations using Manning's Equation were performed for the following two scenarios:

- Trapezoidal channel: Using the 25-year design discharge and conservative assumptions for bottom width (1 foot), slope (0.5 percent), and Manning's roughness coefficient (0.055). Channel depth was calculated such that overtopping would not occur.
- Partially full pipe: Using the 25-year design discharge and conservative assumptions for slope (0.5 percent) and Manning's roughness coefficient (0.015). Pipe size was determined such that the pipe was not flowing full.

For the problem at Crystal River Ranch Estates (problem UWR-06) a number of site visits were conducted due to the extent of the problem. The proposed drainage improvements were determined by identifying the number of culverts that were undersized. The replacement culvert sizes were determined from the width of the existing roadside ditch and culvert size required to provide for fish passage. The replacement culvert lengths were estimated from the width of the driveways under which the new culverts would be installed. Further analysis will be needed to determine the volume of runoff from the design event and refine the culvert sizes to provide adequate conveyance capacity for this event.

6.3 EXISTING FLOODING AND DRAINAGE PROBLEMS ANALYSIS RESULTS

The following sections summarize the existing flooding and drainage problems for the White River Basin. Section 6.3.1 summarizes the results of the evaluation of riverine flooding problems. Section 6.3.2 summarizes the result of analyses of local flooding problems.

6.3.1 Riverine Flooding Analysis Results

PSE owned much of the undeveloped land along the bypass reach of the White River. Since it sold Lake Tapps to the Alliance, it has sold many of its properties to the MIT. PSE also placed 500 acres, in the riparian areas of the bypass reach, into restrictive covenant. Based on GIS data, there are still undeveloped, forested, and agricultural properties in the 100-year floodplain of the lower White River between the county line and the Lake Tapps diversion, within the basin planning area. PSE owns some of these parcels; however, there may be other willing sellers of properties that could provide floodplain preservation opportunities.

6.3.2 Local Flooding Analysis Results

Local flooding problems include minor stormwater drainage failures and roadway/driveway flooding. Of the 35 local flooding problem locations identified, 14 are related to

roadway/driveway flooding, including 12 in the Lake Tapps subbasin, 1 in the Mud Mountain subbasin, and 1 in the Upper White River subbasin. As described in Section 6.2.2, additional information about each problem location, except problem UWR-06, was obtained from a single site visit, during dry weather, and subsequent mapping with the County's drainage inventory. An initial screening of the problems was performed to determine how each problem would be addressed. Among those local flooding problems located in unincorporated Pierce County, many were reported by residents who live on the shore of Lake Tapps. During the site visit, some indications of flooding were observed; however, the source and extent of the problem could not always be determined in dry weather. The following conditions were observed at a typical site:

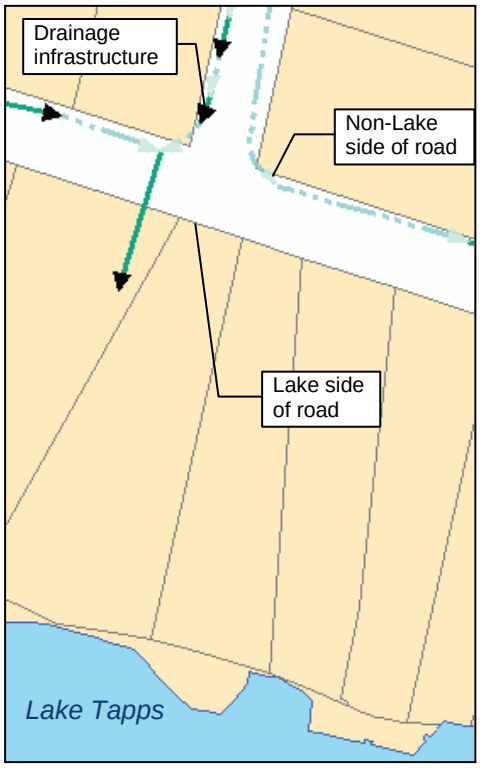


Figure 6-1. Typical shoreline drainage problem

- The land surface and road gradient slopes toward the residence and the lake
- County drainage infrastructure (ditches and culverts) exists along the non-lake side of the road (see Figure 6-1)
- No drainage infrastructure is found on the lake side of the road.

SWM will perform additional investigations including revisiting these sites during a storm event to obtain a better understanding of the source and extent of the problem. Specific information on each problem site in the planning area is provided below. Table 6-3 at the end of this section summarizes all the problems and how they will be addressed.

Problem MMT-01: Old Buckley Hwy. Flooding

A residential questionnaire reported flooding in the winter over the roadway of Old Buckley Highway in the vicinity of the fire station on the east side of Lake Tapps.

At the time of the field visit, standing water was observed in the ditch running along the west side of the highway (see Figure 6-2). A culvert did not appear to be located under the road to allow the ditch to drain to the other side of the road. The County's drainage inventory shows a 12-inch-diameter culvert under Old Buckley Highway farther south, but this culvert was also not observed during the field visit. It is possible that wet weather could cause the ditch to fill and flow over the roadway.

Figure 6-2. Roadside ditch along Old Buckley Hwy.

The source and extent of the problem cannot clearly be determined from the observations made during the site visit; therefore, additional investigations are recommended. The site should be revisited during a storm event to obtain a better understanding of the source and extent of the problem. If a culvert under the road is located during the event, the condition of the existing culvert should be assessed to ensure adequate drainage.

If the culvert is in good condition and passing flow, an analysis should be completed to evaluate ditch and culvert capacities. If the culvert is in good condition and not passing flow, the ditch could be regraded to improve drainage to the culvert. If the culvert is damaged or does not have adequate capacity, a new culvert could be installed at the lowest point along the drainage ditch.

Problem TAP-02: 17912 17th Street E Driveway Flooding

A residential questionnaire reported driveway flooding during winter and spring at 17912 17th Street E. This residence is located on the shore of Lake Tapps.

Figure 6-3. Roadside ditch along north side of 17th St. E

The area of concern is located at a T-intersection of 180th Avenue E and 17th Street E. Roadside ditches are located along both sides of 180th Avenue E, but there are no ditches along 17th Street E. There is a culvert under 17th Street E providing conveyance from the roadside ditch along the west side 180th Avenue E. This is assumed be an outfall to Lake Tapps.

According to the County's drainage inventory, the ditch along the east side of 180th Avenue E turns at the T-intersection and continues to drain along the non-lake side of 17th Street E to a culvert under the road. However, the ditch appears to undulate and have insufficient gradient to convey flow to the culvert (see Figure 6-3). In addition, at the time of the field visit the ditch contained garbage and debris, which could also be causing conveyance problems. During wet weather, this roadside ditch could fill and flow over 17th Street E in the vicinity of the residence. It is also possible that roadway runoff from 17th Street E drains toward the residence.

The extent of the problem cannot clearly be determined from the observations made during the site visit; therefore, additional investigations are recommended as follows:

- The ditch along the non-lake side of 17th Street E should be cleaned and maintained to improve conveyance.
- The site should be visited during a storm event to observe drainage patterns and verify GIS drainage inventory data (i.e., locations and sizes of existing culverts and outfalls).

If the site visit confirms a problem, one of the following projects could be implemented:

- Install a new culvert, under 180th Avenue E, to tie into the existing drainage system. Flow would pass under 180th Avenue E, from east to west, then into the culvert/outlet under 17th Street E.

- Regrade the ditches to drain as shown in the drainage inventory. The ditch along the east side of 180th Avenue E should slope from west to east to allow flow to reach an existing culvert under 17th Street E. The downstream drainage line should be checked to ensure adequate conveyance to an outfall at Lake Tapps.

Problem TAP-03: 2302 Tacoma Point Drive E Stormwater Backup

A residential questionnaire reported a stormwater backup in the vicinity of 2302 Tacoma Point Drive E.

Figure 6-4. Outlet, surrounded by ivy, to Lake Tapps

The residence at 2302 Tacoma Point Drive E is located near a three-way intersection of Tacoma Point Drive E and 186th Avenue E. At the time of the field visit, the roads had recently been resurfaced and appeared to be relatively flat. A private park is located near this intersection on the shore of Lake Tapps.

Stormwater is collected along the non-lake sides of Tacoma Point Drive E and 186th Avenue E, through a roadside ditch, a driveway culvert under multiple residential driveways (including at 2302 Tacoma Point Drive E), and then another roadside ditch. The ditch slopes toward a second culvert which drains water under 186th Avenue E, and according to the County's drainage inventory discharges to Lake Tapps at the shore of the park. The upstream end of the culvert is located in a resident yard surrounded by ivy (see Figure 6-4).

The source and extent of the problem cannot clearly be determined from the observations made during the site visit. Backups might be caused by high lake levels, a blocked inlet, or an undersized outlet. Therefore, additional investigations are recommended. The site should be visited during a storm event to obtain a better understanding of the extent of the problem. If the site visit confirms a problem, an analysis could be completed to evaluate the ditch and outlet capacities, including potential backwater effects caused by high lake levels.

Problem TAP-04: 1917 Tacoma Point Drive E House Damage Due to Flooding

A residential questionnaire reported damage (cracks in basement, walls, floor, or foundation) to the residence at 1917 Tacoma Point Drive E as a result of flooding. This residence is located on the shore of Lake Tapps.

Figure 6-5. Residence at 1917 Tacoma Point Drive E (photo from top of driveway)

The bottom floor of the residential structure at 1917 Tacoma Point Drive E is at a lower elevation than the road surface. Figure 6-5 shows the driveway sloping downward from the road to the home. A roadside ditch is located on the non-lake side of Tacoma Point Drive E. There is no ditch on the lake side. Runoff from the road surface may be draining toward the residence.

The extent of the problem cannot clearly be determined from the observations made during the site visit. Flooding could have been caused by roadway runoff or high lake levels. Because the flooding may have been caused by high lake levels, the property owner should be contacted to obtain a better understanding the problem.

If the property owner confirms a roadway runoff problem, one of the following projects could be implemented:

- Construct roadside ditches on the lake side of Tacoma Point Drive E.
- Increase the ditch capacity on the non-lake side of Tacoma Point Drive E.
- Construct a new outlet that routes roadway runoff away from the residence, to the lake. Include a passive water quality component, prior to discharging to the lake.

Problem TAP-05: 18402 9th Street E Driveway Flooding

A residential questionnaire reported driveway flooding during heavy rains at 18402 9th Street E, a residence located on the shore of Lake Tapps.

9th Street E slopes down toward the residence. The driveway also slopes down from the road toward the house. It is possible that roadway runoff from 9th Street E is draining onto the driveway.

Although roadside ditches are located along the non-lake side of 9th Street E, the ditch directly across from the residence was found to be overgrown and contained standing water at the time of the site visit (see Figure 6-6). It is possible that these roadside ditches are filling and that water is flowing across 9th Street E toward the residence.

Figure 6-6. Roadside ditch along north side of 9th St. E

Ditches are located intermittently along the lake side of the road, where this residence is located, but none appear to have drainage lines leading to the lake. Lack of drainage along the lake side could also be contributing to the flooding issues.

The extent of the problem cannot clearly be determined from the observations made during the site visit; therefore, additional investigations are recommended as follows:

- The site should be visited during a storm event to observe drainage patterns.
- The ditches should be cleaned and maintained to improve conveyance.

If the site visit confirms a capacity problem, one of the following projects could be implemented:

- Increase ditch capacity on the non-lake side of 9th Street E.
- Construct new roadside ditches on the lake side of 9th Street E.
- Construct a new outlet that routes roadway runoff away from the residence to the lake. Include a passive water quality component prior to discharging to the lake.

Problem TAP-06: 1126 184th Avenue Court E Side Yard Erosion

A residential questionnaire reported side yard erosion at 1126 184th Avenue Court E from roadway runoff. This residence is located on the shore of Lake Tapps.

Figure 6-7. 184th Avenue Court E with 1126 driveway on the left side of photo

This residence is located at the end of 187th Avenue N, where it forms a T-intersection with 184th Avenue Court E. A roadside ditch is located along the non-lake side of 184th Avenue Court E. This ditch turns east at the intersection and drains along the north side of 187th Avenue N. There is no roadside ditch along the lake sides of the roads (see Figure 6-7). Roadway runoff from 184th Avenue Court E might be flowing onto the property at 1126 184th Avenue Court E.

The extent of the problem cannot clearly be determined from the observations made during the site visit; therefore, additional investigations are recommended as follows:

- The property owner should be contacted to understand the problem better.
- The site should be visited during a storm event to observe drainage patterns.

If the site visit confirms a roadway runoff problem, one of the following projects could be implemented:

- Construct roadside ditches on the lake side of 184th Avenue Court E.
- Construct a new outlet that routes roadway runoff away from the residence to the lake. Include a passive water quality component prior to discharging to the lake.

Problem TAP-13: 4800–4900 W Tapps Drive Road Flooding

A residential questionnaire reported road flooding in the 4800–4900 block of W Tapps Drive.

A County-owned infiltration pond is located in this block of W Tapps Drive (see Figure 6-8). The roadway slopes down toward the center of the block, which is where the infiltration pond is located. The County's drainage inventory shows three catch basins located at the bottom of the hill, as well as one located approximately mid-slope on the southwest side of the road. Only the mid-slope catch basin was observed during the site visit.

Figure 6-8. Infiltration pond on W Tapps Drive

The extent of the problem cannot clearly be determined from the observations made during the site visit; therefore, additional investigations are recommended. The site should be visited to verify that existing catch basins, indicated in the GIS drainage inventory, are functioning properly.

If the catch basins are operating as intended, it is recommended that the storm pipe and infiltration pond capacities be evaluated.

Problem TAP-14: 4751 Lakeridge Drive E Road Flooding

A residential questionnaire reported road flooding near 4751 Lakeridge Drive E, and basement flooding due to excessive rain and faulty drainage provisions. This residence is located on the shore of Lake Tapps near a low point in Lakeridge Drive E. At the time of the site visit, water was ponded along the non-lake side of the roadway with no culvert allowing drainage to the other side of the road. A culvert inlet was found on the non-lake side of the road, but it was nearly 100 feet up-slope from the ponded area (see Figure 6-9). That culvert appeared to pass under the road toward a drainage swale on the lake side of the road; however, the downstream end of the culvert could not be located in the field.

On the lake side of the road, another culvert drains under the driveway of the residence at 4751 Lakeridge Drive E. The downstream end of the culvert appeared to be partially buried in sediment and it was unclear where water at the downstream end of the culvert would flow (see Figure 6-10).

Figure 6-9. Culvert on Lakeridge Drive E

Figure 6-10. Driveway culvert at 4751 Lakeridge Drive E

The County's drainage inventory indicates that the low point is farther west and that multiple driveway culverts and roadside ditches are draining toward a single culvert leading under the roadway, leading to a ditch on the lake side of the road, which in turn drains to the lake.

Roadway runoff from both directions on Lakeridge Drive E may be causing local flooding due to inadequate roadside ditch capacity. In addition, water may be accumulating in the low point during wet weather. Surcharging of culverts and roadside ditches may cause water to flow over the road.

The extent of the problem cannot clearly be determined from the observations made during the site visit; therefore, additional investigations are recommended as follows:

- The ends of the culverts, shown in the GIS drainage inventory, should be exposed and/or cleaned and maintained to improve conveyance.
- After conveyance has been improved, the site should be visited during a storm event to observe drainage patterns and verify GIS drainage inventory data (i.e., locations and sizes of existing culverts).

Problem TAP-15: 185th Avenue E Cul-de-Sac Road Flooding

A residential questionnaire reported road flooding due to moderate rain events at the cul-de-sac near 4468 185th Avenue E.

The cul-de-sac is relatively flat (see Figure 6-11), and at the time of the site visit, ponded water was observed in the northeast corner. Two culverts were observed along the perimeter of the cul-de-sac. Both culverts are located under driveways; however, the downstream outlet could not be located for one of the culverts. This culvert may lead directly to the lake; however, the cul-de-sac's surface does not appear to slope toward this culvert. This culvert may also have capacity problems because it appeared to be one-half to three-quarters full of sediment at the time of the site visit (see Figure 6-12).

Figure 6-11. 185th Avenue E cul-de-sac

Figure 6-12. Potential lake outlet

It is recommended that the ditches along the cul-de-sac be cleaned of sediment and the inlets to existing culverts be fully exposed. All existing culverts and drainage pipes should be inspected. A new Type 1 catch basin should be installed at the downstream-most culvert and surrounding areas should be regraded to improve inflow to the catch basin. Downstream infrastructure should be evaluated to ensure adequate downstream capacity.

Problem TAP-16: Road Flooding at Corner of 43rd Street E and 183rd Avenue E

A residential questionnaire reported roadway flooding at the corner of 43rd Street E and 183rd Avenue E.

The runoff from 183rd Avenue E flows north toward the intersection with 43rd Street E, and then drains west along 43rd Street E. No drainage outlet was observed at the low point in the intersection (see Figure 6-13). Although there are roadside ditches they are small and intermittent. In addition, driveway culverts appeared to be partially or completely buried.

Figure 6-13. Corner of 43rd Street E and 183rd Avenue E

According to the County's drainage inventory, there are consecutive roadside ditches and culverts flowing toward a storm pipe under 43rd Street E, which leads to the lake. However, this was not observed in the field.

It is recommended that culverts and ditches be cleaned and maintained to restore conveyance.

Problem TAP-18: Road/House Flooding near 3229 Deer Island Drive E

A residential questionnaire reported flooding from the side of the road into the house next to 3229 Deer Island Drive E. Deer Island Drive E is on a peninsula of Lake Tapps, and these residences are located on the shore of Lake Tapps.

The road had been recently resurfaced at the time of the site visit. In the vicinity of 3229 Deer Island Drive E the road slopes southeast toward a low point located on a narrow strip of land with the lake on both sides. The lake side of the road, where the flooding was reported, does not have a roadside ditch (see Figure 6-14). A catch basin is located down-slope from 3229 Deer Island Drive E; however, at the time of the

Figure 6-14. North side of Deer Island Drive E

field visit, the catch basin was partially covered with dirt and moss.

The source and extent of the problem cannot clearly be determined from the observations made during the site visit; therefore, additional investigations are recommended as follows:

- The site should be visited during a storm event to observe drainage patterns.
- The catch basin should be cleaned and maintained to improve conveyance.

If observations during a storm event indicate that roadway runoff is not being captured, but is flowing into the adjacent residence, a catch basin could be installed up-slope of the driveway opposite the existing catch basin. A culvert (approximately 30 feet in length) could be installed under the driveway, and a drainage swale (approximately 50 feet in length) could be constructed to direct roadway runoff to the new catch basin. An evaluation of the downstream storm pipes should be conducted to ensure adequate capacity, given the additional flow.

Problem TAP-19: 2706 185th Avenue E House Damage Due to Flooding

A residential questionnaire reported that high water, heavy rain, and/or snowmelt causes the house at 2706 185th Avenue E to flood.

This residence is located on the west side of the road, which is the non-lake side. Roadside ditches and driveway culverts are located on this side of the road that appear to be well-maintained and collect and convey runoff. The house sits above the road (see Figure 6-15). Based on the field visit, it was determined that the flooding problem is a homeowner issue, and does not fall under the County's jurisdiction.

Figure 6-15. Residence at 2706 185th Avenue E

Problem TAP-20: 2325 185th Avenue E Yard Damage Due to Flooding

A residential questionnaire reported cracking/settlement in the yard at 2325 185th Avenue E, resulting from flooding. This residence is located on the shore of Lake Tapps.

The house is situated slightly lower than the road, and the driveway slopes down from the road to the house (see Figure 6-16). No roadside ditches or conveyance structures were observed on this side of the road, in front of this residence. The County's drainage inventory shows a catch basin to the west, approximately 125 feet from the residence.

Figure 6-16. East side of 185th Avenue E

Roadway runoff may drain onto the property. However, the extent of the problem cannot clearly be determined from the observations made during the site visit. Therefore, it is recommended that the site be visited during a storm event to observe drainage patterns.

If observations during a storm event indicate a roadway runoff problem, a catch basin could be installed on the east side of the driveway, and a culvert could be installed under the driveway to drain to the existing catch basin to the west.

Problem UWR-06: Crystal River Ranch Estates, Mountain Side Drive E Damage Due to Flooding

A resident reported a flooding problem near her home in January 2011. The problem is located in a subdivision called Crystal River Ranch Estates on the east side of Mountain Side Drive E. Roadside runoff floods the parcel located at 16611 Mountain Side Drive E. Much of the runoff originates in the hills west of Mountain Side Drive E. The runoff flows down steep side slopes on the west side of Mountain Side Drive E and is conveyed along the west side of the road through a ditch and several driveway culverts. The driveway culverts have insufficient capacity to convey the runoff during moderate storm events. When the water overtops the ditch, it flows across the road and onto the private property adjacent to the east side of the roadway.

Figure 6-17. Property at 16611 Mountain Side Drive E

It is recommended that the culverts along the west side of Mountain Side Drive E and under Birch Way E be replaced with larger culverts that increase conveyance capacity and provide fish passage.

6.4 POTENTIAL FUTURE FLOODING AND DRAINAGE PROBLEMS

This section describes potential future flooding problems for tributaries and stormwater conveyance in the White River planning area. The eastern portion of the basin will not have substantive changes in land use and will remain predominantly forest land (national forest or national park). The western portion of the basin will experience some increase in impervious areas with the highest increase of 6 percent in the Lower White River Subbasin. The most intense projected development includes:

- Increase in commercial development west of Lake Tapps (incorporated areas)
- Conversion of open space to residential developments.

Figures 4-5 and 4-6 show areas in the White River basin with the greatest potential to experience stormwater flooding due to changes in percent impervious surface. Localized flooding and stream channel erosion could occur in these areas; however, new development

would be subject to County site development standards 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:

- Invasive weeds reducing ditch and stream channel capacities
- Debris accumulations in roadside ditches and culverts.

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 White River Basin will be addressed. Table 6-3 summarizes the recommendations. Proposed programmatic measures and capital improvement projects are described in Chapter Nine and Figure 9-1 shows capital improvement project locations.

6.5.1 Problems Resolved or Not Addressed in the Basin Plan

Twenty of the flooding problems identified are not addressed in this Basin Plan, for the reasons listed below:

- Ten problems were found to be outside Pierce County's jurisdiction and will be referred to the agency or City shown on Table 6-3.
- Six problems were found to be outside Pierce County's jurisdiction because they were located on private property and did not appear to be related to County infrastructure or operations.
- Three problems were located along the reaches that are to be included in the *Pierce County Rivers Flood Hazard Management Plan*.
- One of the flooding problems appears to have been resolved.

6.5.2 Maintenance and Enforcement Issues

Six local flooding problems were identified as requiring maintenance. Most of these problems were sediment or debris in drainage conveyance structures, or overgrown vegetation along drainage ditches. These problems will be referred to Pierce County Department of Transportation Services.

6.5.3 Capital Improvement Program Projects

Two projects were developed to address two local drainage problems in the White River Basin (TAP-15 and UWR-06). These projects are discussed in greater detail in Chapter Nine. The project locations are shown on Figure 9-1.

6.5.4 Programmatic Measures

The countywide programmatic measures relevant to drainage and flooding problems are listed below:

- PRG00-01, Low Impact Development Program
- PRG00-02, Update Stormwater Management Manual
- PRG00-03, Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit
- PRG00-04, Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation
- PRG00-06, Education, Outreach, and Technical Assistance Program
- PRG00-08, Best Management Practices Manual for Pierce County Surface Water Management Maintenance Activities
- PRG00-09, Invasive Species Management Program
- PRG00-10, Beaver Management Policy

Chapter Nine contains detailed descriptions of these measures.

6.5.5 Problems Requiring More Detailed Data or Analysis

Ten local flooding problems were identified as requiring additional investigation. Many of the problems were reported by residents who live on the shore of Lake Tapps, where:

- The land surface and road gradient slopes toward the residence and the lake
- County drainage infrastructure (ditches and culverts) exists along the non-lake side of the road (see Figure 6-1)
- No drainage infrastructure was found on the lake side of the road.

SWM will perform additional investigations including revisiting these sites during a storm event to obtain a better understanding of the source and extent of the problem.

Table 6-3
Flooding and Stormwater Drainage Problem Recommendations

Problem ID	Location	Description	Recommendation
LWR-78	City of Pacific	In January 2009, flooding occurred in the city when the Corps released water from the Mud Mountain Dam during a storm event	Problem is outside the County's jurisdiction.

Table 6-3
Flooding and Stormwater Drainage Problem Recommendations

Problem ID	Location	Description	Recommendation
MMT-01	Old Buckley Hwy. by the fire station on the east side of the lake	Road flooding during winter	SWM will perform additional investigations.
MMT-02	Residences in the Red Creek area just downstream from Mud Mountain Dam	Area threatened by discharges of 12,000 cfs from the Mud Mountain Dam	Problem is outside the County's jurisdiction.
MMT-03	Muckleshoot Tribe fish hatchery	Area threatened by discharges of 12,000 cfs from the Mud Mountain Dam	Problem is outside the County's jurisdiction.
MWR-01	58122 SR 410 E	Need dike rebuilt in the back of residence; need help getting FEMA grants	This reach of the White River is covered under the *Pierce County Rivers Flood Hazard Management Plan*.
TAP-01	Sumner/Tapps Hwy. bridge between Driftwood Points and Fairweather Cove Estates	Flooding at corners of bridge, could be storm drain blockage	Site visit could not confirm the blockage. Problem is assumed to have been resolved.
TAP-02	17912 17th St. E	Driveway flooding during winter/spring	Report to Transportation Services for required maintenance to ditches. Increase Inspections for Compliance with Stormwater Requirements, and NPDES Permit (PRG00-03). SWM will perform additional investigations.
TAP-03	2302 Tacoma Pt. Dr. E	Stormwater backup at residence	SWM will perform additional investigations.
TAP-04	1917 Tacoma Pt. Dr. E	Cracks in basement, walls, floor, or foundation due to flooding	SWM will perform additional investigations.
TAP-05	18402 9th St. E	Driveway flooding during heavy rains	Report to Transportation Services for required maintenance to ditches. Increase Inspections for Compliance with Stormwater Requirements, and NPDES Permit (PRG00-03). SWM will perform additional investigations.
TAP-06	1126 184th Ave. Ct. E	Erosion of side yard from road runoff	SWM will perform additional investigations.
TAP-07	20207 Island Pkwy. E	Cracking or settlement in yard due to flooding	Problem is outside the County's jurisdiction. Flooding occurred at a residence on a private road.
TAP-08	2905 196th Ave. Ct. E	Cracking or settlement in yard due to flooding	Problem is outside the County's jurisdiction. Flooding occurred at a residence on a private road.

Table 6-3
Flooding and Stormwater Drainage Problem Recommendations

Problem ID	Location	Description	Recommendation
TAP-09	19816 34th St. E	Cracks in basement, walls, floor, or foundation due to flooding	Problem is outside the County's jurisdiction. Flooding occurred at a residence on a private road.
TAP-10	4904 N Island Dr. E	Road/house flooding	Refer problem to City of Bonney Lake.
TAP-11	20201 Church Lake Dr. E	Every winter lot and garage get flooded from drainage ditch overflows	Refer problem to City of Bonney Lake.
TAP-12	19512 56th St. E	Stormwater backup and damage to landscape and driveway due to flooding	Refer problem to City of Bonney Lake.
TAP-13	4800–4900 block, W Tapps Dr.	Road flooding	SWM will perform additional investigations.
TAP-14	Lakeridge Dr. E near 4751	Road near house and driveway; basement flooded due to excessive rain and faulty drainage provisions	Report to Transportation Services for required maintenance to ditches. Increase Inspections for Compliance with Stormwater Requirements, and NPDES Permit (PRG00-03). SWM will perform additional investigations.
TAP-15	Cul-de-sac of 185th Ave. E near 4468	Moderate rains cause the cul-de-sac to flood up to 8" which drains across driveway requiring cleanup	185th Ave. E. Drainage Improvements (CIP15-TAP-C01).
TAP-16	Corner of 43rd St. E & 183rd Ave. E	Road flooding	Report to Transportation Services for required maintenance to catch basins. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PRG00-03).
TAP-17	3609 Lakeridge Dr. E	Water damages to house or structure due to flooding	Report to Transportation Services for required maintenance to catch basins. Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit (PRG00-03).
TAP-18	Deer Island Dr. E near 3229	Road/house flooding	Report to Transportation Services for required maintenance to ditches. Increase Inspections for Compliance with Stormwater Requirements, and NPDES Permit (PRG00-03). SWM will perform additional investigations.
TAP-19	2706 185 Ave. E	Water damages to house or structure, and sanitary sewer backup due to flooding	Problem is outside the County's jurisdiction. This is a private residence issue.
TAP-20	2325 185th Ave. E	Cracking or settlement in yard due to flooding	SWM will perform additional investigations.

Table 6-3
Flooding and Stormwater Drainage Problem Recommendations

Problem ID	Location	Description	Recommendation
TAP-21	Sumner Golf Course	Area threatened by discharges of 12,000 cfs from the Mud Mountain Dam	Problem is outside the County's jurisdiction. Area is within the city of Sumner.
TAP-22	Sumner Sewage Treatment Plant	Area threatened by discharges of 12,000 cfs from the Mud Mountain Dam	Problem is outside the County's jurisdiction. Area is within the city of Sumner.
TAP-23	Residences near intersection of 8th St. E and 138th Ave. E	Area threatened by discharges of 12,000 cfs from the Mud Mountain Dam	Problem is outside the County's jurisdiction. Area is within the city of Sumner.
TAP-24	Buckley Meadows subdivision	Area threatened by discharges of 12,000 cfs from the Mud Mountain Dam	Problem is outside the County's jurisdiction. Area is a private subdivision on private roads.
TAP-25	Lower White River	Riverine flooding potential and degraded aquatic/riparian habitat due to channelization by levees	This problem is addressed by the Levee Setback projects at Interurban-White Site (Site 27), 24th Street East Pointbar (Site 28), 8th Street East Setback (Site 29), Pacific Pointbar (Site 30), Pacific Avenue setback (Site 31), and County Line Site (Site 32). These projects will be included in the *Pierce County Rivers Flood Hazard Management Plan*.
UWR-01	SR 410 E (mile post 41)	Road flooding in November 2006	Refer problem to King County.
UWR-02	583rd Ave. E	Road flooding in November 2006	This road is almost entirely in the White River floodway. In November 2006, 18" of rain fell on Mount Rainier within 36 hours; this was a record event. This reach of the White River is covered under the *Pierce County Rivers Flood Hazard Management Plan*.
UWR-03	58617 Lumpy Ln. E	Transportation disruption due to flooding	Problem is outside the County's jurisdiction. Flooding occurred at a residence on a private road.
UWR-06	Mountain Side Drive E, Crystal River Ranch Estates	Moderate rains cause roadside ditches to overtop, draining across the roadway and flooding private property	Crystal River Ranch Estates Drainage Improvements (CIP21-UWR-C01).

CHAPTER SEVEN
WATER QUALITY ANALYSIS

Chapter Seven provides an analysis of the water quality information and problems described in Chapter Four, Existing Conditions, and Chapter Five, Identification of Problems. Section 7.1 is a review of the 2008 Water Quality Assessment for water bodies throughout the White River Basin. Section 7.2 focuses on the water quality concerns and management needs for Lake Tapps, which is the largest water body in the planning area. Section 7.3 discusses potential future problems within the White River Basin. Section 7.4 recommends potential solutions to the water quality problems. The recommended solutions include a range of programmatic measures. Specific recommendations for this White River Basin Plan (Basin Plan) are described in Chapter Nine.

7.1 REVIEW OF 2008 WATER QUALITY ASSESSMENT

The federal Clean Water Act Section 303(d) requires that every 2 years the Washington State Department of Ecology (Ecology) must identify all water bodies that do not support their designated beneficial uses, as indicated by water quality standards excursions. The resulting list of "impaired" or "polluted" waters is called the "303(d) list." Prior to 2002, all water bodies in Washington were either listed as "impaired" or not listed at all. In 2002, Ecology developed a more comprehensive system for classifying water bodies. This system involves five water quality assessment categories, which are defined below.

1. ***Category 1*: Meets tested standards for clean waters**. Placement in this category does not necessarily mean that a water body is free of all pollutants. Most water quality monitoring is designed to detect a specific array of pollutants, so placement in this category means that the water body met standards for all the pollutants for which it was tested. Specific information about the monitoring results can be found in the individual listings.
2. ***Category 2*: Waters of concern** is for waters where there is some evidence of a water quality problem, but not enough to require production of a total maximum daily load (TMDL) at this time. A water body could be placed in this category for several reasons. 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. In all of these situations, these waters will continue to be tested.
3. ***Category 3*: No data** is a category that will be largely empty. Water bodies that have not been tested will not be individually listed, but if they do not appear in one of the other categories, they are assumed to belong here.
4. ***Category 4*: Polluted waters that do not require the establishment of a TMDL.** This category is for waters that have pollution problems that are being solved in one of the following three ways:

a. ***Category 4a*** is for water bodies that have approved TMDLs in place that are actively being implemented.

b. ***Category 4b*** is for water bodies that have a plan in place that is expected to solve the pollution problems. While pollution control plans are not TMDLs, they must have many of the same features and must contain some legal or financial guarantee that they will be implemented.

c. ***Category 4c*** is for water bodies impaired by causes that cannot be addressed through a TMDL. These impairments include low water flow, stream channelization, and dams. These problems require complex solutions to help restore streams to more natural conditions.

2. ***Category 5*****: Polluted waters that require a TMDL**. Placement in this category means that Ecology has data showing that the water quality standards have been violated for one or more pollutants, and there is no TMDL or pollution control plan in place; thus, TMDLs are required for the water bodies in this category. Category 5 is equivalent to the pre-2002 303(d) lists.

Ecology's most recent Water Quality Assessment was issued in 2008. Table 7-1 lists the Category 4 and 5 water bodies in the White River Basin. Figure 7-1 shows the locations of these water bodies.

Table 7-1
White River Basin Water Bodies
in 2008 Water Quality Assessment

Water Body	Water Quality Category	Fecal Coliform	pH	Sediment	Temperature	Other	Jurisdiction for Tributary Area of Listed Reach
Boise Creek	5: Polluted; requires TMDL	✓	✓		✓		Entirely King County
Bowman Creek	5: Polluted; requires TMDL					✓ DO	Entirely King County
Clearwater River	5: Polluted; requires TMDL				✓		Entirely designated forest land/ national forest
Huckleberry Creek	5: Polluted; requires TMDL				✓		Entirely designated forest land/national forest/Mt. Rainier National Park
Lower White River	5: Polluted; requires TMDL	✓	✓		✓		Primarily incorporated Pierce County/King County
Lyle Creek	5: Polluted; requires TMDL				✓		Entirely designated forest land/ national forest
Milky Creek	5: Polluted; requires TMDL				✓		Entirely designated forest land/ national forest
Salmon Creek	5: Polluted; requires TMDL	✓					Primarily Sumner

Table 7-1
White River Basin Water Bodies
in 2008 Water Quality Assessment

Water Body	Water Quality Category	Fecal Coliform	pH	Sediment	Temperature	Other	Jurisdiction for Tributary Area of Listed Reach
Scatter Creek	5: Polluted; requires TMDL				✓		Entirely King County
Greenwater River	4c: Impaired by nonpollutant					✓ fish habitat	Primarily King County/ designated forest land/national forest
Hidden Lake	4c: Impaired by nonpollutant					✓ Eurasian milfoil	Primarily unincorporated Pierce County
Lake Tapps	4c: Impaired by nonpollutant					✓ Eurasian milfoil	Primarily unincorporated Pierce County
Lower White River	4c: Impaired by nonpollutant					✓ in-stream flow	Primarily incorporated Pierce County/King County
Brush Creek	4a: Approved TMDL in place			✓	✓		Entirely King County
Eleanor Creek	4a: Approved TMDL in place			✓			Entirely designated forest land/ national forest/Mt. Rainier National Park
Greenwater River	4a: Approved TMDL in place			✓	✓		Unincorporated Pierce County/King County/designated forest land/national forest
Lightning Creek	4a: Approved TMDL in place			✓			Entirely designated forest land/ national forest
Minnehaha Creek	4a: Approved TMDL in place			✓			Entirely designated forest land/ national forest
Pyramid Creek	4a: Approved TMDL in place			✓	✓		Entirely national forest/King County
Slide Creek	4a: Approved TMDL in place			✓			Entirely national forest/King County
Straight Creek	4a: Approved TMDL in place				✓		Entirely national forest/King County
West Fork White River	4a: Approved TMDL in place			✓			Entirely designated forest land/ national forest
Whistler Creek	4a: Approved TMDL in place				✓		Entirely national forest/King County

The majority of the water bodies shown in Table 7-1 have tributary areas outside the planning area. With the exception of the lower White River, the tributary areas of the Category 5, polluted waters requiring a TMDL, are entirely or primarily outside the planning area. The lower White River is currently listed for fecal coliform, pH, and temperature. The reaches listed for pH and temperature, however, are mainly in King County and incorporated areas. For all

the Category 5 waters in the White River Basin, temperature is the most common water quality problem, with a few water bodies listed for fecal coliform, pH, and dissolved oxygen (DO).

Table 7-1 also shows the four water bodies, with tributary areas at least partially in the planning area, classified as 4c, impaired by nonpollutants. Hidden Lake and Lake Tapps are both experiencing problems with Eurasian milfoil, an invasive water weed. The lower White River has low in-stream flow. The Greenwater River has a fish habitat problem, related to fine sediments. The majority of the tributary area to this reach of the Greenwater River, however, is either designated forest land or within King County.

Several water bodies in the upper basin, with tributary areas mostly outside the planning area, are covered by U.S. Environmental Protection Agency (EPA)-approved TMDLs. These TMDLs address sediment and temperature problems.

Sections 7.1.1 through 7.1.5 below discuss the water quality problems in the planning area and their likely sources or causes.

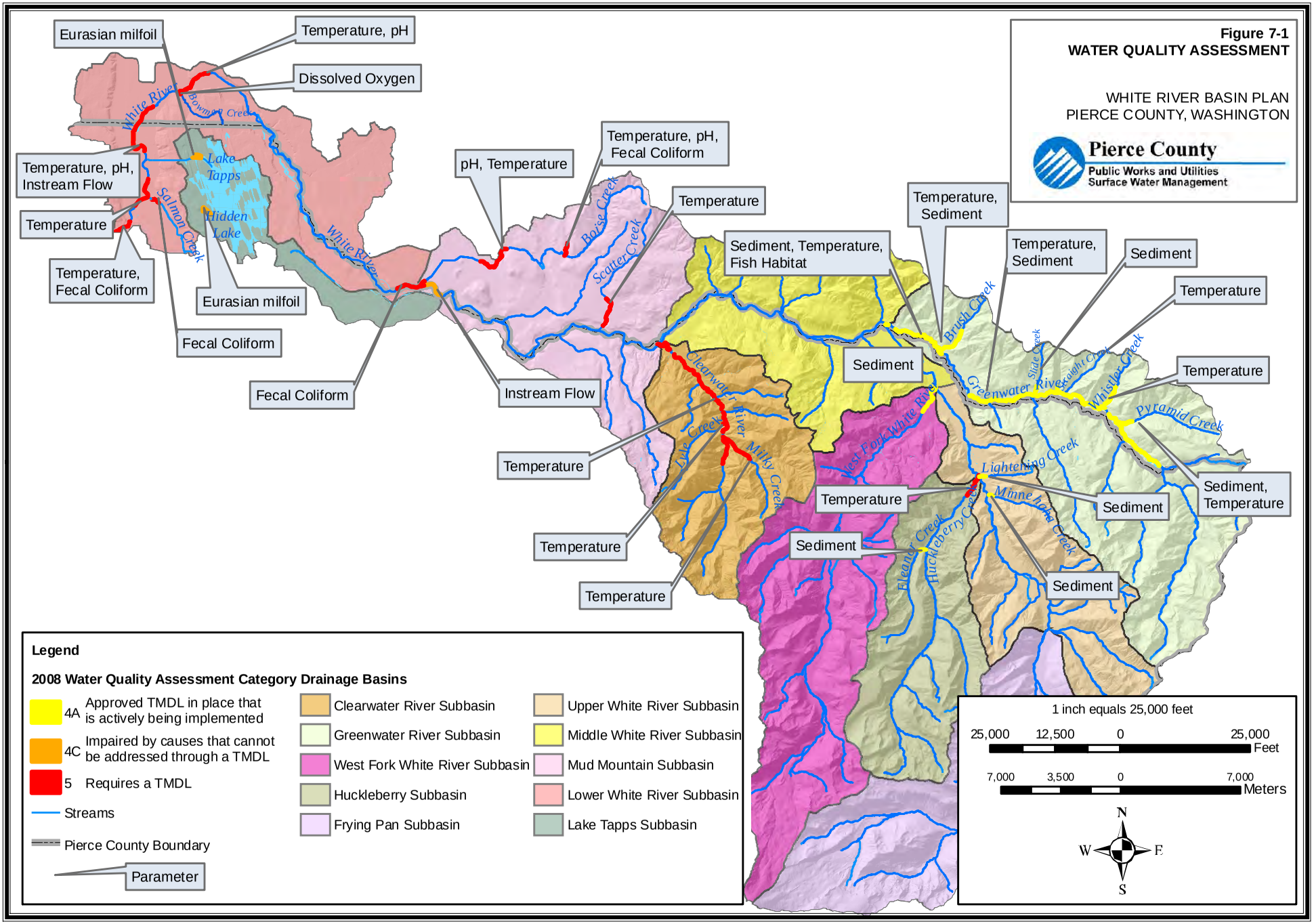


Figure 7-1
WATER QUALITY ASSESSMENT
WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON
Pierce County
Public Works and Utilities
Surface Water Management
Eurasian milfoil
Temperature, pH
Dissolved Oxygen
Temperature, pH, Instream Flow
Temperature
Temperature, Fecal Coliform
Eurasian milfoil
Fecal Coliform
Fecal Coliform
pH, Temperature
Temperature, pH, Fecal Coliform
Temperature
Instream Flow
Temperature
Temperature
Temperature
Sediment, Temperature, Fish Habitat
Temperature, Sediment
Temperature, Sediment
Sediment
Temperature
Temperature
Sediment
Temperature
Sediment, Temperature
Sediment
Sediment
Sediment
White River
Bowman Creek
Lake Tapps
Hidden Lake
Salmon Creek
White River
Boise Creek
Scatter Creek
Clearwater River
Milky Creek
Dale Creek
West Fork White River
Greenwater River
Brush Creek
Slide Creek
Whistler Creek
Pyramid Creek
Lightening Creek
Minnehaha Creek
Huckleberry Creek
Eleanor Creek
Legend
2008 Water Quality Assessment Category Drainage Basins
4A Approved TMDL in place that is actively being implemented
4C Impaired by causes that cannot be addressed through a TMDL
5 Requires a TMDL
Streams
Pierce County Boundary
Parameter
Clearwater River Subbasin
Greenwater River Subbasin
West Fork White River Subbasin
Huckleberry Subbasin
Frying Pan Subbasin
Upper White River Subbasin
Middle White River Subbasin
Mud Mountain Subbasin
Lower White River Subbasin
Lake Tapps Subbasin
1 inch equals 25,000 feet
25,000 12,500 0 25,000 Feet
7,000 3,500 0 7,000 Meters
N
W
E
S

7.1.1 Temperature

Elevated water temperatures can be harmful to salmon, trout, and other aquatic species adapted to cold water. Water temperatures have exceeded the state standards in several streams in the eastern portion of the planning area, as shown on Figure 7-1. An approved TMDL is in place as noted in Table 7-1. The elevated temperatures in these streams are probably related to sparse shade along the streams (Ecology, 2006a).

The lower White River is listed as polluted due to elevated water temperature. Elevated water temperatures are a common problem in streams draining urban areas. Typical causes for higher temperatures in urban streams include loss of riparian shade, reduced summer baseflow, and heating of runoff as it flows across impervious surfaces and through detention ponds (Ecology, 2005). Several of the listed reaches of the lower White River, however, are along the bypass reach (see Section 4.5.3). By reducing flows within the bypass reach, diversions from the river to Lake Tapps could have caused increased temperatures, resulting in the listing. Summer flows in the bypass reach have increased since hydropower operations ceased in 2004; therefore, water temperatures in the bypass reach may have improved and should be reevaluated.

A couple of listed reaches are located downstream of the bypass reach (i.e., downstream of the Lake Tapps outlet to the White River). Elevated temperatures in these reaches could be coming from the bypass reach; however, temperatures could also be impacted by return flows from Lake Tapps. Water temperatures in these reaches may also improve due to the change in diversions to Lake Tapps resulting from 2008 White River Management Agreement (see Section 4.7.1).

7.1.2 Fecal Coliform

Fecal coliform bacteria come from feces of warm-blooded animals. Fecal matter can contain a wide variety of potentially harmful bacteria, viruses, and parasites. Analyzing a water sample for the full range of potential pathogens is very costly; therefore, the State of Washington and many other jurisdictions use fecal coliform bacteria as an “indicator parameter” for the potential presence of disease-causing microorganisms in water bodies. 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 by ingesting it.

Potential fecal contamination sources in the lower White River and Salmon Creek include stormwater runoff from residential areas, failing on-site sewer systems, livestock, and wildlife (e.g., birds, rodents, and pets). These potential sources are described below.

Stormwater Runoff from Residential Areas

Stormwater runoff from residential areas often contains elevated concentrations of fecal bacteria. Dogs, birds, and rodents are common sources of fecal matter in residential areas (Brown and Caldwell, 2005; Clean Water Services, 2005). Fecal coliform are subject to a wide range of removal mechanisms after leaving the digestive system of the host organism. The extent to which these attenuation processes occur depends on the flow path between the fecal deposit and the receiving water body. Artificial drainage systems, such as storm sewer pipes,

can substantially increase the potential for fecal coliform from deposits in upland areas to reach receiving water bodies. Many older pipe drainage systems (such as those in the Lake Tapps area) were designed to quickly convey runoff to receiving water bodies, so they provide little opportunity for bacterial attenuation by ultraviolet light, adsorption, filtering, or sedimentation. Newer and retrofitted storm drainage systems may include treatment measures (e.g., wet ponds, wetlands, bioinfiltration swales, sand filters) intended to reduce bacteria and other urban runoff pollutants. In general, measures that ensure a long flow path through the soil are most effective at removing fecal coliform bacteria (Schueler, 1999).

Failing On-site Sewer Systems

On-site sewer system effluent typically contains high concentrations of fecal bacteria (e.g., 1 million per 100 mL). Nevertheless, on-site sewer systems with properly functioning drain fields are unlikely to be significant bacteria sources unless the systems are very close to a receiving water body or storm conveyance. This is because fecal bacteria typically do not move far in the soil due to filtering, adsorption, predation, and other removal processes. However, on-site sewer system drain fields tend to clog over time. Severe clogging can result in on-site sewer system failure, wherein inadequately treated effluent flows on the ground surface. Effluent from failed on-site sewer systems can flow overland into nearby lakes and streams with relatively little bacteria removal en route.

On-site sewer system failures are also more likely to occur in older systems, which are less likely to incorporate design features required by current regulations to improve treatment and reduce clogging. On-site sewer system failures in shoreline areas are more likely to affect the lake than failures in upland areas. However, failures in upland areas could affect the lake if the effluent flows into a storm sewer pipe that discharges directly into the lake.

Livestock

Livestock are potential fecal contamination sources in the planning area, particularly in the area between Lake Tapps and the city of Buckley, which contains dairies and hobby farms. Two dairies are located near the diversion canal between the White River and Lake Tapps.

An adult dairy cow can generate up to 100 billion fecal coliform bacteria per day, and an adult horse up to 420 million fecal coliform bacteria per day (ASAE, 1998). However, livestock in areas that generate little runoff are unlikely to cause receiving water violations.

Contamination is more likely to occur when livestock are found near streams or man-made conveyances (such as the diversion canal) could result in water quality problems. Subsurface drainage systems (drainage tiles) can also convey fecal contaminants from pastures to nearby water bodies. In addition, irrigation using liquid manure can adversely affect receiving water quality if application rates exceed agronomic needs.

Wildlife

Wildlife can be significant sources of fecal contamination in residential as well as rural areas. Recent DNA studies in the Puyallup and Portland areas found that birds and rodents were the most common sources of fecal bacteria in streams draining residential and commercial areas (Brown and Caldwell and URS, 2005; Clean Water Services, 2005). One possible explanation is

that waterfowl and some rodent species tend to live close to water bodies and therefore are likely to defecate in or near the water body. There is little opportunity for attenuation of fecal coliform bacteria deposited in or near the water body.

7.1.3 pH and Dissolved Oxygen

Three water bodies located within the White River Basin have problems with pH and/or DO. Boise Creek (high pH) and Bowman Creek (low DO content) are both located entirely in King County. However, areas under Pierce County's jurisdiction drain into the listed reaches.

The lower White River has three reaches listed due to high pH. One of these is in the Pierce County portion of the bypass reach; the other two reaches are in King County. As noted above, flows in the bypass reach have increased since 2004 due to the reduction in Lake Tapps diversion rates. It is possible that the increased flows have improved pH in the bypass reach.

Ecology has attributed the DO and pH problems to algal growth triggered primarily by elevated phosphorus loads (Ecology, 2003). Phosphorus can come from a variety of sources, including on-site sewer systems, livestock, and stormwater runoff. These potential sources are discussed below.

On-Site Sewer Septic Systems

On-site sewer systems can contribute phosphorus via overland flow caused by on-site sewer system failure. As discussed in Section 7.1.1, on-site sewer system drain fields tend to clog over time, resulting in surface failures that allow inadequately treated effluent to flow overland into lakes and streams. On-site sewer 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. On-site sewer 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, however, groundwater "plumes" from shoreline on-site sewer systems can carry phosphorus to nearby lakes or streams.

Runoff

Stormwater runoff from residential areas and runoff from agricultural areas often contains elevated concentrations of phosphorus. Typical phosphorus sources in residential areas include eroded soil from fertilized areas, leaves and other plant debris, certain cleaning products, and pet and wildlife feces. Runoff from agricultural areas can contain elevated phosphorus concentrations due to fertilizer use and animal waste.

7.1.4 Sediment

High levels of suspended sediments increase water turbidity and can be directly harmful to aquatic organisms. Suspended sediments can also transport pollutants that adsorb to sediment particles. For example, Ecology (2006) found that total phosphorus (TP) concentrations in the White River diversion to Lake Tapps were strongly correlated with turbidity. Also, sediments

that settle out of the water column and accumulate on the channel bottom can decrease channel conveyance capacity and adversely affect aquatic habitat.

During the warm season, the White River can contain high concentrations of fine "rock flour" from the glaciers on Mount Rainier. This glacial flour is a natural source of turbidity in the White River and Lake Tapps.

Human activities also contribute sediments to water bodies in the planning area. As noted on Table 7-1 and shown on Figure 7-1 , Ecology has placed a number of streams in the eastern portion of the study area on the 303(d) "polluted" water bodies list based on sediment problems caused by logging, road construction and maintenance, and vehicle use (Ecology, 2006a). Stormwater runoff from developed areas often contains elevated concentrations of sediments from construction sites, roads and parking lots, and landscaped areas. In addition, development typically increases peak flow rates and runoff volumes, which can cause channel erosion and increasing sediment loads in creeks.

7.1.5 Nonpollutants

The following section describes other water quality problems in the planning area, including Eurasian milfoil, impaired fish habitat, and impaired in-stream flow.

Eurasian milfoil

Hidden Lakes and Lake Tapps are listed as "impaired" by Eurasian water milfoil (milfoil), an invasive water weed. Milfoil has been spread from lake to lake on boat trailers (Ecology, 2010). Because it is widely distributed and difficult to control, milfoil is considered to be the most problematic plant in Washington (Ecology, 2010). The introduction of milfoil can drastically alter a water body's ecology in the following ways:

- Milfoil forms very dense mats of vegetation on the surface of the water; these mats interfere with recreational activities such as swimming, fishing, water skiing, and boating.
- The sheer mass of plants can cause flooding and the stagnant mats can create good habitat for mosquitoes.
- Milfoil mats can decrease DO concentrations by preventing the wind from mixing the oxygenated surface waters to deeper water.
- The dense mats of vegetation can increase the sedimentation rate by trapping sediments.
- Milfoil starts spring growth sooner than native aquatic plants and can shade out these beneficial plants (Ecology, 2010).
- Milfoil can shade out native aquatic plants, thereby reducing species diversity.

Fish Habitat

In Ecology's 2008 Water Quality Assessment, the Greenwater River is listed as having impaired fish habitat. The reach is upstream of the town of Greenwater, with the tributary areas located

within unincorporated Pierce County, King County, designated forest lands, and national forest lands. The Ecology listing states that the fish habitat is impaired because of increased peak discharges and fine sediment inputs from humans.

In-Stream Flow

Two lower White River reaches are listed as having impaired in-stream flow due to low flows. These reaches are located along the bypass reach of the White River. The flow regime along this reach has changed due to the sale of Lake Tapps to the Cascade Water Alliance (Alliance). The Alliance will be diverting less flow into Lake Tapps than had been diverted when the lake was used for hydropower. The reduced diversions will increase flows in the bypass reach of the White River.

7.2 LAKE TAPPS WATER QUALITY

Lake Tapps is the largest lake in the White River Basin planning area. Much of the residential development in the planning area is concentrated around Lake Tapps. Most of the lakeshore area is in unincorporated Pierce County.

Lake Tapps is heavily used for boating, water skiing, swimming, and other recreational activities. Many of the shoreline residences have private docks. Two public parks, one at the north end and one at the south end, allow for public access to the water. Eight other private parks located around the lake provide access for resident members.

In addition to aesthetic and recreational uses, Lake Tapps will soon serve as a potable water supply. In 2010, Puget Sound Energy (PSE) sold the Lake Tapps facilities to the Alliance. The Alliance plans to use Lake Tapps as a source of potable water while continuing to support recreational uses of the lake.

Lake Tapps has been the subject of several recent water quality studies, which are summarized in Chapter 4 (see Section 4.7). The water quality issue identified in the studies is presented in Section 7.2.1. In addition to the water quality studies, two residential questionnaires were sent to lakeshore residents—one in January 2005 and another in September 2007—to identify problems in the planning area (see Section 3.2). In 2010, Pierce County Surface Water Management (SWM) staff also met with the Alliance, the new owners of Lake Tapps, to discuss lake issues that may be relevant to the basin planning process. The Alliance shared some water quality concerns. The responses from the second questionnaire and the interview with the Alliance are summarized in Section 7.2.2. As part of the analysis of Lake Tapps water quality, results from diversion canal water quality sampling was reviewed and a lake management gap analysis was completed. A summary of the diversion canal sampling effort and results is provided in Section 7.2.3. A summary of the lake management gap analysis is provided in 7.2.4.

7.2.1 Lake Tapps Water Quality Issues Review

As discussed in Section 4.7, Lake Tapps has been the subject of several recent water quality studies. These studies showed that water quality in the lake is generally good except for excessive growth of Eurasian milfoil. Dense growth of milfoil in Lake Tapps impacts water quality, limits recreation and navigation, and disrupts natural water flow (Tetra Tech, 2010).

The lake has been operated to reduce milfoil growth with winter drawdowns to expose plants to freezing temperatures. However, milfoil continues to be a problem and the Alliance is evaluating other means to limit growth.

7.2.2 Lake Tapps Residential Survey and Stakeholder Interviews

In fall 2007, the County sent questionnaires to 2,400 property owners in the White River Basin. Questionnaires were sent to all properties within 150 feet of Lake Tapps and all properties in the Greenwater area. The questions focused on land use, on-site sewer system use, use of pesticides and fertilizers, water quality, flooding, and habitat issues.

A total of 375 completed questionnaires were returned to Pierce County. No specific water quality problem locations were identified. The following bullets summarize questionnaire responses related to water quality:

- Almost all of the respondents own a single-family, lakefront residence with landscaping that they water and fertilize.
- Greater than 70 percent of respondents believe that water quality is not a problem in Lake Tapps.
- More than 40 percent of respondents believe there is a weed (primarily milfoil) problem in the spring, summer, or fall.
- Approximately 18 percent of respondents indicated that algae blooms are a problem in Lake Tapps.
- Approximately 50 percent of the respondents would be willing to accept some limitations on the use of their property if they understood those limitations, especially regarding limits on fertilizer or pesticide use.
- Only seven respondents (2 percent) indicated that the on-site sewer system on their property had failed in the past. The average age of reported on-site sewer systems was 25 years, and the oldest on-site sewer system reported was 50 years old. Although not all respondents indicated that inspections were performed on their on-site sewer systems, the average date of last inspection of on-site sewer systems was 2004.

The responses support the conclusions discussed in section 7.2.1. Water quality is generally good, except for the excessive growth of milfoil.

In spring 2010, SWM and the Alliance met to discuss the basin plan as it relates to Lake Tapps. The Alliance shared concerns about runoff, from roads and adjacent properties, entering the Lake Tapps flume. They also notified the County that solid waste is being dumped into the flume.

7.2.3 Lake Tapps Diversion Canal Pollution Source Tracking

In fall 2006, an outfall reconnaissance inventory was completed to identify and map discharges to the Lake Tapps diversion canal (Brown and Caldwell, 2006). The results of this inventory were used to develop a list of potential monitoring locations, based on the observed outfalls

and the land uses within the areas draining to the outfalls. Ten locations, which included both in-reach (i.e., diversion canal) and outfalls, were selected for monitoring (see Figure 7-2).

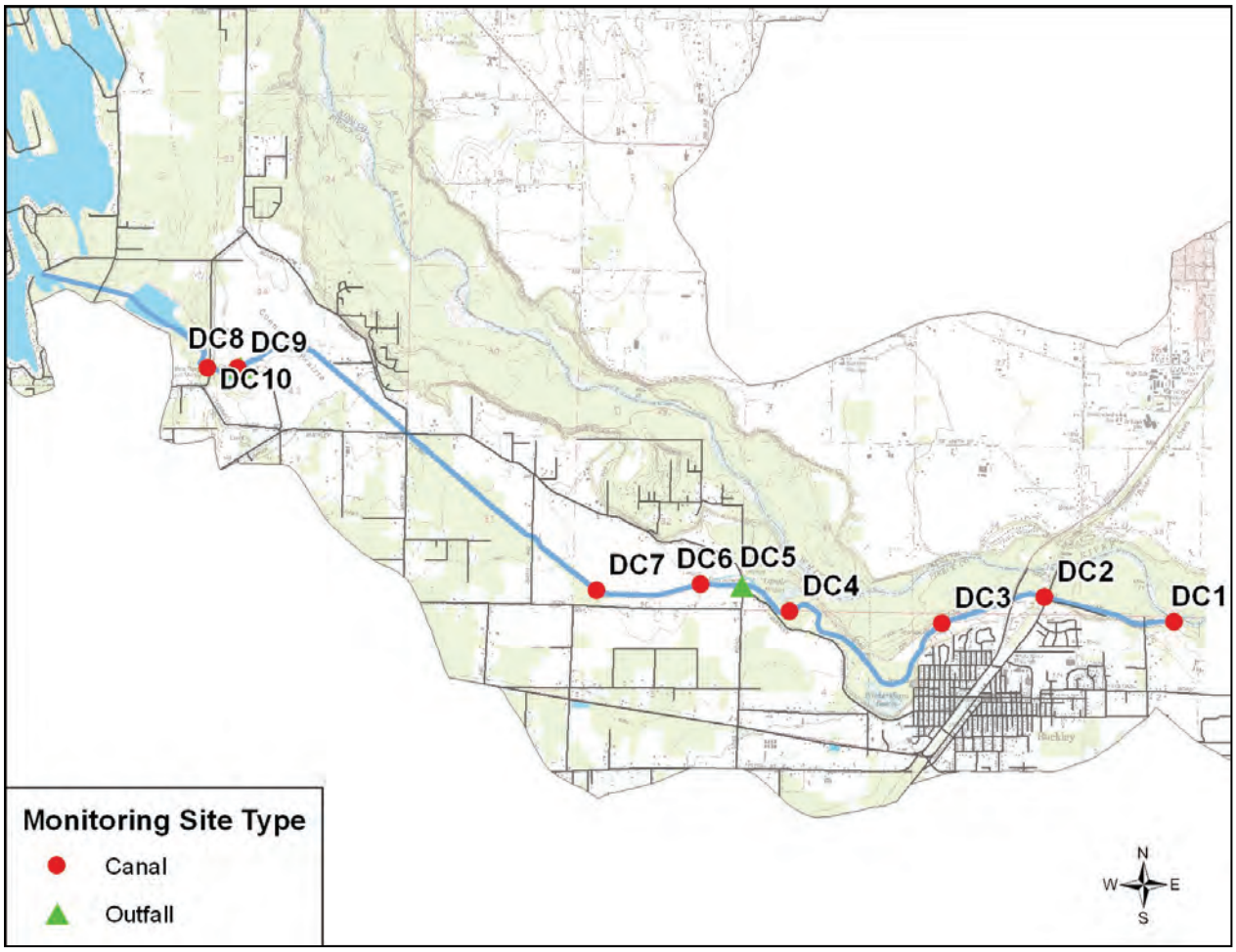


Figure 7-2. Lake Tapps diversion canal monitoring locations

Grab samples were collected from each location during wet weather conditions. The samples were analyzed for the parameters listed in Table 7-2 below. In addition, microbial source tracking (DNA ribotyping) was performed to identify the sources of the fecal coliform bacteria found in the grab samples. As shown in Table 7-2, several locations had elevated levels of TP and nitrate-nitrogen, and fecal coliform. The microbial source tracking identified avian, rodent, canine, deer, and bovine fecal sources (see Table 7-3). The elevated phosphorus and nitrate concentrations found at DC-8 suggest agricultural sources. Three locations (DC-5, DC-7, and DC-10) had fecal coliform concentrations above 200 colony forming units (cfu)/100 mL. The microbial source tracking results for these locations identified avian, deer, rodent, and unknown sources. The results indicate potential dairy farm impacts to the Lake Tapps flume.

Table 7-2
Diversion Canal Sampling Laboratory Results

Sample ID	Total-P (mg/L)	TDP (mg/L)	SRP (mg/L)	Ammonia (mg/L)	NO_3 + NO_2 (mg/L)	Total-N (mg/L)	Chloride (mg/L)	TSS (mg/L)	Fecal Coliform (#/100 mL)	DO (mg/L)
DC-1	0.043	0.007	0.006	0.014	0.192	0.282	1.56	15	6	12.5
DC-2	0.025	0.01	0.008	<0.010	0.263	0.403	1.08	13	28	12.2
DC-3	0.027	0.011	0.009	<0.010	0.328	0.508	1.37	9	74	11.8
DC-4	0.028	0.012	0.009	0.015	0.369	0.586	1.37	5	46	11.9
DC-5	0.056	0.038	0.021	0.035	0.163	0.788	2.54	1.3	202	10.5
DC-D	0.055	0.04	0.022	<0.010	0.148	0.787	2.35	1.3	62	10.2
DC-6	0.082	0.056	0.045	0.045	0.469	0.947	1.96	6.8	106	10.6
DC-7	0.06	0.032	0.023	0.333	0.61	1.65	1.86	7.3	202	10.1
DC-8	0.623	0.539	0.452	0.43	7.31	11.5	15.9	2.3	90	7.5
DC-9	0.202	0.179	0.174	0.077	2.82	4.37	5.47	1.5	64	10.9
DC-10	0.234	0.214	0.195	0.158	3	4.31	5.67	1.3	380	11.5

Table 7-3
Microbial Source Tracking Results

Sample ID	Sources Identified
DC-1	Avian
DC-2	Avian, rodent
DC-3	Avian, coyote
DC-4	Avian, bovine
DC-5	Avian, unknown
DC-6	Horse, raccoon, rodent
DC-7	Avian, deer
DC-8	Bovine, canine
DC-9	Avian, rodent
DC-10	Avian, rodent

7.2.4 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:

- Monitoring and source identification
- Volunteer monitoring

- Data management and dissemination
- Education and outreach
- Community technical assistance
- Inter-agency coordination and information sharing
- Aquatic invasive species management
- Funding for lake projects:
  - Detailed lake studies
  - In-lake control and management strategies
  - Watershed strategies
  - Provide funding for private projects
- Enforcement
- Legal authority.

The analysis found that SWM, the Tacoma-Pierce County Health Department (TPCHD), Pierce Conservation District (PCD), Ecology, and the Washington Department of Fish and Wildlife (WDFW) 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 the Lake Water Quality Management Plan for the White River Basin, which includes 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 are 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).

Table 7-4
Gaps in Pierce County Lakes Program

Lake Management Component	Function	Current Work	Gap/Need
Volunteer monitoring	Train volunteers in lake monitoring techniques, collect samples from volunteers, perform testing on samples, and distribute data to public via Web site.	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 need to be accessible to other organizations and to the public. If additional monitoring is conducted, data management and dissemination will be required as well.
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 SWM Invasive Vegetation project such as education, lake monitoring and management activities.	SWM 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.

Table 7-4
Gaps in Pierce County Lakes Program

Lake Management Component	Function	Current Work	Gap/Need
Funding for lake projects	Provide funding to implement projects to improve lake health.	None.	As a result of the Invasive Vegetation project, 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 $150K to $400K or more per lake studied. There is one 1st Tier Lake (Lake Tapps) in the basin. Funding will be needed.
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 $10K to $8M 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.	SWM and PCD implement watershed improvements for stormwater and water quality enhancement.	Costs could range from $10K to $20M or more per lake studied and managed. Funding will be needed.

Table 7-4
Gaps in Pierce County Lakes Program

Lake Management Component	Function	Current Work	Gap/Need
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 $10K to $1M 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 it has 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 and TMDL programs.	To implement a lake management program, a countywide ordinance may be needed to establish the program and the lake management function in Surface Water Management. This will not require ongoing FTE support; however, temporary initial investment by County staff may be needed.

7.3 POTENTIAL FUTURE PROBLEMS

As described in Chapter Four, the predominant existing land use patterns in the lower White River Basin or planning area are rural residential and suburban residential. From the lower basin to the upper portions of the basin, agricultural lands transition to open spaces and then transition to timber lands.

Most of the unincorporated land in the lower basin is zoned Rural Residential. Most of the projected increase in impervious areas, in unincorporated Pierce County, is in the Lake Tapps subbasin. Areas that were once open space or vacant may have fewer trees and less native vegetation, and may have pets, livestock, on-site sewer 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.

Most of the upper basin is currently zoned for forest use. Future water quality problems could arise in forested areas due to forest practices as well as conversion of forests to other land uses.

Forest Practices

Forest practices (e.g., road construction, timber harvesting) have the potential to cause significant water quality problems. Timber harvesting and logging roads can increase soil erosion and mass wasting, thereby increasing sediment loads to receiving water bodies. Logging of riparian areas can increase water temperatures and reduce large woody debris recruitment.

The Forests & Fish Law was enacted in 2001 to minimize the adverse impacts of state and private forest practices on water quality and aquatic habitat. This comprehensive system of forest management practices was developed in collaboration with federal, state, tribal, and county governments and private forest landowners. Its requirements include:

- Increased riparian buffer requirements (from 0 to 100 to 200-foot managed buffers on fish bearing streams)
- Slope protection
- More stringent road construction standards
- Road maintenance and abandonment plans
- Sustainable forestry management.

Conversion of Forests to other Land Uses

Under present planning and zoning regulations, it is possible to convert commercial timber lands to rural residential lands that have a 20-acre minimum lot size. Pierce County comprehensive land use policies, however, state that lands should be considered for removal from the Forest Land zone only when it is demonstrated that the land is no longer suitable for long-term forest production. The Pierce County Planning Department is not aware of any planned conversions in the upper basin from commercial forest use to subdivisions, at the time this plan was developed. However, there are vested subdivisions and short plats in the lower portion of the basin. Future development (during the planning period) in the upper basin is expected to be relatively minimal.

7.3.1 Lake Tapps

Lake Tapps water quality monitoring conducted in 2004–2006 found that water quality in the lake was generally good. However, water quality could decline in the future due to changes in the lake operations and/or pollutant inputs from the area around the lake.

Conversion of Lake Tapps from hydropower and recreational uses to municipal water supply and recreational uses (as discussed in Chapter Four) will result in lower flow rates through the lake. Initial monitoring data suggest that the lower flow rates have not degraded water quality in the lake. According to Ecology (2006), lower flows could degrade lake water quality in the following ways:

- Decreasing DO levels in the warmer surface layer of the lake (because warm water can hold less DO than cold water).

- Increasing light penetration could increase algae and aquatic plant growth.
- Decreasing dilution of any phosphorus that enters the lake from lake-side sources could cause increased algae levels, more turbid water, and lower levels of DO in the deeper lake waters.

However, Ecology also noted that lower flows could improve water quality in the following ways:

- Reducing phosphorus loads from the White River would reduce algal growth, improve water clarity, and increase DO levels in the deeper lake waters.
- Reducing sediment loads from the White River would improve water clarity.

Increasing water residence times would result in warmer water near the lake surface, where most recreation occurs. In addition to White River inflows, dairies, and other land uses along the diversion canal contribute pollutants to the lake. Limited sampling conducted along the diversion canal in 2006 found that phosphorus and fecal bacteria concentrations were higher near the downstream end of the canal (see Table 7-2). Other potential pollutant sources to Lake Tapps include stormwater runoff and on-site sewer system effluent from lakeshore areas. The water quality of Lake Tapps can also be impacted by dock maintenance and deck sealing. Settling basins located on the diversion canal remove some of the particulate materials from the White River before they can enter the lake.

Early detection of adverse water quality could provide an opportunity for corrective measures to be implemented before the beneficial uses of the lake are compromised. Information on the likely causes of water quality degradation would help ensure that corrective measures are focused and effective. A long-term monitoring program (described below and in Appendix J) should be implemented to track the lake's water quality.

Lake eutrophication due to phosphorus enrichment is the primary concern for Lake Tapps. Eutrophication could impair the recreation, aesthetic, and water supply uses of the lake. Therefore, the long-term monitoring program should be designed to determine whether the lake's trophic state is changing over time. To evaluate trends in trophic state, sampling and analysis should be completed for the following parameters: chlorophyll-a, total phosphorous, soluble reactive phosphorous, total Kjeldahl nitrogen, ammonia-N, nitrate + nitrite-N, settleable solids, total suspended solids, turbidity, and total organic carbon. Also, datasondes should be installed to automatically measure and record Secchi depth, DO, temperature, conductivity, turbidity, and chlorophyll-a at short time intervals (e.g., 15 minutes).

Fecal contamination is also a concern because of the numerous on-site sewer systems around the lake. The lake should be sampled for fecal coliform and E. coli. If the results show that fecal coliform and E. coli concentrations exceed state standards, microbial source-tracking analyses could be warranted to identify the specific sources.

Lake Tapps does not have any known or suspected problems associated with pesticides, metals, or other toxic pollutants from human sources; therefore, testing for toxic pollutants does not appear to be warranted at this time. If future conditions raise concerns about toxic compounds in the lake (e.g., fish kills), the Early Life Stages (ELS) in situ bioassay could be used to screen for

aquatic toxicity problems in the lake. The *Countywide Water Quality Monitoring Plan* (Pierce County, 2006b) contains a detailed description of the ELS method. SWM is currently conducting a pilot test of the ELS at several stream locations.

Since it acquired Lake Tapps, the Alliance has taken initiatives to address water quality issues in the lake. An Integrated Aquatic Vegetation Management Plan (IAVMP) was created to develop a long-term strategy to eradicate milfoil from Lake Tapps Reservoir to continue to improve existing beneficial and recreational uses, and ensure water quality to meet future water demands (Tetra Tech, 2010).

7.4 POTENTIAL SOLUTIONS

A total of 38 water quality problems were identified. This section describes how water quality problems identified in the White River Basin will be addressed. Table 7-5 summarizes the recommended actions. Proposed programmatic measures are described in Chapter Nine.

7.4.1 Problems Resolved or Not Addressed in the Basin Plan

Twenty-one of the water quality problems noted in this chapter are not addressed in this White River Basin Plan (Basin Plan), for the reasons listed below:

- Nineteen problems were found to be outside of the planning area or Pierce County's jurisdiction.
- One problem has been addressed by the Greenwater River TMDL Implementation Plan.
- One issue does not appear to be a water quality problem.

7.4.2 Maintenance and Enforcement Issues

No water quality problems were associated with maintenance. One problem with illicit dumping will be referred to Pierce County Solid Waste Division for enforcement of County ordinances.

7.4.3 Capital Improvement Program Projects

One project was developed to address water quality problems in the White River Basin. This project is discussed in greater detail in Chapter Nine. The project location is shown on Figure 9-1.

7.4.4 Programmatic Measures

In addition to the water quality problems identified in Chapter Five, additional problems associated with water bodies within the planning area were identified during the water quality analysis described in this chapter. These problems are addressed by the recommended programmatic measures. The following six programmatic measures (three countywide and three basin-specific) are recommended to protect and improve water quality:

- PRG00-05, Program to Enhance Degraded Riparian Habitat and Water Quality

- PRG00-06, Education, Outreach, and Technical Assistance program
- PRG00-12, Lakes Water Quality Management Program
- PRG15-01, Coordinate with the Cascade Water Alliance on Developing a Lake Tapps Water Quality Monitoring Plan
- PRG15-02, Lake Tapps Pollutant Source Identification and Monitoring Program
- PRG15-03, Coordinate with TPCHD to Address Reported On-site Sewer System Problems.

Additional countywide programmatic measures relevant to water quality are listed below:

- PRG00-01, Low-Impact Development Program
- PRG00-04, Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation
- PRG00-07, Surface Water Monitoring Program.

Chapter Nine contains detailed descriptions of these measures.

7.4.5 Problems Requiring More Detailed Data or Analysis

Two studies are recommended to address water quality data gaps:

- ST15-TAP-ST01, Lake Tapps Diversion Canal Stormwater Outfall Assessment
- ST15-TAP-ST02, White River Water Quality Assessment for Fecal Coliform, Temperature, pH, and In-stream Flow

Table 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
CWR-01	Clearwater River	Ecology water quality assessment Category 5 listing for temperature	Problem is outside the planning area
CWR-02	Lyle Creek	Ecology water quality assessment Category 5 listing for temperature	Problem is outside the planning area
CWR-03	Milky Creek	Ecology water quality assessment Category 5 listing for temperature	Problem is outside the planning area
GWR-03	Greenwater and along Mountain Beaver Drive (Crystal River Ranch)	Three on-site sewer complaints	Coordinate with Tacoma-Pierce County Health Department to Address Reported On-site Sewer System Problems (PRG15-03)
GWR-04	Greenwater River	Ecology water quality assessment Category 4c listing for fish habitat	Problem is outside the County's jurisdiction

Table 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
GWR-05	Greenwater River	Ecology water quality assessment Category 4a listing for sediment and temperature	This problem has already been addressed through the County's, and others', efforts to implement the TMDL Implementation Plan
GWR-06	Brush Creek	Ecology water quality assessment Category 4a listing for sediment and temperature	Problem is outside the County's jurisdiction
GWR-07	Slide Creek	Ecology water quality assessment Category 4a listing for sediment	Problem is outside the planning area
GWR-08	Straight Creek	Ecology water quality assessment Category 4a listing for temperature	Problem is outside the planning area
GWR-09	Pyramid Creek	Ecology water quality assessment Category 4a listing for sediment and temperature	Problem is outside the planning area
HUK-01	Huckleberry Creek	Ecology water quality assessment Category 5 listing for temperature	Problem is outside the planning area
HUK-02	Eleanor Creek	Ecology water quality assessment Category 4a listing for sediment	Problem is outside the planning area
LWR-02	Lower White River	Ecology water quality assessment Category 5 listing for fecal coliform, pH, and temperature	White River Water Quality Assessment for Fecal Coliform, Temperature, pH, and In-stream Flow (ST15-TAP-ST02), and Lower White River Property Acquisition (CIP15-LWR-AC01)
LWR-32	Strawberry Creek, Reach: 0035-15	This reach flows primarily through culverts that are under a meat-packing plant; there are concerns that the plant's activities may impact the stream's water quality	Problem is outside the County's jurisdiction
LWR-37	Salmon Creek near 162nd Avenue East	Sewage observed and odor noted during a windshield survey	Coordinate with Tacoma-Pierce County Health Department to Address Reported On-site Sewer System Problems (PRG15-03)
LWR-38	Salmon Creek	Ecology water quality assessment Category 5 listing for fecal coliform	Problem is outside the County's jurisdiction
LWR-51	Tributary 0040 at 136th Avenue East	Sewage odor noted during a windshield survey	Coordinate with Tacoma-Pierce County Health Department to Address Reported On-site Sewer System Problems (PRG15-03)
LWR-57	Bowman Creek	Ecology water quality assessment Category 5 listing for DO	Problem is outside the County's jurisdiction

Table 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
MMT-04	Lower White River	Ecology water quality assessment Category 4c listing for in-stream flow	White River Water Quality Assessment for Fecal Coliform, Temperature, pH, and In-stream Flow (ST15-TAP-ST02)
MMT-05	Boise Creek	Ecology water quality assessment Category 5 listing for fecal coliform, pH, and temperature	Problem is outside the County's jurisdiction
MMT-06	Scatter Creek	Ecology water quality assessment Category 5 listing for temperature	Problem is outside the County's jurisdiction
TAP-26	Lake Tapps	Pollutant from dock maintenance and deck sealing could impact Lake Tapps	Lakes Water Quality Management Program (PRG00-12), and Coordinate with the Cascade Water Alliance on Developing a Lake Tapps Water Quality Monitoring Plan (PRG15-01)
TAP-27	Lake Tapps	Potential for discharge of TP, bacteria, and other pollutants from numerous on-site septic systems and stormwater outfalls on the lakeshore	Lakes Water Quality Management Program (PRG00-12), Coordinate with the Cascade Water Alliance on Developing a Lake Tapps Water Quality Monitoring Plan (PRG15-01), Lake Tapps Pollutant Source Identification and Monitoring Program (PRG15-02), and Coordinate with Tacoma-Pierce County Health Department to Address Reported On-site Sewer System Problems (PRG15-03)
TAP-28	Lake Tapps	Ecology water quality assessment Category 4c listing for Eurasian milfoil	Lakes Water Quality Management Program (PRG00-12), and Coordinate with the Cascade Water Alliance on Developing a Lake Tapps Water Quality Monitoring Plan (PRG15-01)
TAP-29	Adjacent to Lake Tapps flume	Roadway runoff from Mundy Loss Rd. entering Lake Tapps flume	Lake Tapps Diversion Canal Stormwater Outfall Assessment (ST15-TAP-ST01)
TAP-30	Adjacent to Lake Tapps flume	Runoff from agricultural areas and a dairy farm is draining into the flume. Lake Tapps pollution source (Brown and Caldwell, 2006) tracking also indicates potential dairy farm impacts	Education, Outreach, and Technical Assistance program (PRG00-06) and Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05)
TAP-31	Adjacent to Lake Tapps flume	Buried wooden pipe with steel straps adjacent to flume may be leaching pollutants	There is no indication that that water quality in the flume is being impacted by the buried pipe
TAP-32	218th Street Bridge	Solid waste is dumped off bridge into Lake Tapps flume	Report to Pierce County Solid Waste
TAP-33	Lake Tapps region	Three on-site sewer service calls during 2004	Coordinate with Tacoma-Pierce County Health Department to Address Reported On-site Sewer System Problems (PRG15-03)

Table 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
TAP-34	Hidden Lake	Ecology water quality assessment Category 4c listing for invasive plants	Lakes Water Quality Management Program (PRG00-12)
UWR-04	Lightning Creek	Ecology water quality assessment Category 4a listing for sediment	Problem is outside the planning area
UWR-05	Minnehaha Creek	Ecology water quality assessment Category 4a listing for sediment	Problem is outside the planning area
WFW-03	West Fork White River	Ecology water quality assessment Category 4a listing for sediment	Problem is outside the planning area
WFW-04	Whistler Creek	Ecology water quality assessment Category 4a listing for temperature	Problem is outside the planning area

CHAPTER EIGHT
AQUATIC/RIPARIAN HABITAT ANALYSIS

This chapter documents the aquatic/riparian habitat analysis and summarizes potential measures to preserve and enhance habitat conditions in the White River Basin planning area. Section 8.1 summarizes the field investigations for the basin. Section 8.2 describes the aquatic/riparian limiting factors. Section 8.3 summarizes existing aquatic/riparian habitat problems and the results of the analyses. Section 8.4 makes recommendations for addressing each of the problems; recommendations include capital improvement projects and programmatic measures. Specific recommendations for this White River Basin Plan (Basin Plan) are described in Chapter Nine.

8.1 SUMMARY OF FIELD INVESTIGATIONS

In September through November 2004, URS conducted stream surveys to characterize existing stream corridor conditions and identify opportunities to protect high-quality aquatic/riparian habitat, restore degraded habitat, protect and improve water quality, reduce flood hazard risk, and reduce erosion. Streams were surveyed using the Ecosystem Diagnosis and Treatment (EDT) Level 2 parameters (Pierce County, 2000) and the Urban Stream Baseline Evaluation Method (USBEM) Tri-County guidance (Pierce County, 2000) as described in Appendix E (see also Section 4.6).

EDT is a system for rating the quality, quantity, and diversity of habitat along a stream. It can be used to help in the assessment of existing conditions and a prioritization of restoration needs. The USBEM provides a method of characterizing the aquatic/riparian habitat. Detailed stream reach information using the EDT and USBEM methods is presented in Tables F-1 and F-2 in Appendix F.

In August 2007, Brown and Caldwell conducted additional field investigations of stream reaches within the County's jurisdiction to determine the potential for aquatic/riparian habitat restoration projects. These reaches are discussed in Section 8.3. In addition, six potential levee setback sites along the lower White River were visited to identify opportunities to improve aquatic/riparian habitat, water quality, and local drainage conditions.

8.2 LIMITING FACTORS

The USBEM was developed as part of the Tri-County Urban Issues Endangered Species Act (ESA) Study, a cooperative effort to restore salmon in King, Pierce, and Snohomish Counties. The methodology has two phases; the first stage classifies habitat suitability using existing data. The second stage is a detailed field investigation. Additional indicators have been incorporated to broaden applicability of the methodology to include habitat conditions for terrestrial wildlife, resulting in a modified, more comprehensive version of the USBEM (Pierce County, 2006a).

Limiting factors to healthy fisheries and wildlife populations were characterized from the results of the USBEM analysis. Detailed explanations of these factors are included in Appendix E. The relative degree of limitation was obtained for each stream by summing the USBEM ratings for each attribute across all reaches within a stream and then ranking them from most impaired (Most Limiting) to least impaired (Least Limiting). Table 8-1 shows the limiting factors in relative order of importance for each of the creeks surveyed in the White River Basin. The USBEM ratings indicate that pool frequency, in-stream cover provided by large woody debris (LWD), and high substrate embeddedness are the most limiting factors for healthy fisheries in the majority of the streams. Invasive species is the least limiting factor affecting the health of the riparian corridor and terrestrial wildlife populations. Detailed summaries of each reach can be found in Section 4.6.

Table 8-1
Limiting Factors for Aquatic/Riparian Habitat

Stream	Most Limiting													Least Limiting
White River mainstem	Pool frequency	Invasive species	Canopy cover	LWD	Recruitment potential	Channel pattern and bedform	Snags	Structural diversity	Embeddedness	Substrate	Bank condition	Buffer width	Dead and down	Riparian cover
Tributary 0032	Pool frequency	Invasive species	LWD	Substrate	Channel pattern and bedform	Embeddedness	Snags	Recruitment potential	Dead and down	Buffer width	Structural diversity	Canopy cover	Riparian cover	Bank condition
Jovita Creek	Invasive species	Snags	Pool frequency	LWD	Channel pattern and bedform	Embeddedness	Recruitment potential	Substrate	Canopy cover	Dead and down	Riparian cover	Buffer width	Structural diversity	Bank condition
Tributary 0034	Pool frequency	Invasive species	LWD	Substrate	Embeddedness	Snags	Structural diversity	Recruitment potential	Bank condition	Channel pattern and bedform	Dead and down	Canopy cover	Riparian cover	Buffer width
Strawberry Creek	Snags	Invasive species	Recruitment potential	LWD	Dead and down	Pool frequency	Canopy cover	Structural diversity	Embeddedness	Substrate	Buffer width	Channel pattern and bedform	Riparian cover	Bank condition
Salmon Creek	Pool frequency	Snags	Embeddedness	Recruitment potential	Riparian cover	Canopy cover	Invasive species	Substrate	Channel pattern and bedform	LWD	Dead and down	Structural diversity	Buffer width	Bank condition
Tributary 0037	Canopy cover	Riparian cover	Buffer width	Invasive species	Snags	Recruitment potential	Pool frequency	LWD	Dead and down	Bank condition	Embeddedness	Structural diversity	Substrate	Channel pattern and bedform
Tributary 0038	Pool frequency	LWD	Channel pattern and bedform	Invasive species	Substrate	Snags	Embeddedness	Recruitment potential	Structural diversity	Canopy cover	Dead and down	Buffer width	Riparian cover	Bank condition
Tributary 0039 and 003905	Invasive species	Pool frequency	Embeddedness	Snags	Channel pattern and bedform	Recruitment potential	LWD	Dead and down	Channel pattern and bedform	Substrate	Canopy cover	Riparian cover	Buffer width	Bank condition
Tributary 0040 and 004005	Embeddedness	Recruitment potential	LWD	Invasive species	Snags	Pool frequency	Canopy cover	Channel pattern and bedform	Substrate	Structural diversity	Dead and down	Riparian cover	Buffer width	Bank condition
Tributary 0051	Embeddedness	Invasive species	LWD	Substrate	Snags	Pool frequency	Riparian cover	Canopy cover	Channel pattern and bedform	Dead and down	Recruitment Potential	Structural diversity	Buffer width	Bank condition
Tributary 0052	Pool frequency	Substrate	LWD	Embeddedness	Invasive species	Snags	Recruitment potential	Riparian cover	Buffer width	Structural diversity	Canopy cover	Dead and down	Channel pattern and bedform	Bank condition
Tributary 0053	Pool frequency	Substrate	LWD	Embeddedness	Invasive species	Snags	Recruitment potential	Riparian cover	Buffer width	Structural diversity	Canopy cover	Dead and down	Channel pattern and bedform	Bank condition
Greenwater River	Pool frequency	Canopy cover	LWD	Riparian cover	Bank condition	Channel pattern and bedform	Snags	Recruitment potential	Structural diversity	Embeddedness	Dead and down	Invasive species	Substrate	Buffer width
West Fork White River	Pool frequency	LWD	Canopy cover	Bank condition	Riparian cover	Recruitment potential	Channel pattern and bedform	Structural diversity	Invasive species	Dead and down	Snags	Embeddedness	Buffer width	Substrate

**The relative degree of limitation was obtained for each stream by summing the USBEM ratings for each attribute across all reaches within a stream and then ranking them from most impaired (Most Limiting) to least impaired (Least Limiting).*
** For detailed definitions of limiting factors, see Appendix E.*

8.3 ANALYSIS RESULTS

The stream survey was used to assess aquatic/riparian habitat. Detailed results of the stream surveys are presented in Appendix F, and reach-by-reach summaries of the results are included in Section 4.6. Surveyed stream reaches were subsequently screened to determine whether they are located within the County's jurisdiction. Stream reaches within the County's jurisdiction, along with their aquatic habitat and riparian corridor conditions as described by USBEM criteria, are listed in Table 8-2. Survey information for streams within the planning area was used to develop recommendations for the Basin Plan. Survey information for streams within incorporated areas will be shared with the appropriate city; such streams were not considered when developing recommendations for this Basin Plan.

Table 8-2
USBEM Aquatic Habitat and Riparian Corridor Condition Summary Ratings: Stream Reaches in Unincorporated Pierce County

Stream Name	Stream No.	Reach	Reach Designation	Reach Description	Reach Length (ft)	Channel Type[a]	Aquatic Habitat	Riparian Corridor
White River mainstem	0031	01	0031-01	Mouth to confluence with Dieringer Canal	19,500	Large contained	Poor	Fair
White River mainstem	0031	02	0031-02	From confluence with Dieringer Canal to Stewart Rd. bridge	6,900	Large contained	Fair	Fair
White River mainstem	0031	03	0031-03	From Stewart Rd. bridge to bluff at Auburn Game Farm Park	18,600	Floodplain	Fair	Fair
White River mainstem	0031	04	0031-04	From bluff at Auburn Game Farm Park to pipeline crossing on Muckleshoot Indian Reservation	12,000	Floodplain	Fair	Fair
White River mainstem	0031	05	0031-05	From pipeline crossing on Muckleshoot Indian Reservation to RM 14.7	18,000	Floodplain	Good	Fair
White River mainstem	0031	06	0031-06	From RM 14.7 to RM 19.0	22,800	Floodplain	Fair	Fair
White River mainstem	0031	07	0031-07	From RM 19.0 to Buckley diversion dam	27,600	Floodplain	Fair	Good
Tributary 0040	0040	01	0040-01	From mouth at White River to control structure that diverts part of flow into upstream end of 0040.5	220	Floodplain	Poor	Fair
Tributary 0040	0040	02	0040-02	From control structure at upstream end of 0045.5 to reach where dominant riparian vegetation changes from trees to shrubs	240	Floodplain	Fair	Fair
Tributary 0040	0040	03	0040-03	From where dominant riparian vegetation changes from trees to shrubs to King County Line	260	Floodplain	Poor	Poor
Tributary 004005	004005	01	4005-01	From mouth at White River to upstream end of constructed wetland	160	Palustrine	Fair	Fair
Tributary 004005	004005	02	4005-02	From upstream end of constructed wetland to control structure that diverts part of flow from 0040 into 004005	880	Floodplain	Fair	Fair
Tributary 0051	0051	01	0051-01	From mouth of stream to start of mixed control moderate gradient reach	1,340	Floodplain	Fair	Fair

Table 8-2
USBEM Aquatic Habitat and Riparian Corridor Condition Summary Ratings: Stream Reaches in Unincorporated Pierce County

Stream Name	Stream No.	Reach	Reach Designation	Reach Description	Reach Length (ft)	Channel Type[a]	Aquatic Habitat	Riparian Corridor
Tributary 0051	0051	02	0051-02	From start of mixed control moderate gradient reach to start of high gradient contained reach	260	Moderate gradient mixed control	Good	Fair
Tributary 0051	0051	03	0051-03	From start of high gradient contained reach to start of palustrine reach at culvert under 230th Ave. E	1,900	High gradient contained	Good	Fair
Tributary 0051	0051	04	0051-04	From culvert under 230th Ave. E to culvert where dominant riparian vegetation changes from trees to shrubs	1,540	Palustrine	Fair	Fair
Tributary 0051	0051	05	0051-05	From culvert where dominant riparian vegetation changes from trees to shrubs to source of stream	1,360	Palustrine	Poor	Poor
Tributary 0052	0052	01	0052-01	From mouth of stream to end of coniferous forest and beginning of hardwood forest	940	Palustrine	Good	Fair
Tributary 0052	0052	02	0052-02	From beginning of hardwood forest to beginning of coniferous forest	2,240	Palustrine	Good	Fair
Tributary 0052	0052	03	0052-03	From beginning of coniferous forest to source of stream	1,400	Palustrine	Good	Fair
Tributary 0053	0053	01	0053-01	From mouth of stream to end of coniferous forest and beginning of hardwood forest	340	Palustrine	Good	Fair
Tributary 0053	0053	02	0053-02	From beginning of hardwood forest to beginning of coniferous forest	1,880	Palustrine	Good	Fair
Tributary 0053	0053	03	0053-03	From beginning of coniferous forest to source of stream	2,140	Palustrine	Good	Fair

Table 8-2
USBEM Aquatic Habitat and Riparian Corridor Condition Summary Ratings: Stream Reaches in Unincorporated Pierce County

Stream Name	Stream No.	Reach	Reach Designation	Reach Description	Reach Length (ft)	Channel Type[a]	Aquatic Habitat	Riparian Corridor

a. Channel types:

Palustrine: Wetland channels, beaver complexes, or sloughs. Velocity is generally low, substrates are composed of fine sediment or organic matter, and channel morphology is sinuous or irregular and dominated by pools or glides.

Floodplain: Low-gradient depositional channels. Substrates are typically small gravel to cobble, and the bedform is typically regularly spaced pool-riffles. LWD is important for forming pools and providing cover. These channels migrate freely across alluvial floodplains, and off-channel habitats are normally abundant.

Large contained: Low to moderate gradient channels that are moderately to deeply incised. Stream power is moderate to high with coarse substrates. LWD is easily transported and generally located along channel margins. These channels rarely have extensive off-channel habitats.

Moderate gradient mixed control: Transport dominated channels with moderate to high stream power. LWD is important for forming pools and storing sediment, thus substrates and bedforms are highly variable. Off channel habitats may be present, but are not abundant.

High gradient contained: Moderately to deeply incised channels with high stream power. Most sediment is easily transported, thus gravel and small cobbles deposit only in hydraulically protected areas. Pools tend to be small and shallow, although LWD and bedrock may form large, deep pools.

The following sections describe the major habitat issues and restoration opportunities on reaches within the County's jurisdiction. In some cases, specific locations for restoration opportunities are identified. In other cases, a general restoration need for a section of stream is described.

8.3.1 White River Mainstem (WRIA 10)

Major habitat issues on the White River mainstem, from the confluence with the Puyallup River to the Lake Tapps diversion dam, include the following:

- Channel confinement, which has affected channel pattern and bedform, pool frequency, and the presence of LWD
- Fair riparian corridor conditions dominated by invasive species, which has affected canopy cover and recruitment of LWD.

The following restoration opportunities have potential to address these habitat issues:

- ***Riparian corridor protection:*** Undeveloped properties along the reach from the county line to the Lake Tapps diversion dam should be acquired to protect riparian areas and preserve riparian function.
- ***Invasive species management:*** The County's program to control invasive species and to restore native vegetation will help improve riparian habitat conditions.

Additional restoration opportunities were identified at the six potential levee setback sites along the lower White River (Brown and Caldwell, 2008b). All of these sites are located along the reach of the White River that will be included in the *Pierce County Rivers Flood Hazard Management Plan* (see Section 2.4.4). Those potential projects and other flooding improvement projects developed under that plan are likely to improve aquatic/riparian habitat. Therefore, restoration recommendations at the six potential levee setback sites, as well as any other restoration opportunities along this reach, are not included in this Basin Plan.

8.3.2 Tributary 0040 or Government Ditch

Major habitat issues on Tributary 0040 include the following:

- Channel confinement, which has affected channel pattern and bedform, pool frequency, and the presence of LWD
- Sedimentation of the substrate, which impacts quality of spawning habitat
- Poor/fair riparian corridor conditions dominated by invasive species, which has affected canopy cover and recruitment of LWD.

The following restoration opportunities have potential to address these habitat issues:

- ***Culvert removal:*** Stream 0040 flows under a dirt road and through the levee via two 36-inch culverts. If vehicle access along the dirt road is not needed, the two 36-inch culverts under the road should be removed and replaced with a boulder/gravel channel crossing with stepping stones.

- ***Riparian revegetation and invasive species management:*** Revegetation of the riparian buffer with native vegetation should be completed along Tributary 0040, particularly upstream of the diversion structure to Tributary 004005. Perennial flow is exposed to summer sunlight, which could cause temperature problems. Additional riparian vegetation will provide shade and reduce water temperatures. The County's program to control invasive species and to restore native vegetation will help improve riparian habitat conditions.

These restoration opportunities are within the project area of the proposed Levee Setback Project 31 (GeoEngineers, 2007). This lower White River levee setback project may be included in the *Pierce County Rivers Flood Hazard Management Plan*; therefore, these restoration opportunities are not included in this Basin Plan.

8.3.3 Tributary 004005 or Government Ditch Tributary

Major habitat issues on Tributary 004005 include the following:

- Low flow due to diversion structure
- Possible fish barrier
- Sedimentation of the substrate, which impacts quality of spawning habitat
- Fair riparian corridor conditions dominated by invasive species, which has affected canopy cover and recruitment of LWD.

The following restoration opportunities have potential to address these habitat issues:

- ***Rebuild diversion structure:*** Tributary 004005 is a stream diverted away from Tributary 0040 by a concrete diversion structure. The concrete diversion structure may be a fish passage barrier, in which case it should be rebuilt. Increasing the height of the diversion structure or changing its configuration could divert higher flows toward the wetland and allow Tributary 0040 to serve as a high-flow refuge. Flow in Tributary 4005 should be maintained.
- ***Riparian revegetation and invasive species management:*** The constructed wetland that Tributary 004005 flows into should be enhanced by increasing vegetation complexity. The County's program to control invasive species and to restore native vegetation will help improve riparian habitat conditions.

These restoration opportunities are within the project area of proposed Levee Setback Project 31 (GeoEngineers, 2007). This lower White River levee setback project may be included in the *Pierce County Rivers Flood Hazard Management Plan*; therefore, these restoration opportunities are not included in this Basin Plan.

8.3.4 Tributary 0051

Major habitat issues on Tributary 0051 include the following:

- Channelization, which has affected channel pattern and bedform, pool frequency, the presence of LWD, and substrate quality
- Fair/poor riparian corridor conditions dominated by invasive species, which has affected canopy cover and recruitment of LWD
- Possible nutrient loading.

Restoration opportunities that have potential to address these habitat issues include riparian revegetation and invasive species management. The County should work with landowners in the reaches upstream of the barrier falls to increase native riparian woody vegetation along the stream. These efforts should be focused in areas where good shading and bank stability benefits can be gained. Invasive species management is very important in this disturbed system. Because of frequent disruption of native vegetation communities, invasive species have the potential to dominate the riparian corridor. Proactive measures should be taken to remove invasive species as soon as possible. Benefits could be gained by educating landowners about invasive species management and about how to maintain a healthy riparian buffer. The County's program to control invasive species and to restore native vegetation will help improve riparian habitat conditions.

8.3.5 Tributaries 0052 and 0053

Major habitat issues on Tributaries 0052 and 0053 include the following:

- Natural fish barriers
- Fair riparian corridor conditions dominated by invasive species, which has affected canopy cover and recruitment of LWD.

Invasive species management has the potential to address these habitat issues. The riparian corridor observed during the 2007 field visits provides good shade, but contains invasive species. The County's program to control invasive species and to restore native vegetation will help improve riparian habitat conditions.

8.4 POTENTIAL SOLUTIONS

This section describes how habitat problems identified in the White River basin will be addressed. Recommendations were developed to address the following:

- Reaches with an aquatic habitat rating of fair or poor
- Reaches with a riparian corridor rating of fair or poor
- Problems identified during field work.

A total of 76 aquatic/riparian habitat problems were identified in the White River Basin. Table 8-3 summarizes the recommendations. The aquatic/riparian habitat problems have multiple causes that will require a range of solutions. Proposed programmatic measures and capital improvement projects are described in Chapter Nine and Figure 9-1 shows capital improvement project locations.

8.4.1 Problems Resolved or Not Addressed in the Basin Plan

Sixty-six of the aquatic/riparian habitat problems identified are not addressed in this Basin Plan, for the reasons listed below:

- Fifty-one problems were found to be outside Pierce County's jurisdiction.
- Nine problems were located along reaches to be included in the *Pierce County Rivers Flood Hazard Management Plan*. Aquatic/riparian habitat will be improved through the flood mitigation projects developed under that plan.
- Six problems were investigated and it was found that fish passage downstream was blocked by natural barriers. Improving upstream aquatic habitat is not warranted.

8.4.2 Maintenance and Enforcement Issues

No problems were identified as maintenance or enforcement issues.

8.4.3 Capital Improvement Program Projects

One land acquisition project was developed to address aquatic/riparian habitat problems in the White River Basin. This project is discussed in greater detail in Chapter Nine. The project location is shown on Figure 9-1.

8.4.4 Potential Programmatic Measures

Programmatic solutions can benefit existing aquatic/riparian habitat and prevent future degradation. For instance, programs can preserve high-quality habitat areas, and provide for maintenance of restored areas. Three programmatic measures are recommended that will serve to improve aquatic/riparian habitat and address problems:

- PRG00-05, Program to Enhance Degraded Riparian Habitat and Water Quality
- PRG00-06, Education, Outreach, and Technical Assistance Program
- PRG00-09, Invasive Species Management Program.

Additional countywide programmatic measures relevant to aquatic/riparian habitat are listed below:

- PRG00-04, Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation
- PRG00-13, Habitat Monitoring Program
- PRG00-14, Vegetation Management Program.

Chapter Nine contains detailed descriptions of these measures.

8.4.5 Problems Requiring More Detailed Data or Analysis

No separate recommendations were made for additional studies.

Table 8-3
Aquatic/Riparian Habitat Problem Recommendations

Problem ID	Location	Description	Recommendation
GWR-01	Greenwater River, Reach 0122-03; from downstream end of large island dividing river into 2 channels to upstream end of island	Aquatic habitat is fair.	Problem is outside the County's jurisdiction.
GWR-02	Greenwater River, Reach 0122-07; from confluence with stream 0126 to change from large contained to floodplain channel	Aquatic habitat is fair.	Problem is outside the County's jurisdiction.
LWR-01	White River mainstem, Reach 0031-01; mouth to confluence with Dieringer Canal	Aquatic habitat is poor and riparian corridor is fair.	This reach of the White River is covered under the *Pierce County Rivers Flood Hazard Management Plan*. Aquatic habitat and riparian corridor may be improved with flooding improvement projects developed under that plan.
LWR-03	Tributary 0032, Reach 0032-01; from mouth to upstream end of first culvert under SR 167	Aquatic habitat is poor and riparian corridor is fair; possible fish passage barrier (3 culverts).	Problem is outside the County's jurisdiction.
LWR-04	Tributary 0032, Reach 0032-02; from upstream end of culvert under SR 167 to confluence with ditch draining constructed wetland	Aquatic habitat is poor and riparian corridor is poor.	Problem is outside the County's jurisdiction.
LWR-05	Tributary 0032, Reach 0032-03; from confluence with ditch draining constructed wetland to 32nd St. off-ramp	Aquatic habitat is poor and riparian corridor is poor; possible fish passage barrier, bottomless 30-foot-wide by 10-foot-high concrete culvert, under 32nd St. on-ramp to Valley Freeway.	Problem is outside the County's jurisdiction.
LWR-06	Tributary 0032, Reach 0032-04; from 32nd St. off-ramp to upstream end of second culvert under Hwy. 167 (near Tarp World at end of 132nd Ave. E)	Aquatic habitat is poor and riparian corridor is poor; possible fish passage barriers (two 8-inch culverts) under Valley Freeway (near Tarp World).	Problem is outside the County's jurisdiction.

Table 8-3
Aquatic/Riparian Habitat Problem Recommendations

Problem ID	Location	Description	Recommendation
LWR-07	Tributary 0032, Reach 0032-05; from second culvert to confluence with Jovita Creek	Aquatic habitat is poor and riparian corridor is fair; Possible fish passage barrier, bottomless 2-barrel box culvert (approximately 30 feet wide [total width] and 10 feet high), under Stewart St.	Problem is outside the County's jurisdiction.
LWR-08	Tributary 0032, Reach 0032-06; from confluence with Jovita Creek to County Line Rd.	Aquatic habitat is poor and riparian corridor is fair.	Problem is outside the County's jurisdiction.
LWR-09	Jovita Creek, Reach 0033-01; from mouth to upstream end of culvert under SR 167	Aquatic habitat is fair and riparian corridor is poor; Possible fish passage barrier (8-inch culvert).	Problem is outside the County's jurisdiction.
LWR-10	Jovita Creek, Reach 0033-02; from upstream end of culvert under SR 167 to upstream end of culvert under West Valley Hwy.	Aquatic habitat is poor and riparian corridor is poor; Possible fish passage barrier: 2 box culverts and a small falls (less than 3 feet high) about 15 feet below the highway culvert.	Problem is outside the County's jurisdiction.
LWR-11	Jovita Creek, Reach 0033-03; from upstream end of culvert under West Valley Hwy. to upstream end of culvert at lowest crossing by Jovita Blvd.	Aquatic habitat is fair and riparian corridor is fair; possible fish passage barrier (culvert).	Problem is outside the County's jurisdiction.
LWR-12	Jovita Creek, Reach 0033-04; from upstream end of culvert at lowest crossing by Jovita Blvd. to confluence with stream 0034	Aquatic habitat is poor and riparian corridor is fair; possible fish passage barrier (3-foot culvert).	Problem is outside the County's jurisdiction.
LWR-13	Jovita Creek, Reach 0033-05; from confluence with stream 0034 to culvert at County Line Rd. E	Aquatic habitat is fair and riparian corridor is fair; fish passage barrier: culvert under the King County Line Rd.	Problem is outside the County's jurisdiction.
LWR-14	Tributary 0034, Reach 0034-01; from mouth to culvert at 114th Ave. E	Aquatic habitat is poor and riparian corridor is poor; possible fish passage barrier (18-inch culvert).	Problem is outside the County's jurisdiction.
LWR-15	Tributary 0034, Reach 0034-02; from culvert at 114th Ave. E to where floodplain narrows	Aquatic habitat is poor and riparian corridor is fair.	Problem is outside the County's jurisdiction.

Table 8-3
Aquatic/Riparian Habitat Problem Recommendations

Problem ID	Location	Description	Recommendation
LWR-16	Tributary 0034, Reach 0034-03; from where floodplain narrows upstream from 114th Ave. E to outlet of private pond (source of stream)	Aquatic habitat is poor and riparian corridor is fair.	Problem is outside the County's jurisdiction.
LWR-17	Strawberry Creek, Reach 0035-01; from mouth of stream to upstream end of culvert under sod farm road	Aquatic habitat is fair and riparian corridor is fair; possible fish passage barrier (2-by-4-foot culvert). Culvert may violate the Hydraulic Code.	Problem is outside the County's jurisdiction.
LWR-18	Strawberry Creek, Reach 0035-02; from upstream end of culvert under sod farm road to where dominant riparian vegetation changes from trees to shrubs	Aquatic habitat is fair and riparian corridor is fair.	Problem is outside the County's jurisdiction.
LWR-19	Strawberry Creek, Reach 0035-03; from where dominant riparian vegetation changes from trees to shrubs to culvert immediately downstream from railroad tracks	Aquatic habitat is fair and riparian corridor is fair; possible fish passage barrier (4.5-foot culvert).	Problem is outside the County's jurisdiction.
LWR-20	Strawberry Creek, Reach 0035-04; from culvert immediately downstream from railroad tracks to confluence with stream 0037	Aquatic habitat is fair and riparian corridor is poor.	Problem is outside the County's jurisdiction.
LWR-21	Strawberry Creek, Reach 0035-05; from confluence with stream 0037 to bridge at East Valley Hwy.	Riparian corridor is fair.	Problem is outside the County's jurisdiction.
LWR-22	Strawberry Creek, Reach 0035-06; from bridge at East Valley Hwy. to where dominant riparian vegetation changes from grass to trees	Aquatic habitat is fair and riparian corridor is poor.	Problem is outside the County's jurisdiction.
LWR-23	Strawberry Creek, Reach 0035-07; from where dominant riparian vegetation changes from grass to trees to confluence with stream 0036	Aquatic habitat is fair and riparian corridor is poor.	Problem is outside the County's jurisdiction.
LWR-24	Strawberry Creek, Reach 0035-08; from confluence with stream 0036 to start of reach dominated by reed canary grass	Aquatic habitat is fair and riparian corridor is fair.	Problem is outside the County's jurisdiction.

Table 8-3
Aquatic/Riparian Habitat Problem Recommendations

Problem ID	Location	Description	Recommendation
LWR-25	Strawberry Creek, Reach 0035-09; from start of reach dominated by reed canary grass to start of reach dominated by riparian shrubs	Aquatic habitat is poor and riparian corridor is poor.	Problem is outside the County's jurisdiction.
LWR-26	Strawberry Creek, Reach 0035-10; from start of reach dominated by riparian shrubs to upstream end of culvert under North Parker Rd.	Aquatic habitat is poor and riparian corridor is poor; possible fish passage barrier (culvert) due to a 2-foot drop across the trash rack at the upstream end.	Problem is outside the County's jurisdiction.
LWR-27	Strawberry Creek, Reach 0035-11; from upstream end of culvert under North Parker Rd. to culvert under dirt access road to residence on east side of stream	Aquatic habitat is poor and riparian corridor is poor.	Problem is outside the County's jurisdiction.
LWR-28	Strawberry Creek, Reach 0035-12; from culvert under dirt access road to residence on east side of stream to the corner of Elm St. and 160th Ave. E	Aquatic habitat is poor and riparian corridor is poor.	Problem is outside the County's jurisdiction.
LWR-29	Strawberry Creek, Reach 0035-13; from corner of Elm St. and 160th Ave. E. to culvert under 52nd St. E	Aquatic habitat is fair and riparian corridor is poor.	Problem is outside the County's jurisdiction.
LWR-30	Strawberry Creek, Reach 0035-14; from culvert under 52nd St. E to upstream end of culvert under meat-packing plant and parking lot	Aquatic habitat is poor and riparian corridor is poor; possible fish passage barrier (culvert).	Problem is outside the County's jurisdiction.
LWR-31	Strawberry Creek, Reach 0035-15; from upstream end of culvert under meat-packing plant and parking lot to upstream end of culvert under dirt road	Aquatic habitat is poor and riparian corridor is poor.	Problem is outside the County's jurisdiction.
LWR-33	Strawberry Creek, Reach 0035-16; from upstream end of culvert under dirt road upstream from meat-packing plant to upstream end of culvert under 162nd Ave. E	Aquatic habitat is poor and riparian corridor is fair; possible fish passage barrier (3 culverts).	Problem is outside the County's jurisdiction.
LWR-34	Strawberry Creek, Reach 0035-17; from upstream end of culvert under 162nd Ave. E to upstream end of culvert under 60th St. E	Aquatic habitat is poor and riparian corridor is poor.	Problem is outside the County's jurisdiction.

Table 8-3
Aquatic/Riparian Habitat Problem Recommendations

Problem ID	Location	Description	Recommendation
LWR-35	Strawberry Creek, Reach 0035-18; from upstream end of culvert under 60th St. E to source of stream near corner of 64th St. E and 166th Ave. E	Aquatic habitat is poor and riparian corridor is fair.	Problem is outside the County's jurisdiction.
LWR-36	Salmon Creek, Reach 0036-02	Eroding bank.	Problem is outside the County's jurisdiction.
LWR-39	Tributary 0037, Reach 0037-01; from mouth of stream to culvert at East Valley Hwy.	Aquatic habitat is fair and riparian corridor is poor; possible fish passage barrier due to low flow through the culvert.	Problem is outside the County's jurisdiction.
LWR-40	Tributary 0038, Reach 0038-001; from mouth of stream to upstream end of culvert under sod farm road in turf farm	Aquatic habitat is poor and riparian corridor is fair; possible fish passage barrier (48-inch culvert).	Problem is outside the County's jurisdiction.
LWR-41	Tributary 0038, Reach 0038-02; from upstream end of culvert under dirt farm road in turf farm to upstream end of culvert under railroad tracks	Aquatic habitat is poor and riparian corridor is poor; possible fish passage barrier (3-foot culvert).	Problem is outside the County's jurisdiction.
LWR-42	Tributary 0038, Reach 0038-03; from upstream end of culvert under railroad tracks to upstream end of culvert under dirt road paralleling buried fiber optic cable	Aquatic habitat is poor and riparian corridor is poor; possible fish passage barrier (culvert) under railroad tracks.	Problem is outside the County's jurisdiction.
LWR-43	Tributary 0038, Reach 0038-04; from upstream end of culvert under dirt road paralleling buried fiber optic cable to upstream end of palustrine channel	Aquatic habitat is fair and riparian corridor is poor; culvert inlet at end of reach is not passable by juvenile salmonids.	Problem is outside the County's jurisdiction.
LWR-44	Tributary 0038, Reach 0038-05; from upstream end of palustrine channel to upstream end of culvert under East Valley Hwy.	Aquatic habitat is poor and riparian corridor is poor; possible fish passage barrier (2-foot culvert).	Problem is outside the County's jurisdiction.
LWR-45	Tributary 0038, Reach 0038-06; from upstream end of culvert under East Valley Hwy. to upstream end of culvert under Forest Canyon Rd.	Aquatic habitat is fair and riparian corridor is fair; fish passage barrier (culvert) and stream channel immediately upstream of the culvert.	Problem is outside the County's jurisdiction.

Table 8-3
Aquatic/Riparian Habitat Problem Recommendations

Problem ID	Location	Description	Recommendation
LWR-46	Tributary 0039, Reach 0039-01; from confluence with Dieringer Canal to upstream end of culvert under East Valley Hwy.	Aquatic habitat is poor and riparian corridor is poor; possible fish passage barrier (culverts).	Problem is outside the County's jurisdiction.
LWR-47	Tributary 0039, Reach 0039-02; from upstream end of culvert under East Valley Hwy. to outlet at East Valley Hwy. of culvert draining ravine	Aquatic habitat is poor and riparian corridor is poor.	Problem is outside the County's jurisdiction.
LWR-48	Tributary 0039, Reach 003905-01; from confluence of Dieringer Canal with White River to confluence with stream 0039	Aquatic habitat is poor and riparian corridor is poor.	Problem is outside the County's jurisdiction.
LWR-49	White River mainstem, Reach 0031-02; from confluence with Dieringer Canal to Stewart Rd. bridge	Aquatic habitat is fair and riparian corridor is fair.	This reach of the White River is covered under the *Pierce County Rivers Flood Hazard Management Plan*. Aquatic habitat and riparian corridor may be improved with flooding improvement projects developed under that plan.
LWR-50	Tributary 0040, Reach 0040-01; from mouth at White River to control structure that diverts part of flow into upstream end of 0040.5	Aquatic habitat is poor and riparian corridor is fair; artificial passage problems: weir or control structure that diverts 0040 into 0040.5 and 0040; fish passage barrier—concrete control structure diverting water to constructed wetlands.	This problem is addressed by a Levee Setback project at Pacific Park (Site 31, GeoEngineers, 2007). This project may be included in the *Pierce County Rivers Flood Hazard Management Plan*.
LWR-52	Tributary 0040, Reach 0040-02; from control structure at upstream end of 0045.5 to reach where dominant riparian vegetation changes from trees to shrubs	Aquatic habitat is fair and riparian corridor is fair.	This problem is addressed by a Levee Setback project at Pacific Park (Site 31, GeoEngineers, 2007). This project may be included in the *Pierce County Rivers Flood Hazard Management Plan*.
LWR-53	Tributary 0040, Reach 0040-03; from where dominant riparian vegetation changes from trees to shrubs to King County Line	Aquatic habitat is poor and riparian corridor is poor	This problem is addressed by a Levee Setback project at Pacific Park (Site 31, GeoEngineers, 2007). This project may be included in the *Pierce County Rivers Flood Hazard Management Plan*.

Table 8-3
Aquatic/Riparian Habitat Problem Recommendations

Problem ID	Location	Description	Recommendation
LWR-54	Tributary 004005-01; from mouth at White River to upstream end of constructed wetland	Aquatic habitat is fair and riparian corridor is fair; constructed wetland is not accessible to rearing juvenile salmonids.	This problem is addressed by a Levee Setback project at Pacific Park (Site 31, GeoEngineers, 2007). This project may be included in the *Pierce County Rivers Flood Hazard Management Plan*.
LWR-55	Tributary 004005-02; from upstream end of constructed wetland to control structure that diverts part of flow from 0040 into 004005	Aquatic habitat is fair and riparian corridor is fair.	This problem is addressed by a Levee Setback project at Pacific Park (Site 31, GeoEngineers, 2007). This project may be included in the *Pierce County Rivers Flood Hazard Management Plan*.
LWR-56	White River mainstem, Reach 0031-03; from Stewart Rd. bridge to bluff at Auburn Game Farm Park	Aquatic habitat is fair and riparian corridor is fair.	This reach of the White River is covered under the *Pierce County Rivers Flood Hazard Management Plan*. Aquatic habitat and riparian corridor may be improved with flooding improvement projects developed under that plan.
LWR-58	White River mainstem, Reach 0031-04; from bluff at Auburn Game Farm Park to pipeline crossing on Muckleshoot Indian Reservation	Aquatic habitat is fair and riparian corridor is fair.	Problem is outside the County's jurisdiction.
LWR-59	White River mainstem, Reach 0031-05; from pipeline crossing Muckleshoot Indian Reservation to RM 14.7	Riparian corridor is fair.	Lower White River Property Acquisition (CIP15-LWR-AC01) and Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05).
LWR-60	Tributary 0051, Reach 0051-01; from mouth of stream to start of mixed control moderate gradient reach	Aquatic habitat is fair and riparian corridor is fair. There is a 6-foot drop in the tributary to the White River. The drop is impassable by anadromous fish.	Education, Outreach, and Technical Assistance Program (PRG00-06), Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05), and Invasive Species Management (PRG00-09).

Table 8-3
Aquatic/Riparian Habitat Problem Recommendations

Problem ID	Location	Description	Recommendation
LWR-61	Tributary 0051, Reach 0051-02; from start of mixed control moderate gradient reach to start of high gradient contained reach	Riparian corridor is fair.	Education, Outreach, and Technical Assistance Program (PRG00-06), Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05), and Invasive Species Management (PRG00-09).
LWR-62	Tributary 0051, Reach 0051-03; from start of high gradient contained reach to start of palustrine reach at culvert under 230th Ave. E	Riparian corridor is fair.	Education, Outreach, and Technical Assistance Program (PRG00-06), Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05), and Invasive Species Management (PRG00-09).
LWR-63	Tributary 0051, Reach 0051-04	A number of drain pipes extend from the horse pasture bordering Reach 04 of Tributary 0052. Drainage likely increases the nutrient loading in this stream.	Education, Outreach, and Technical Assistance Program (PRG00-06), Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05), and Invasive Species Management (PRG00-09).
LWR-64	Tributary 0051, Reach 0051-04; from culvert under 230th Ave. E to culvert where dominant riparian vegetation changes from trees to shrubs	Aquatic habitat is fair and riparian corridor is fair. Falls in reach 2 are a complete barrier to fish passage.	Education, Outreach, and Technical Assistance Program (PRG00-06), Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05), and Invasive Species Management (PRG00-09).
LWR-65	Tributary 0051, Reach 0051-05; from culvert where dominant riparian vegetation changes from trees to shrubs to source of stream	Aquatic habitat is poor and riparian corridor is poor. Falls in reach 2 are a complete barrier to fish passage.	Education, Outreach, and Technical Assistance Program (PRG00-06), Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05), and Invasive Species Management (PRG00-09).
LWR-66	Tributary 0052, Reach 0052-01; from mouth of stream to end of coniferous forest and beginning of hardwood forest	Riparian corridor is fair. There is a 6-foot drop in the tributary to the White River. The drop is impassable by anadromous fish.	Invasive Species Management (PRG00-09).
LWR-67	Tributary 0052, Reach 0052-02; from beginning or hardwood forest to beginning of coniferous forest	Riparian corridor is fair.	Invasive Species Management (PRG00-09).

Table 8-3
Aquatic/Riparian Habitat Problem Recommendations

Problem ID	Location	Description	Recommendation
LWR-68	Tributary 0052, Reach 0052-03; from beginning of coniferous forest to source of stream	Riparian corridor is fair.	Invasive Species Management (PRG00-09).
LWR-69	Tributary 0053, Reach 0053-01; from mouth of stream to end of coniferous forest and beginning of hardwood forest	Riparian corridor is fair. There is a 6-foot drop in the tributary to the White River. The drop is impassable by anadromous fish.	Invasive Species Management (PRG00-09).
LWR-70	Tributary 0053, Reach 0053-02; from beginning of hardwood forest to beginning of coniferous forest	Riparian corridor is fair.	Invasive Species Management (PRG00-09).
LWR-71	Tributary 0053, Reach 0053-03; from beginning of coniferous forest of source of stream	Riparian corridor is fair.	Invasive Species Management (PRG00-09).
LWR-72	White River mainstem, Reach 0031-06; from RM 14.7 to RM 19.0	Aquatic habitat is fair and riparian corridor is fair.	Lower White River Property Acquisition (CIP15-LWR-AC01).
LWR-73	White River mainstem, Reach 0031-07; from RM 19.0 to Buckley diversion dam	Aquatic habitat is fair.	Lower White River Property Acquisition (CIP15-LWR-AC01).
LWR-74	White River mainstem, between the Buckley diversion canal and the Dieringer Canal, Reaches 02-07	Potential for low stream flows (due to Mud Mountain Dam and the Buckley diversion) and elevated stream temperatures, creating both temperature and physical barriers to fish passage.	Problem is outside the County's jurisdiction. The White River flow regime is likely to change (to higher flows) based on the Cascade Water Alliance's management requirements specified in the Reports of Examination for the water rights transfer.
LWR-75	White River mainstem, Reaches 01-07	Mud Mountain Dam and the Buckley diversion dam have resulted in the loss of pool habitat, and lack of large woody debris and spawning gravel recruitment.	Problem is outside the County's jurisdiction.
LWR-76	Tributaries to White River mainstem	Many of the channels of the larger tributaries west of Lake Tapps have been channelized into straight ditches with no channel complexity. Increased nutrient loading may be result.	Problem is outside the County's jurisdiction.

Table 8-3
Aquatic/Riparian Habitat Problem Recommendations

Problem ID	Location	Description	Recommendation
LWR-77	Tributaries of the Lower White River	Several wetlands are not accessible to rearing juvenile salmonids.	It is assumed that this problem is addressed by a Levee Setback project at Pacific Park (Site 31, GeoEngineers, 2007). This project may be included in the *Pierce County Rivers Flood Hazard Management Plan*.
WFW-01	White River West Fork, Reach 0186-01; from mouth of river to change from large contained to floodplain channel	Aquatic habitat is fair.	Problem is outside the County's jurisdiction.
WFW-02	White River West Fork, Reach 0186-02; from floodplain channel to upstream end of surveyed reach	Aquatic habitat is fair.	Problem is outside the County's jurisdiction.

CHAPTER NINE
BASIN PLAN

This chapter contains the White River Basin Plan (Basin Plan). The Basin Plan sets out recommended Capital Improvement Program (CIP) projects[1], programmatic measures[2], and studies that address the stormwater and surface water management problems identified in previous chapters.

The Basin Plan establishes the direction that Pierce County Surface Water Management (SWM) will take within the White River Basin over the next 5 to 10 years. The recommended measures are intended to reduce flooding and storm drainage hazards, improve water quality, improve aquatic/riparian habitat potentially affected by surface water management methods, ensure coordinated and responsible use of public resources, and coordinate with the Planning Department to help guide new development.

Section 9.1 provides a summary of Basin Plan recommendations. Section 9.2 describes the Basin Plan's approach to basin needs, including a description of key assumptions and analysis behind the recommendations. Section 9.3 presents specific recommendations with descriptions of individual capital improvement projects, programmatic measures, and studies to close data gaps. Section 9.4 discusses implementation of the recommendations, and Section 9.5 provides a cross-reference table of problems and recommended capital improvement projects.

9.1 SUMMARY OF PLAN RECOMMENDATIONS

The Basin Plan contains three (3) capital improvement projects, 18 programmatic measures, and two (2) studies to address flooding, water quality, and aquatic/riparian 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"[3] groups. Studies were not prioritized with capital improvement projects and the programmatic measures. Priority groups are based on scores from prioritization worksheets common to all basin plans. Worksheets estimate the project's or program's potential for various aspects of flood reduction, improvement of water quality, aquatic habitat protection, and other benefits using approximately 40 criteria. (Appendix L contains a ranking sheet for each capital improvement project and each programmatic measure.)

1 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.
2 Programmatic measures are nonstructural solutions, such as changing particular Pierce County procedures, providing technical assistance, enforcing regulations, and offering public information.
3 "Low-Priority" does not mean "not a priority." "No Priority" actions have already been excluded from this Basin Plan. Rather, "Low-Priority" means that 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.

The top 25 percent of the projects are designated High-Priority, the middle 50 percent are Medium-Priority, and the remaining 25 percent are assigned Low-Priority status. Estimated costs of the recommendations by priority group over the 10-year implementation period are as follows:

- "High-Priority" recommendations: $389,000
- "Medium-Priority" recommendations: $4,567,950
- "Low-Priority" recommendations: $1,196,400.

In addition, two studies to fill information gaps totaling $170,500 have been identified. Table 9-1 presents the estimated costs of the 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	-	$2,000,000	$619,700
Programmatic measures	$389,000	$2,567,950	$576,700
Studies	$170,500		
Total estimated cost	**$6,323,850**		

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.

Table 9-2
High-Priority Recommendations

ID Code	Project Title	Rating Score	Estimated Cost
PRG00-02	Update Stormwater Management Manual	385	$2,000
PRG00-08	BMP Manual for Pierce County Surface Water Management Maintenance Activities	401	$11,000
PRG00-04	Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation	367	$14,000
PRG00-06	Education, Outreach, and Technical Assistance Program	402	$52,000
PRG00-03	Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit	380	$310,000
		Total estimated cost	**$389,000**

Table 9-3
Medium-Priority Recommendations

ID Code	Project Title	Rating Score	Estimated Cost
PRG00-09	Invasive Species Management Program	338	$11,000
PRG00-11	Enhance Cooperation with Cities and Other Agencies	211	$90,000
PRG15-04	Enhance Puyallup River Watershed Council's Capacity	285	$93,750
PRG00-01	Low-Impact Development Program	277	$116,000
PRG00-05	Program to Enhance Degraded Riparian Habitat and Water Quality	309	$169,000
PRG00-14	Vegetation Management Program	343	$209,000
PRG00-07	Surface Water Monitoring Program	235	$240,000
PRG15-02	Lake Tapps Pollutant Source Identification and Monitoring Program	238	$359,200
PRG00-12	Lakes Water Quality Management Program	335	$1,280,000
CIP15-LWR-AC01	Acquire Property Adjacent to White River for Floodplain Preservation and Water Quality Protection	207	$2,000,000
		Total estimated cost	**$4,567,950**

Table 9-4
Low-Priority Recommendations

ID Code	Project Title	Rating Score	Estimated Cost
PRG00-10	Beaver Management Policy	174	$700
PRG00-13	Habitat Monitoring Program	203	$12,000
PRG15-03	Coordinate with Tacoma-Pierce County Health Department to Address Reported Onsite Sewer System Problems	206	$116,000
CIP15-TAP-C01	185th Avenue East Drainage Improvements	68	$190,000
CIP21-UWR-C01	Crystal River Ranch Estates Drainage Improvements	159	$429,700
PRG15-01	Coordinate with the Cascade Water Alliance to Develop a Lake Tapps Water Quality Monitoring Plan	204	$448,000
		Total estimated cost	**$1,196,400**

9.1.1 Capital Improvement Projects

The Basin Plan proposes two capital improvement projects within the Lower White River Basin, and a third project in the Upper White River Basin. These projects address multiple problems, reflecting the interrelationship of environmental factors. Table 9-5 presents a summary of capital improvement projects.

Table 9-5
Summary of Capital Improvement Projects

ID Code	Project Title	Problem Types Addressed	Rating Score	Estimated Cost
CIP15-LWR-AC01	Acquire Property Adjacent to White River for Floodplain Preservation and Water Quality Protection	Water quality, Aquatic/riparian habitat, Flood mitigation	207	$2,000,000
CIP15-TAP-C01	185th Avenue East Drainage Improvements	Flood mitigation	68	$190,000
CIP21-UWR-C01	Crystal River Ranch Estates Drainage Improvements	Flood mitigation	159	$429,700
			Total estimated cost	$2,619,700

Figure 9-1 shows the locations of the recommended projects. A general location is provided to concentrate on project concepts and promote 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 capital improvement project and presents an estimated cost and a project rating score. Project rating scores measure how well each capital improvement project is in line with the Basin Plan objectives and key *Pierce County Comprehensive Plan* (Comprehensive Plan) policies.

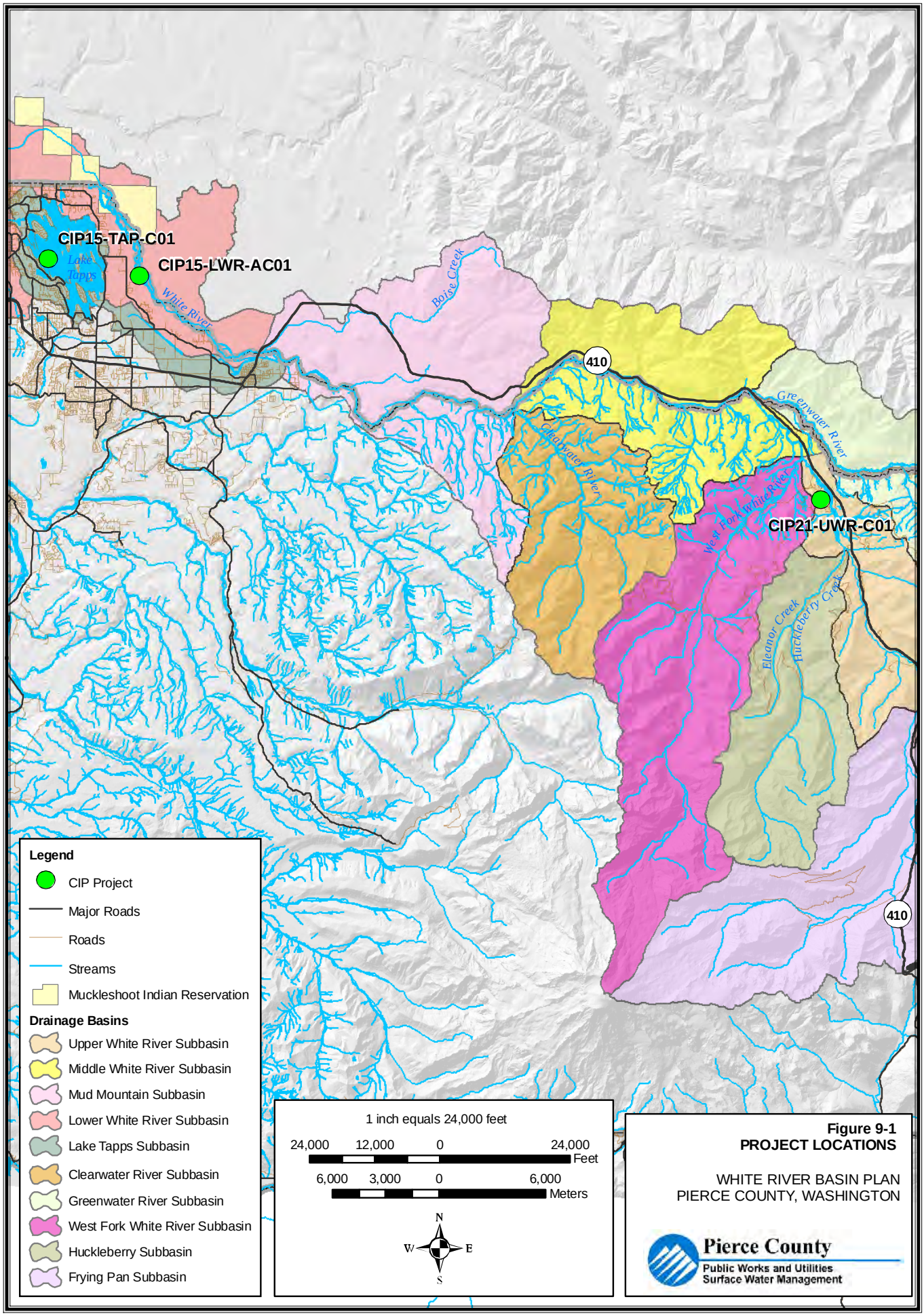


Figure 9-1
PROJECT LOCATIONS

WHITE RIVER BASIN PLAN
PIERCE COUNTY, WASHINGTON

9.1.2 Programmatic Measures

The Basin Plan recommends 18 programmatic measures. The term "programmatic" relates to a plan of action or procedure for addressing a drainage need or problem. Programmatic measures bear on regulations, policy guidelines, site design standards, operational policies, technical assistance, enforcement, public outreach, and educational programs. Four of the programmatic recommendations are specific to the White River Basin. The other programmatic activities would be undertaken with countywide applicability, with the basin paying its share[1] of program costs. In 2010, the White River Basin contributed approximately 4.6 percent of the revenue from storm drainage and surface water management fees.

Recommended programmatic measures reflect a policy in the Comprehensive Plan that advocates use of nonstructural solutions to storm drainage problems before committing to hard-engineered solutions. Pierce County Code (PCC) 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

- PRG00-02: Update Stormwater Management Manual
- PRG00-03: Increase Inspections for Compliance with Stormwater Requirements and National Pollution Discharge Elimination System (NPDES) Permit
- PRG00-04: Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation
- PRG00-06: Education, Outreach, and Technical Assistance Program
- PRG00-08: BMP Manual for Pierce County Surface Water Management Maintenance Activities

Medium-Priority Programmatic Measures

- PRG00-01: Low Impact Development Program
- PRG00-05: Program to Enhance Degraded Riparian Habitat and Water Quality
- PRG00-07: Surface Water Monitoring Program
- PRG00-09: Invasive Species Management Program
- PRG00-11: Enhance Cooperation with Cities and Other Agencies
- PRG00-12: Lakes Water Quality Management Program
- PRG00-14: Vegetation Management Program

1 Share is the percentage share of SWM fee-based revenue contributed by property owners in the basin.

- PRG15-02: Lake Tapps Pollutant Source Identification and Monitoring Program
- PRG15-04: Enhance Puyallup River Watershed Council's Capacity

Low-Priority Programmatic Measures

- PRG00-10: Beaver Management Policy
- PRG00-13: Habitat Monitoring Program
- PRG15-01: Coordinate with the Cascade Water Alliance to Develop a Lake Tapps Water Quality Monitoring Plan
- PRG15-03: Coordinate with Tacoma-Pierce County Health Department to Address Reported On-site Sewer System Problems

The estimated cost of implementing the recommended programmatic measures for the White River Basin over the 10-year implementation period is $3,533,650.

9.1.3 Additional Studies

The Basin Plan recommends two 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:

- ST15-TAP-ST01: Lake Tapps Diversion Canal Stormwater Outfall Assessment
- ST15-TAP-ST02: White River Water Quality Assessment for Fecal Coliform, Temperature, pH, and In-stream Flow

The estimated cost of the studies is $170,500.

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 implementation varies due to several factors such 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.

The annual Capital Facilities Element of the Comprehensive Plan reflects the specific annual strategy for capital improvement projects. Programmatic measures and capital improvement projects also appear in the annual budget for SWM.

SWM 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 Basin Plan anticipates full implementation over a 10-year period beginning in 2011. 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 Comprehensive Plan, and secondly in the operating budget for SWM.

9.2 PLAN APPROACH TO BASIN NEEDS

The following sections describe key approaches to addressing surface water management needs in the White River Basin.

9.2.1 Preference for Nonstructural Solutions

The 1991 *Pierce County Storm Drainage and Surface Water Management Plan* and the Capital Facilities Element of the Comprehensive Plan contain the following policy: "Nonstructural measures should be preferred over structural measures." In keeping with this policy, the Basin Plan recommends 18 nonstructural, or programmatic, measures. Examples include the following programs:

- Low Impact Development Program
- Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation
- Lakes Water Quality Management Program.

Section 9.3.3 describes the recommended programmatic measures.

9.2.2 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, provides 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 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.

9.2.3 Critical Areas Conservation

Surface water management problems such as stormwater drainage, flooding, and loss of aquatic habitat are ongoing in the White River Basin. These problems can be partially

addressed through conservation of critical areas, including preservation of flood-prone lands, 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 nearly the same.

The Basin Plan recommends property acquisitions for conservation of critical areas or mitigation of adverse effects of urban development along the Lower White River as part of a capital improvement project (CIP 15-LWLR-AC01; refer to Section 9.3.2).

9.2.4 Public Involvement and Education

A goal of public involvement is to improve public understanding of the various surface water management issues in the White River Basin. Individual recommendations of this Basin Plan should be incorporated into a comprehensive public education program that informs White 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 water and groundwater resources of the White River Basin.

A countywide watershed education program would help to educate watershed residents about the consequences of their 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. Coordination with other jurisdictions within the White River Basin would be used for effective communication to watershed citizens.

Programmatic measure PRG00-06, Education, Outreach, and Technical Assistance Program, should include some of the components and recommendations of this Basin Plan and should provide for public involvement and information in the White River Basin as part of the countywide program.

9.2.5 Property Acquisition Prioritization

Property acquisition projects that target more than one parcel should be implemented in phases based on a standard prioritization method that is consistent with the requirements of potential funding sources such as the Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program (i.e., parcels should be ranked using a system of scoring that evaluates each parcel based on a set of categories, or criteria).

The following is an example set of categories and weighted scoring that SWM has previously implemented for flood hazard mitigation:

- Benefit-cost ratio: A ratio less than 1.0 equals 60 points, between 1.0 and 1.5 equals 80 points, and greater than 1.5 equals 100 points.
- Is the house structure owner-occupied? A yes response equals 70 points.
- Is property a FEMA-classed repetitive loss house structure? A yes response equals 75 points.

- Is the house structure substantially damaged according to FEMA definitions? A yes response equals 95 points.
- Is the house structure in a floodway according to FEMA or County mapping? A yes response equals 90 points.
- What is the flooding risk/severity? Low equals 10 points, moderate equals 30 points, and high equals 50 points.
- Importance for maintaining continuity of the floodplain corridor: Low equals 10 points, moderate equals 20 points, and high equals 30 points.
- River erosion hazard potential/hazard to structures: Low equals 25 points, moderate equals 50 points, and high equals 75 points.

In the above example, points were assigned to each parcel and then the total scores were used to prioritize the parcels for acquisition.

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. In addition, existing federal, state, 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 (CWA) and Code of Federal Regulations, state water quality standards, Endangered Species Act (ESA), 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 White 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 (PCC Title 18E) and requirements to control erosion and sedimentation during land clearing, grading, construction, and in the long-term. As a National Pollutant Discharge Elimination System (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 conducting activities that alter water temperature.

9.2.7 Drainage and Flood Hazard Management

Chapter Six describes existing and future drainage and flood hazard problem areas throughout the White River Basin. The Basin Plan identifies projects and programs that will reduce flood hazards.

The Basin Plan contains a number of approaches to meet the goal of flood hazard reduction. Pierce County participates in the National Flood Insurance Program (NFIP) administered by FEMA. FEMA also offers communities the opportunity to receive additional benefits through the CRS. 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. This Basin Plan includes all the necessary program elements for the County to achieve a Class 4 or better rating.

Flood Hazards

According to the latest Flood Insurance Rate Maps (FIRMs), which have been revised but not adopted, approximately 14,700 acres (4.6 percent) of the White River Basin are located within the 100-Year Flood Zone, i.e., the area with a 1 percent annual chance of flooding (see Figure 4-1). Floodplain mapping shows that an additional 590 acres are located within the 500-Year Flood Zone (see Figure 4-1).

SWM maintains a system of flood control levees along the White River. Six potential levee setback sites were identified along the lower White River (GeoEngineers, 2007). Setting back existing levees, to sites farther away from the river provides an opportunity to increase the flood storage capacity of the river, potentially reducing downstream effects of flooding. Flooding problems and projects along this reach of the lower White River are covered by the *Pierce County Rivers Flood Hazard Management Plan,* and are not included in this Basin Plan.

Stormwater flooding is addressed through routine maintenance, response to citizen complaints, and, if necessary, capital improvement projects to provide increased conveyance capacity (e.g., culvert replacement) or enhanced detention storage. Local flooding problems in the White River Basin include minor roadway/driveway flooding. Two capital improvement projects have

been recommended to address local roadway flooding issues, which are described in Section 9.3.2.

Programmatic Measures for Flood Hazard Reduction

The Basin Plan supports programmatic measures that will reduce flood hazard impacts. These include the following programs:

- Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation
- BMP Manual for Pierce County Surface Water Management Maintenance Activities
- Beaver Management Policy.

Capital Improvement Projects Benefiting Flood Hazard Reduction

Two capital improvement projects have been proposed in the White River Basin to alleviate localized flooding problems through drainage improvements. Another capital improvement project involves the acquisition of 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. One condition of the permit required 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 Management Manual for Western Washington*. The new permit also required that the County regulations encourage 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. Pierce County's most recent *Stormwater Management and Site Development Manual* (SWM Manual, 2008b) was adopted in 2008 (Ordinance 2008-59S). It meets the 2007 permit requirements and includes LID design standards. The County may need to update its permit based on future NPDES permits. The next permit is to be issued in 2012. Therefore, this Basin Plan includes programmatic measures to regularly update the County stormwater management manual and implement LID.

Ecology has identified several water bodies within the White River Basin as "polluted," or not meeting state water quality criteria. The most common water quality problem is elevated water temperature, which is common for streams draining urban areas. Typical causes for higher temperatures in urban streams include loss of riparian shade, reduced summer baseflow, and heating of runoff as it flows across impervious surfaces and through detention ponds (Ecology, 2005). To address water quality problems, the Basin Plan prescribes a number of programmatic measures, including:

- Program to Enhance Degraded Riparian Habitat and Water Quality
- Education, Outreach, and Technical Assistance Program

- Lakes Water Quality Management Program
- Coordinate with Tacoma-Pierce County Health Department to Address Reported Onsite System Problems.

In addition to improving the water quality of polluted streams, the Basin Plan also recommends focusing on improving the water quality of Lake Tapps (see Section 7.3). Programmatic measures to address potential future Lake Tapps water quality problems consist of developing a water quality monitoring program (in coordination with the Cascade Water Alliance [Alliance]) as well as a pollutant source identification program.

Ecology completed a Total Maximum Daily Load (TMDL) Implementation Plan designed to reduce sediment and temperature in the Upper White River. SWM participated in the development of that plan and has committed to assist in its implementation.

9.2.9 Aquatic/Riparian Habitat Protection

The Lower White River mainstem has generally fair aquatic/riparian habitat, and restoration opportunities were identified. Several of the potential restoration sites are along the reach of the White River that will be covered by the *Pierce County Rivers Flood Hazard Management Plan*. To prevent further degradation of aquatic/riparian habitat, the Basin Plan recommends a capital improvement project to acquire property along the riparian corridor of a reach covered under the Basin Plan.

Aquatic/riparian problems identified on other water bodies in the planning area include channelization, low flow, invasive vegetation, potential nutrient loading, and sedimentation. These problems can be addressed using programmatic measures that benefit existing aquatic/riparian 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. Programmatic measures prescribed by the Basin Plan include:

- Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation
- Program to Enhance Degraded Riparian Habitat and Water Quality
- Habitat Monitoring Program
- Education, Outreach, and Technical Assistance Program.

9.3 SPECIFIC RECOMMENDATIONS

The capital improvement projects 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 percent of the total score),

water quality protection or improvement (30 percent), natural resource improvement (30 percent), and other factors such as multiple use, education, and recreation (5 percent). Appendix L contains a ranking sheet for each capital improvement project and programmatic measure.

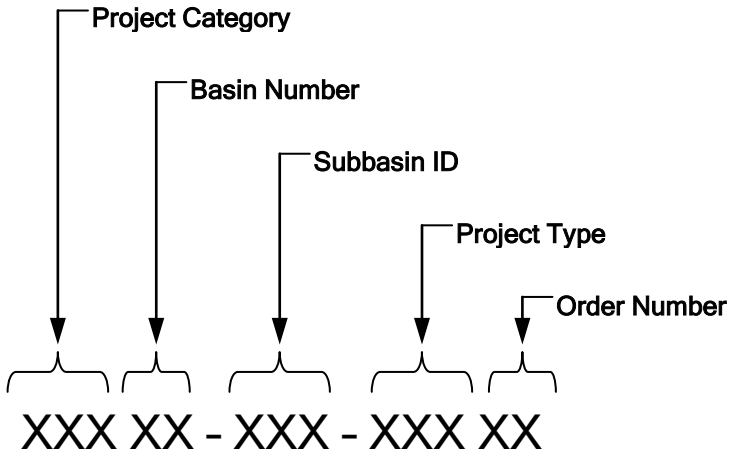
Recommended projects and programs were put in rank order, based on their numeric benefit score (project score). Then, High-, Medium-, or Low-Priority status was assigned as follows:

- High-Priority: 25 percent of total number of recommendations
- Medium-Priority: 50 percent of total number of recommendations
- Low-Priority[1]: 25 percent 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. Table 9-2, Table 9-3, and Table 9-4 present the recommended capital improvement projects and programmatic measures.

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 Improvement Program
PRG	Programmatic

1 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. "No-Priority" actions have already been excluded from this Basin Plan. "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.

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 White River Basin are as follows:

13 Mud Mountain
15 Lower White River
21 Upper White River

Subbasin ID: This is a three-letter abbreviation identifying the subbasin designated within the Basin Plan. This is used only for capital improvement projects and studies; it is omitted from programmatic recommendations. The abbreviations are defined as follows:

UWR Upper White River
MWR Middle White River
MMT Mud Mountain
LWR Lower White River
TAP Lake Tapps

Project Type: This is a one- or two-letter code indicating the general category of project that best describes the project activities. This is used only for capital improvement projects and studies; it is omitted from programmatic recommendations. The codes are defined as follows:

AC Property Acquisition
C Culvert

9.3.2 Capital Improvement Projects

The Basin Plan contains three capital improvement projects to address the flooding, water quality, and aquatic/riparian habitat problems in the White River Basin. Table 9-6 presents scoring, costs, and priorities for these capital improvement projects. Two projects are located within the Lower White River Basin (No. 15) and one project is located with the Upper White River Basin (No. 21). A spreadsheet summarizing the concept-level cost estimates for the projects is contained in Appendix K. The cost of CIP15-LWR-AC01 is the amount SWM has set aside for land acquisition in the basin.

Table 9-6
Capital Improvement Projects, Scoring, Costs, and Priorities

ID	Project Name	Project Score	Estimated Cost	Priority
CIP15-LWR-AC01	Acquire Property Adjacent to White River for Floodplain Preservation and Water Quality Protection	207	$2,000,000	Medium
CIP15-TAP-C01	185th Avenue East Drainage Improvements	68	$190,000	Low
CIP21-UWR-C01	Crystal River Ranch Estates Drainage Improvements	159	$429,700	Low
		Total estimated cost	**$2,619,700**	

Lower White River: County Basin No. 15

Project Number: CIP15-LWR-AC01

Project Name: Acquire Property Adjacent to White River for Floodplain Preservation and Water Quality Protection

Cost Estimate: $2,000,000

Project Score: 207

Problem: Sections of the lower White River, from the Lake Tapps diversion to its confluence with the Puyallup River, are on Ecology's 303(d) list for temperature, pH, and fecal coliform. Stream-survey observations resulted in ratings of "fair" for aquatic habitat and riparian corridor. Channel conveyance capacity downstream of Mud Mountain Dam is decreasing. Reduced capacity could increase flooding occurrences.

Solution: Purchase properties along the White River mainstem, within the 100-year floodplain, to preserve riparian function and maintain flood storage. Acquisitions should be focused between the Lake Tapps diversion and the county line; and priority should be given to improved properties that are the subject of repeated flooding or channel migration.

Benefit: This project will provide water quality benefits (problem LWR-02), aquatic/riparian habitat benefits (problems LWR-59, LWR-72, LWR-73), and maintain flood storage.

Project Number: CIP15-TAP-C01

Project Name: 185th Avenue E Drainage Improvements

Cost Estimate: $190,000

Project Score: 68

Problem: A residential questionnaire reported road flooding due to moderate rain events at the cul-de-sac near 4468 185th Avenue E. The cul-de-sac is relatively flat, and at the time of the site visit, water was ponded in the northeast corner. Two culverts were observed along the perimeter of the cul-de-sac. Both culverts are located under driveways; however, the downstream outlet could not be located for one of the culverts. This culvert may lead directly to the lake; however, the cul-de-sac's surface does not appear to slope toward this culvert. This culvert may also have capacity problems because it appeared to be one-half to three-fourths full of sediment at the time of the site visit.

Solution: A detailed field survey is recommended to verify sizes, slopes, and maintenance needs for the existing storm drainage infrastructure. In addition, the following drainage improvements are recommended:

- Remove vegetation and deposited sediments from the cobble swale along 185th Avenue E; the swale should be excavated and expanded as necessary to ensure a minimum bottom width of 1 foot, a minimum of 2:1 side slopes, and a minimum

channel depth of 18 inches (includes 6 inches of freeboard as required by the SWM Manual).

- Remove sediments and expose the culvert inlet at the 185th Avenue E cul-de-sac. Check the condition of the culvert, and verify that the culvert outlet is free from obstruction (the outlet could not be found during the site visit). For cost estimating purposes, it is assumed that the culvert must be replaced with 70 linear feet of new 12-inch storm drainage pipe.
- Install a Type 1 catch basin at the end of the new 12-inch storm drainage pipe to replace what would have been the old culvert outlet. This catch basin will help to capture runoff from the cul-de-sac.

Install an additional 120 linear feet of 12-inch tightline downstream from the new catch basin. This will reduce the potential for erosion caused by discharging concentrated runoff onto the steep slope near the lakeshore. Because the 120 feet of tightline will need to cross private properties, a drainage easement will need to be established.

Install an energy dissipater structure at the outfall to prevent shoreline erosion.

Re-grade and re-surface the cul-de-sac as necessary to divert runoff into the swale and catch basin along the northeast side of 185th Avenue E.

Benefit: This project alleviates roadway flooding for problem TAP-15.

Upper White River: County Basin No. 21

Project Number: CIP21-UWR-C01

Project Name: Crystal River Ranch Estates Drainage Improvements

Cost Estimate: $429,700

Project Score: 159

Problem: Both Mountain Side Drive and the abutting private property to the east of Mountain Side Drive have been flooded during high flows. The flooding is due to insufficient capacity in the driveway culverts on the west side of Mountain Side Drive East. The drainage area is comprised of approximately 150 acres of steep slopes to the west of Mountain Side Drive East. There are no cross drain culverts and the driveway culverts are undersized. The drainage continues downstream under Alpine Drive East and Birch Way East toward the White River. The existing driveway culverts are not fish passable.

Solution: Install 18-20 culverts as a single project. Prior to project implementation, flow calculations should be performed to determine the exact number and size of the culverts needed. The culverts will provide the necessary conveyance capacity while maintaining the current elevations of the existing driveways. The new culverts will allow for fish passage.

Benefit: This project eliminates the flooding on Mountain Side Drive East and abutting private properties, while allowing for fish passage (problem UWR-06). It will also reduce the amount

of maintenance needed to keep the culverts clear of debris.

9.3.3 Programmatic Measures

The Basin Plan contains 18 programmatic measures to address the flooding, water quality, and aquatic/riparian habitat problems in the White River Basin. This section presents programmatic measures grouped by countywide measures, then by basin-wide measures. Each programmatic measure is listed in Table 9-7 along with the program score, estimated cost, and priority ranking. The costs for ongoing programmatic activities (such as an education and outreach program) are estimated over a 10-year period. The cost estimates do not account for inflation.

Table 9-7
Programmatic Measures, Scoring, Costs, and Priorities

Basin	Measure Number	Description of Program	Score	Estimated Cost	Priority
Countywide	PRG00-01	Low Impact Development Program	277	$116,000	Medium
Countywide	PRG00-02	Update Stormwater Management Manual	385	$2,000	High
Countywide	PRG00-03	Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit	380	$310,000	High
Countywide	PRG00-04	Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation	367	$14,000	High
Countywide	PRG00-05	Program to Enhance Degraded Riparian Habitat and Water Quality	309	$169,000	Medium
Countywide	PRG00-06	Education, Outreach, and Technical Assistance Program	402	$52,000	High
Countywide	PRG00-07	Surface Water Monitoring Program	235	$240,000	Medium
Countywide	PRG00-08	BMP Manual for Pierce County Surface Water Management Maintenance Activities	401	$11,000	High
Countywide	PRG00-09	Invasive Species Management Program	338	$11,000	Medium
Countywide	PRG00-10	Beaver Management Policy	174	$700	Low
Countywide	PRG00-11	Enhance Cooperation with Cities and Other Agencies	211	$90,000	Medium
Countywide	PRG00-12	Lakes Water Quality Management Program	335	$1,280,000	Medium
Countywide	PRG00-13	Habitat Monitoring Program	203	$12,000	Low
Countywide	PRG00-14	Vegetation Management Program	343	$209,000	Medium
Lower White River	PRG15-01	Coordinate with the Cascade Water Alliance to Develop a Lake Tapps Water Quality Monitoring Plan	204	$448,000	Low
Lower White River, Mud Mountain	PRG15-02	Lake Tapps Pollutant Source Identification and Monitoring Program	238	$359,200	Medium

Table 9-7
Programmatic Measures, Scoring, Costs, and Priorities

Basin	Measure Number	Description of Program	Score	Estimated Cost	Priority
Lower White River, Mud Mountain, and Upper White River	PRG15-03	Coordinate with Tacoma-Pierce County Health Department to Address Reported Onsite Sewer System Problems	206	$116,000	Low
Lower White River, Mud Mountain, and Upper White River	PRG15-04	Enhance Puyallup River Watershed Council's Capacity	285	$93,750	Medium
Total estimated cost for all programmatic measures				**$3,533,650**	

Project Number: PRG00-01

Project Name: Low-Impact Development Program

Cost Estimate: $116,000 ($11,600 annually over 10 years)

Cost Assumption: Assumes 0.1 FTE per year in White River Basin

Project Score: 277

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 White River planning area, LID efforts should focus on the Lake Tapps lakeshore and Greenwater areas because: (1) much of the new development and redevelopment 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: $2,000

Cost Assumption: Includes 0.25 FTE as a one-time, 1-year cost. Prorated for the White River Basin share of the countywide cost (4.6 percent).

Project Score: 385

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 has updated its stormwater management manual; however, the County may need additional updates to the manual to maintain compliance with future NPDES permits. The next version of the NPDES permit is due to be issued in 2012.

Project Number: PRG00-03

Project Name: Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit

Cost Estimate: $310,000

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 White River Basin's share of the countywide cost (4.6 percent).

Project Score: 380

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, and enforcement actions would be taken when necessary.

Project Number: PRG00-04

Project Name: Land Management Program for Flood Hazard Reduction, Water Quality, and Habitat Impact Mitigation

Cost Estimate: $14,000

Cost Assumption: Includes 0.5 FTE for 1 year to develop the inventory countywide and establish the policies and procedures for acquisition and management. Also, 0.25 FTE per year for 9 years to pursue purchases and oversee property management. Prorated for the White River Basin share of the countywide cost (4.6 percent). The estimate does not include costs to purchase the properties. Property acquisition is included in the capital improvement projects recommended in this basin plan. Therefore, land acquisition costs are included in the capital improvement project cost estimates.

Project Score: 367

SWM 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:** 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, local tribes, local land trusts, or other entities that have a stake in property acquisition sites or the overall program.
- **Acquisition:** 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 as part of this element.
- **Management:** Manage 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 Pierce Conservation District (PCD) or local land trusts, on managing certain parcels where appropriate.

Project Number: PRG00-05

Project Name: Program to Enhance Degraded Riparian Habitat and Water Quality

Cost Estimate: $169,000

Cost Assumption: Includes 1 FTE per year to establish and run the program (costs estimated for a 10-year period). Prorated for the White River Basin share of the countywide cost (4.6 percent). The estimate does not include cost for site restoration projects.

Project Score: 309

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 SWM. Soft-bank engineering techniques, such as those contained in the Washington Department of Fish and Wildlife (WDFW)'s Integrated Streambank Protection Guidelines, should be developed and enhanced (WDFW, 2002). Duties would include identifying potential projects, obtaining access, developing restoration plans, identifying resources to help in the restoration including 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 PCD, Puyallup River Watershed Council (PRWC), Puyallup Tribe of Indians, Muckleshoot Indian Tribe, Lake Tapps homeowners associations, and Pierce Stream Team to restore or enhance riparian and estuarine areas.

Project Number: PRG00-06

Project Name: Education, Outreach, and Technical Assistance program

Cost Estimate: $52,000

Cost Assumption: Includes 0.25 FTE per year over a 10-year life-cycle cost. Prorated for the White River Basin share of the countywide cost (4.6 percent).

Project Score: 401

SWM 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, and nutrients; or issues such as flooding, lawn and garden chemicals, native plant landscaping, lake management, all-terrain vehicle (ATV) use, coastal bluff erosion, stormwater management, small-farm management, and potential climate-change impacts on water resources. Generally, increasing public awareness of best management practices (BMPs) for 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. Preferred methods will be selected 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 PCD and PRWC. Pierce County may offer financial support and assistance to other programs that support the goals and objectives of the Basin Plan. Additional incentives might be provided in the form of free native plants, discounts at

local stores, free workshops, or tax breaks. Pierce County may identify certain staff members to serve as outreach coordinators for specific stream reaches.

- **Coordination:** To efficiently communicate SWM messages, the Education, Outreach, and Technical Assistance Program will include a coordination element with other agencies, groups, or jurisdictions (e.g., Cities of Auburn, Sumner, Bonney Lake, and Buckley, Puyallup Watershed River Council). Coordination efforts will include other education providers but also technical staff.

Project Number:	PRG00-07
Project Name:	Surface Water Monitoring Program
Cost Estimate:	$240,000
Cost Assumption:	Includes 3.75 FTE per year countywide plus a $106,000 life-cycle cost over 10 years. Prorated for the White River Basin share of the countywide cost (4.6 percent).
Project Score:	235

The Monitoring Program would include the following aspects:

- **Monitoring Components:** Monitoring would be performed as outlined in the *Countywide Water Quality Monitoring Plan* (CWQMP) (Pierce County, 2006b). This plan was developed to guide the types and locations 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 of 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., White River), 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 geographic information systems (GIS) 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 5 years, the County 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: BMP Manual for Pierce County Surface Water Management Maintenance Activities

Cost Estimate: $11,000

Cost Assumption: Includes one-time cost for 0.5 FTE plus $84,000 for a consultant contract to develop a BMP manual and an additional 0.1 FTE per year to support ongoing training sessions and updates; life-cycle costs over 10 years. Prorated for the White River Basin share of the countywide cost (4.6 percent).

Project Score: 401

SWM is developing a maintenance manual containing BMPs for maintenance and repair of Pierce County's stormwater management facilities. The BMP manual addresses stormwater conveyance, ponds, levees, and revetments maintenance and repair activities. The maintenance manual is patterned after the Regional Road Maintenance Guidelines and the SWM Manual.

The manual includes practices and techniques that protect water quality and aquatic habitat while preserving the flood control functions of the facilities. The manual provides standard operating procedures for work crews. It is designed to comply with Pierce County's Municipal Stormwater NPDES permit. However, the County may need to update the manual to maintain compliance with future NPDES permits. The next version of the NPDES permit is due to be issued in 2012.

Distribution of the BMP manual will be accompanied by training sessions on its applications. In the White River Basin, special attention would be paid to maintenance of the stormwater ditch system and culvert cleaning practices.

Project Number: PRG00-09

Project Name: Invasive Species Management Program

Cost Estimate: $11,000

Cost Assumption: Includes one-time cost for 0.5 FTE and $84,000 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. Life-cycle cost over 10 years then prorated for the White River Basin share of the countywide cost (4.6 percent).

Project Score: 338

SWM 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 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.

SWM will confer with other agencies, including the Noxious Weed Control Board, Ecology, WDFW, 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. SWM will survey its facilities and properties to identify the presence of invasive species and the extent to which they are impacting facilities. 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.

Project Number: PRG00-10

Project Name: Beaver Management Policy

Cost Estimate: $700

Cost Assumption: Assumed to be negligible.

Project Score: 174

Instances of roadway, tributary, and lake flooding in the County have been attributed to beaver dams. Beaver dams and their backwater effects have damaged to private property and public infrastructure.

There are two general types of beaver-related flooding issues in Pierce County. The first type is beaver dams at culverts that cause flooding problems on public roads. The second type is beaver activity on or near private property that results in property owners requesting technical assistance or information from Pierce County regarding management strategies.

Pierce County Public Works and Utilities 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, installation of dam discouragement devices, or other means.

Although this plan does not recommend that Pierce County SWM become involved in actively

managing beaver activity on private property, this plan does recommend a consistent approach to addressing these issues.

The standard operating procedure will be incorporated into the SWM maintenance manual and its overriding policy be established through its Land Management Program.

Project Number: PRG00-11

Project Name: Enhance Cooperation with Cities and Other Agencies

Cost Estimate: $90,000 ($9,000 annually over 10 years)

Cost Assumption: Includes 1.0 FTE per year (estimated over a 10-year period). Prorated for the White River Basin share of countywide cost (4.6 percent).

Project Score: 211

Pierce County has an established countywide surface water management program that emphasizes drainage basins. Basin planning is an effective way to identify and evaluate problems, analyze and select solutions, monitor their effectiveness, and inform and educate residents. The principal limitation of the program is that the SWM utility is for the unincorporated areas of Pierce County only. Most of its programs and services begin and end at the incorporated limits of cities, whereas flooding, water quality, and aquatic/riparian habitat problems do not conform to political boundaries. Although the primary statutory drivers for stormwater management are the same for incorporated and unincorporated Pierce County (i.e., federal CWA, in particular Sections 402, 404, 303[d], and 319); federal ESA; and federal NFIP, each jurisdiction develops and manages its own approach.

The Pierce County Storm Drainage and Surface Water Management Advisory Board (SWAB) recommended that SWM initiate cooperative arrangements for surface water management services with cities and other agencies countywide. Arrangements can be formal (such as interlocal agreements) or informal as long as they maintain the objectives of reducing flooding and protecting water quality and aquatic/riparian habitat.

This approach will foster cooperation between the County and other agencies to address watershed management issues. It will increase deliberative and informed discussions of the costs and benefits of various choices being considered. An increase in cooperative efforts will enhance the results of recommended projects and programs in this Basin Plan and lead to more efficient surface water management countywide.

Project Number: PRG00-12

Project Name: Lakes Water Quality Management Program

Cost Estimate: $1,280,000 ($128,000 annually)

Cost Assumption: Includes 5.0 FTE per year (estimated over a 10-year period) plus $2,210,000 per year capital costs, goods, and services countywide. Prorated for the White River Basin share of countywide cost (4.6

percent). These are Pierce County costs and do not include costs for TCPHD and the PCD.

Project Score: 335

SWM would work cooperatively with the Tacoma-Pierce County Health Department (TPCHD) and the PCD to implement a fully functional lake management program (described in detail in Appendix I). SWM would provide funds and staff to complete elements of the program, including monitoring, data management, education and outreach, community technical assistance, inter-agency coordination, phased implementation of the aquatic invasive-plant program, and enforcement.

The countywide cost estimates for lake management do not include planning-level cost estimates for specific Lake Tapps long-term monitoring and source identification recommendations (see PRG15-01 and PRG15-02).

Project Number: PRG00-13

Project Name: Habitat Monitoring Program

Cost Estimate: $12,000

Cost Assumption: Includes one-time cost for professional services to conduct study. Prorated for the White River Basin share of the countywide cost (4.6 percent).

Project Score: 203

SWM 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: PRG00-14

Project Name: Vegetation Management Program

Cost Estimate: $209,000

Cost Assumption: 1 FTE biologist and a 3 FTE crew plus equipment and supplies. Prorated for the White River Basin share of the countywide cost (4.6 percent).

Project Score: 343

A healthy riparian plant community is important to aquatic/riparian habitat and water quality. Some riparian areas in the White River Basin have been planted with native vegetation to restore and protect aquatic/riparian 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, the revegetated 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 in order to ensure the survival of the appropriate native vegetation.

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 revegetation sites in the basin. Maintenance would largely consist of replacement plantings to achieve desired densities and invasive weed control if needed.

Project Number: PRG15-01

Project Name: Coordinate with the Cascade Water Alliance on Developing a Lake Tapps Water Quality Monitoring Plan

Cost Estimate: $448,000

Cost Assumption: Includes 0.5 FTE for 1 year to develop the plan with the Alliance. Also, 0.25 FTE and $15,000 per year, for 9 years, as a placeholder for County monitoring activities identified in the plan.

Project Score: 204

The County will work with Cascade Water Alliance on the development of a Lake Tapps Water Quality Monitoring Plan (as described in Section 7.3.1 and Appendix J). SWM should be actively involved with what is occurring at Lake Tapps, as residents have expressed concerns over Lake Tapps water quality conditions. The public could be included in the monitoring plan efforts on a volunteer basis.

Lake Tapps was recently converted from hydropower and recreational uses to municipal water supply and recreational uses, resulting in lower flow rates through the lake. Initial monitoring data suggest that the lower flow rates have not degraded water quality in the lake. However, some people have expressed concern that lake water quality could decline over time due to the many on-site sewer systems and stormwater outfalls around the lake.

Project Number: PRG15-02

Project Name: Lake Tapps Pollutant Source Identification and Monitoring Program

Cost Estimate: $359,200

Cost Assumption: Assumes $84,700 for the first year and $30,500 per year for 9 years

Project Score: 238

Lake Tapps is an important aesthetic amenity for the more than 3,000 residents along its shores. It is also a very important recreational resource. From 1911 until 2004, the lake was used to generate electricity, which required diversions of up to 2,000 cubic feet per second from the White River. Hydropower operations ceased in 2004. Lake Tapps was recently purchased by Cascade Water Alliance as a future source of potable water. Flows through the lake will be lower than they were when the lake was used for hydropower.

Monitoring conducted in 2004–2007 (after hydropower operations had ceased) indicated that the water quality of the lake was sufficient to support the beneficial uses noted above. Nevertheless, some shoreline residents have expressed concern that lake water quality could decline in the future due to decreased flows through the lake. The Lake Tapps drainage area encompasses numerous stormwater outfalls, on-site sewer systems, landscaped areas, and other potential pollutant sources that could degrade water quality. Therefore, to help protect the lake's beneficial uses over the long term, a pollutant source and monitoring program should be implemented to enable the early detection and control of pollution sources that could degrade water quality.

The source-monitoring program should be designed to enable early detection and control of pollution sources that could degrade water quality in Lake Tapps, based on the recommendations in *Technical Information Memorandum (TIM) 9: Pollutant Source Identification and Monitoring Program* (Brown and Caldwell, 2008a), Appendix M. As noted in TIM 9, phosphorus and fecal bacteria are the key constituents of concern. The recommended source-monitoring program includes developing a remote sensing program, developing and executing a volunteer program, collecting and analyzing water quality samples. The program will include collaborating with PCD and other agencies, and coordinating with the in-lake monitoring program and TPCHD monitoring effort. The source-monitoring program should also be designed to complement the long-term water quality trend-monitoring program referenced in PRG15-01.

The source-monitoring program should also include an annual survey of the outfalls along the diversion channel from the White River to Lake Tapps, using the outfall inspection and indicator monitoring techniques described in TIM 9. However, due to access and safety considerations, the diversion channel survey should be performed by SWM rather than by volunteers.

Project Number:	PRG15-03
Project Name:	Coordinate with Tacoma-Pierce County Health Department to Address Reported On-site Sewer System Problems
Cost Estimate:	$116,000 ($11,600 annually over 10 years)
Cost Assumption:	Includes 0.1 FTE per year in White River Basin
Project Score:	206

Failures of on-site sewer treatment systems have occurred in the Basin. Failing on-site systems, especially in shoreline areas, could contribute bacteria and nutrients to lakes and streams. County staff should notify the TPCHD of reported on-site system problems in the basin planning area, so that TPCHD can take appropriate action (e.g., focused education, technical assistance).

Project Number: PRG15-04

Project Name: Enhance Puyallup River Watershed Council's Capacity

Cost Estimate: $93,750 ($9,375 annually over 10 years)

Cost Assumption: 37,500 annually over 10 years. Prorated for the White River Basin share of the cost (assumed 25 percent for each of the four Puyallup River basin plans).

Project Score: 285

SWM will provide support to the Puyallup River Watershed Council (PRWC). The PRWC was created in 1995 to implement the Lower and Upper Puyallup Watershed Action Plans. The Lower and Upper Puyallup Watershed Action Plans identify sources of nonpoint water pollution and recommend actions to reduce pollution from these sources. The PRWC develops recommendations for water quality and habitat problems identified after the plans were developed.

PRWC holds monthly forums and SWM is an active participant. The PRWC forums involve hundreds of volunteer citizens who are interested in annual watershed cleanup activities, guest speakers, basin field trips, and NPDES compliance activities. SWM uses the forums to participate in the development of the recommendations for addressing identified problems and advertise SWM events.

9.3.4 Recommendations for Additional Studies

The Basin Plan contains two studies to provide information needed to address current basin issues that cannot be resolved without additional data collection and analysis. Study results will provide valuable information for the next update of the Basin Plan and for implementation of recommended projects with an improved understanding of basin characteristics.

Each recommended study is listed in Table 9-8 along with the estimated cost. Studies were not ranked because the County's ranking criteria do not apply to studies.

Table 9-8
Studies and Costs

Study Number	Name	Estimated Cost
ST15-TAP-ST01	Lake Tapps Diversion Canal Stormwater Outfall Assessment	$50,000
ST15-TAP-ST02	White River Water Quality Assessment for Fecal Coliform, Temperature, pH, and In-stream Flow	$120,500
	Total estimated cost	$170,500

Note: Costs are for studies only and do not cover costs of projects that may result from the study.

Project Number: ST15-TAP-ST01

Project Name: Lake Tapps Diversion Canal Stormwater Outfall Assessment

Cost Estimate: $50,000

Problem: Lake Tapps receives water from the White River via an 8-mile diversion canal, which receives runoff from adjacent agricultural and residential areas. A limited source-tracking study conducted in 2005–2006 found elevated phosphorus, nitrogen, and fecal coliform bacteria at several locations along the canal. These pollutants could adversely affect water quality in Lake Tapps.

Recommendation: Conduct a study in cooperation with the Alliance to identify pollution sources and source-control needs for discharges to the diversion canal. The study should build on the data contained in *Lake Tapps Pollution Source Tracking Summary Report* (Brown and Caldwell, September 2006) and include the following:

- A review of 2005 outfall reconnaissance results
- Delineation of the drainage area for each outfall
- Dry weather inspections of key outfalls (and sampling if flow is present in outfall)
- Wet weather sampling of key outfalls
- Identification of likely pollutant sources based on monitoring results and land use data
- Identification of any problems that appear to fall under SWM jurisdiction
- Development of source control and/or treatment BMPs where needed.

Pollutant sources that fall outside of SWM's purview should be referred to the appropriate agency. For example, if a commercial agriculture operation is identified as a likely pollutant source, SWM would refer the problem to the PCD.

Benefit: This study would provide a better understanding of the source(s) of pollution that could enter Lake Tapps via the White River diversion canal, and support the development of source control and/or treatment BMPs to help protect water quality in the lake. This study helps assess water quality problem TAP-33.

Project Number: ST15-TAP-ST02

Project Name: White River Water Quality Assessment for Fecal Coliform, Temperature, pH, and In-stream Flow

Cost Estimate: $120,500

Problem: Sections of the Lower White River, between the Lake Tapps diversion dam near Buckley and its confluence with the Puyallup River, are on the state 303(d) list for fecal coliform bacteria, pH, and temperature. In addition, the state has designated some reaches as "impaired by a nonpollutant" due to low flows. The federal CWA requires that TMDLs be prepared to address water bodies and pollutants on the 303(d) list. After a TMDL is

established, TMDL compliance becomes mandatory for all NPDES permittees that discharge to the affected water bodies.

Recommendation: Flows in the White River bypass reach (between the Lake Tapps diversion dam and Lake Tapps discharge to the White River) have increased since 2004 due to the conversion of Lake Tapps from hydropower to other uses. The increased flow is expected to improve water quality in the bypass reach and potentially downstream to the mouth as well. If the listed reaches now meet water quality standards for fecal coliform, pH, and/or temperature, TMDLs may no longer be necessary.

SWM should conduct a study to determine if fecal coliform, pH, and/or temperature in the listed reaches now meet state water quality standards. The study must include at least as many observations as Ecology used for the 303(d) listings cited above. In addition, the study must be conducted in accordance with a Quality Assurance Project Plan consistent with Ecology guidelines. If the study results show that the listed reaches meet state standards for these parameters, SWM should petition Ecology to re-classify the reaches to Category 1 or 2. TMDLs are not required for Category 1 or 2 waters.

This study should include the evaluation of in-stream flows along selected reaches in the bypass reach. Two reaches are currently listed as Category 4C, Impaired by a Nonpollutant. Flow data are collected by gauges operated by Cascade Water Alliance. SWM should obtain flow data from the Alliance to assist in its evaluation of the bypass reach and the effect that the flow may have on the fecal coliform, pH, and/or temperature.

Benefit: If the study shows that TMDLs are no longer required, SWM's NPDES compliance costs will be reduced. In addition, SWM and Ecology will avoid the costs for completing the TMDL report and water quality implementation plan. This study helps assess water quality problem LWR-02.

9.4 IMPLEMENTATION

9.4.1 Capital Facilities Element of Pierce County Comprehensive Plan

The annually updated Capital Facilities Element of the Comprehensive Plan (PCC Title 19E) is the CIP for SWM. It describes the capital improvement projects over $100,000 that SWM intends to construct in a 6-year period. It also presents the non-capital (nonstructural) alternatives that can be used with capital improvement projects to help meet the level of service standard for storm drainage and surface water management facilities. SWM 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 SWM's annual budget.

9.4.2 Annual Budget for Pierce County Surface Water Management

The Pierce County budget each year authorizes the activities of SWM. 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 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-Priority category, followed by the first action in the Medium-Priority 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 an 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 aquatic/riparian habitat. Collectively and individually, these projects are aimed at protecting Pierce County's quality of life. Projects and programs in the Basin Plan will achieve the following goals:

- Afford resource protection as the community develops
- Preserve, enhance, or protect natural floodplain functions
- Balance structural and nonstructural 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 wanting to stay in Pierce County.

SWM will consider the following questions 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 ensure 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 of 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 PRWC can be instrumental in implementation of the Basin Plan. Representatives of environmental interest groups; tribes; business and economic development interests; 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 White 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 on-going 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.

9.5 PROBLEMS AND CAPITAL IMPROVEMENT PROJECTS CROSS-REFERENCE

Table 9-9
Problems and Capital Improvement Projects Cross-Reference

Recommended Action		Problems Addressed
Medium-Priority		
CIP15-LWR-AC01	Acquire Property Adjacent to White River for Floodplain Preservation and Water Quality Protection	LWR-02 (water quality) LWR-59, LWR-72, LWR-73 (habitat)
Low-Priority		
CIP15-TAP-C01	185th Avenue East Drainage Improvements	TAP-15 (flooding)
CIP 21-UWR-C01	Crystal River Ranch Drainage Improvements	UWR-06 (flooding)

CHAPTER TEN
Supplemental Environmental Impact Statement

FACT SHEET

FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

Title and Description of Proposed Title and Description of Proposed Action

White 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 White River Basin. The 1991 Plan has guided the identification, design, construction, and operation of surface water management facilities and the implementation of surface water programs throughout unincorporated Pierce County. The proposed White River Basin Plan (Basin Plan) would include basin-specific capital improvement projects, studies, and programs (activities) to solve flooding, water quality, habitat, and other surface water management problems within the unincorporated Pierce County portion of the White River Basin.

This Final Supplemental Environmental Impact Statement (FSEIS) evaluates two alternatives. The Proposed Action is the adoption and implementation of the Basin Plan. The Proposed Action would achieve the County's basin planning goals to reduce flood hazards, improve water quality, improve aquatic/riparian habitat, coordinate use of public resources responsibly, and influence the location and 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 White River Basin Plan FSEIS adds information to the previous Environmental Impact Statement issued for the 1991 Plan. New and additional information since 1991 includes changes to laws and policies, constructed stormwater facilities, revised existing conditions, new growth and land use patterns in Pierce County, and updated information on water quality, flooding, and aquatic/riparian habitat problems in the White River Basin.

Location of Proposal	The basin planning area is the unincorporated, non-federal portions of the White River watershed that are under Pierce County's jurisdiction, along with those areas that have influence on surface water within unincorporated Pierce County. The basin planning area excludes areas within incorporated towns and cities, most commercial timberlands, and federal lands.
Proponent and Lead Agency	Pierce County Department of Public Works and Utilities, Surface Water Management Division
Proponent Contact	Patricia Byers, Project Manager Pierce County Public Works and Utilities, Surface Water Management 2702 South 42nd Street, Suite 210 Tacoma, WA 98409-7322 253-798-6793
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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 Basin Plan as an update of the 1991 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, Washington State and National Environmental Policy Act review, and/or other approvals.
Authors and Principal Contributors	Patricia Byers, Roy Huberd, and Janine Redmond of the Pierce County Public Works and Utilities Department, Surface Water Management Division. Colleen O. Doten, Mike Milne, Tim Krause, Sharonne Park, and Ada Hamilton of Brown and Caldwell, Inc.

Date of DSEIS Issuance	June 6, 2012
End of DSEIS Comment Period	July 6, 2012
Public Meeting(s)	Pierce County held two public meetings to provide information about the proposed Basin Plan and to collect information on basin issues. The first meeting was held on January 12, 2005, at the North Tapps Middle School in Sumner. A second public meeting was held on September 25, 2007, at North Tapps Middle School. Prior to adoption of the Basin Plan, the Pierce County Council will schedule public hearings.
Date of FSEIS Issuance	September 26, 2012
Date of Final Action	Action by the Pierce County Council is anticipated in 2012.
Subsequent Environmental Review	Environmental review for future capital projects and programs will be performed when site and implementation alternatives are identified and designed. Future environmental review will precede issuance of applicable development permits or construction of individual projects.
Location of Proposed White River Basin Plan and FSEIS, and the Original EIS for the 1991 Plan	Pierce County Planning and Land Services 2401 South 35th Street Tacoma, WA 98409 253-798-7210 Pierce County Public Works and Utilities 2702 South 42nd Street, Suite 210 Tacoma, WA 98409-7322 253-798-7250 The FSEIS, Basin Plan, and other information regarding the Basin Plan are also available at the following Internet address: http://www.co.pierce.wa.us/pc/services/home/environ/water/ps/basinplans/bpmain.htm

Cost of FSEIS The Basin Plan and FSEIS may be purchased for the cost of printing at:

Pierce County Public Works and Utilities
2702 South 42nd Street, Suite 210
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10.1 SUMMARY

The Pierce County Department of Public Works and Utilities, Surface Water Management Division (SWM), proposes the adoption and implementation of the White River Basin Plan (Basin Plan). The Basin Plan would meet the goals for basin planning in Pierce County, and would be consistent with the recent laws and policies regarding water quality, surface water management, and natural habitat. If adopted, the Basin Plan would amend the County's *1991 Storm Drainage and Surface Water Management Plan* (1991 Plan) for the White River Basin within unincorporated Pierce County.

Pierce County has prepared this Final Supplemental Environmental Impact Statement (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 Plan, which was intended to provide a comprehensive, countywide 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 surface water 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 White River Basin was studied as a rural basin. The 1991 Plan identified stormwater and surface water management measures in response to the legal and policy requirements, land use and growth patterns, and surface water problems existing at that time. The 1991 Plan focused primarily on capital projects aimed at addressing flooding problems that existed in 1991. The programmatic recommendations tended to be broad and countywide, rather than basin- or study-area-specific.

Surface water management has increased in complexity since 1991. While the 1991 Plan emphasized flood protection, current laws and policies now consider flood hazards, water quality, fish and wildlife habitat, community concerns, and financial accountability. Current legal and policy requirements include the federal Stormwater National Pollutant Discharge Elimination System (NPDES); water quality standards under the Clean Water Act (CWA); Endangered Species Act (ESA) listings of Chinook salmon and steelhead and bull trout; the Washington Growth Management Act (GMA) mandates; and the 1995 *Pierce County Comprehensive Plan* (Comprehensive Plan). Since 1991, land use, growth patterns, and flooding conditions have changed in many areas of Pierce County.

To maintain consistency with these new requirements, Pierce County has updated the 1991 Plan through a series of basin plans. The basin plans are based on a comprehensive basin planning approach, which considers the multiple benefits of surface water management, environmentally sensitive practices, and financial

accountability. This Basin Plan identifies existing flooding, water quality, and aquatic/riparian habitat problems in the White River Basin, and recommends basin-specific capital improvement projects, studies, and programs to address the problems. The proposed Basin Plan also addresses changes in surface water policies and planning to meet the current requirements of the NPDES municipal stormwater permit, CWA, the ESA fish listings, and the GMA.

10.1.2 Goals and Objectives

Under SEPA, the alternatives are developed to meet the goals and objectives for Pierce County basin planning. The goals are described in detail in Chapter One, and are listed below:

- Reduce flood hazards
- Improve aquatic/riparian habitat
- Improve water quality
- Coordinate use of public resources responsibly
- Influence location and methods for new development.

The goals and objectives for the Basin Plan are based on guidance prepared by Pierce County in 2000. The goals and objectives also reflect the new legal and policy requirements for Pierce County surface water management, which have developed since the 1991 Plan was issued.

10.1.3 Alternatives

The White River Basin SEIS evaluates two alternatives. The Proposed Action is the adoption of the Basin Plan for surface water management of the White River Basin, for non-federal lands 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 would address surface water management in the unincorporated areas of the White River Basin including Lake Tapps and those areas that have influence on surface water within unincorporated Pierce County. Portions of the mainstem White River and its tributary, the Greenwater River, are covered by the *Pierce County Rivers Flood Hazard Management Plan*, and therefore are not included in this Basin Plan. Also, the Basin Plan does not cover areas that lie within incorporated towns and cities, commercial timberlands regulated by the Washington State Department of Natural Resources (DNR), King County, and federal lands. The White River Basin is shown in Figure 1-1.

The Basin Plan includes recommendations for basin-specific projects, studies, and programs to remedy existing surface water and aquatic/riparian habitat problems and

to prevent future water resource and habitat degradation. The projects and programs in the Basin Plan would achieve the County's goals for basin planning, and would be consistent with recent laws and policies regarding surface water management.

The Basin Plan has been prepared in accordance with the 2000 Pierce County document *Guidance for Basin Planning*. Citizens in the basin provided information to the County about the basin; and they commented on problems and recommendations at public meetings and other public outreach efforts.

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, surface water management planning, and public education programs in the White River Basin.

This proposed Basin Plan is a set of recommended solutions in the form of capital improvement projects, basin-specific programs and studies, and countywide programs that would address identified flooding, water quality, and aquatic/riparian habitat problems. Capital improvement projects are designed to deal with localized flooding, water quality, and/or aquatic/riparian habitat issues. Programmatic measures are basin-specific or countywide activities such as inspection, maintenance, monitoring, and educational programs.

The Basin Plan proposes 3 capital improvement projects, 18 programmatic measures, and 2 studies for the White River Basin. The proposed recommendations in the Basin Plan are described in detail in Chapter Nine. The types of projects, studies, and programs are summarized below:

- A capital improvement project to purchase undeveloped properties along the lower White River to preserve riparian function and maintain flood storage,
- A capital improvement project to improve drainage and alleviate roadway flooding for residences at 185th Avenue East,
- A capital improvement project to install culverts to eliminate flooding on Mountain Side Drive East and abutting private properties, and to allow for fish passage,
- A program to develop a Lake Tapps water quality monitoring plan in coordination with the Cascade Water Alliance (the Alliance),
- A program to identify pollutant sources at Lake Tapps,
- A program to address septic system problems in shoreline areas,
- A study to identify pollution sources that could enter Lake Tapps via the White River diversion canal,
- A study to determine if the lower White River meets state water quality standards,

- A program to develop and implement a Lake Water Quality Management Program,
- Programs to reduce stormwater runoff from future development, by implementing low-impact development (LID) techniques and by adopting the updated Stormwater Management Manual,
- A program for education, outreach, and technical assistance with landowners, residents, business owners, and community groups in the basin,
- Programs to increase inspection and maintenance activities for surface water management facilities,
- Programs for long term monitoring of surface water quality and of fish and wildlife habitat,
- A program to restore and enhance degraded riparian habitat and water quality,
- Programs to control invasive species and to restore native vegetation,
- A program for acquisition and management of properties for floodplain, water quality, and habitat protection, and
- Programs to enhance cooperation with cities and other agencies, and to enhance the capacity of the Puyallup River Watershed Council (PRWC).

Adoption of the No Action Alternative would mean that the proposed Basin Plan would not be adopted. Under the No Action Alternative, surface water would continue to be managed under the 1991 Plan and other current County programs. County efforts would continue to focus on serious drainage complaints rather than adopting a more proactive, comprehensive approach specific for the basin planning area. Few, if any, basin-specific projects and programs for surface water management would likely be proposed in the basin. Stormwater from existing and future development would be controlled by current Pierce County policies and regulations.

The No Action Alternative would not address many of the flooding, water quality, and aquatic/riparian habitat problems identified in the basin planning area. Adoption of the No Action Alternative would not achieve many of the County's updated goals for basin planning. Also, the No Action Alternative would be inconsistent with many of the new legal and policy requirements for Pierce County surface water management, which have developed since the 1991 Plan was issued.

10.1.4 SEPA Process and Public Involvement

SEPA, Chapter 43.21C Revised Code of Washington (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 classified as "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 the No Action Alternative. Since then, some of the information and legal requirements evaluated in the original 1991 EIS have changed. Updated information has been collected on flooding, water quality, and habitat problems in the White River Basin. New or additional information also includes land use changes and growth patterns in Pierce County that have occurred since 1991. The legal requirements and Pierce County goals and objectives for surface water planning also have changed since 1991.

Because of the new information collected since the 1991 Plan was issued, Pierce County has prepared this FSEIS for the proposed Basin Plan. The DSEIS under SEPA has been prepared to determine whether any new information or substantial changes in County programs since 1991 as presented in the basin plan could result in probable significant adverse environmental impacts per the Washington Administrative Code (WAC) 197-11-405(4).

This FSEIS compares the implementation of the Proposed Action, which is this Basin Plan, with the No Action Alternative. This FSEIS identifies new information on surface water problems and legal requirements in the 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 per WAC 197-11-704 and WAC 197-11-774 and Pierce County Code (PCC), Title 18D-Environmental. A nonproject analysis under SEPA provides a general discussion of potential environmental impacts, and considers other current regulations and policies. 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 per WAC 197-11-776.

If the Proposed Action is adopted, implementation of the Basin Plan would be phased. Pierce County would not implement a particular recommendation until it is included in a CIP or other approved program.

Future projects to implement the Basin Plan may require environmental review under SEPA, which would evaluate site-specific issues related to individual projects. In addition, future projects may require project-level federal, state, or local government approvals and permits. Individual projects could also require review under the National Environmental Policy Act (NEPA) if a project involves federal permits or approvals. Pierce County would complete environmental review under SEPA and NEPA and obtain required permits when future 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.

SWM incorporated considerable public information and public involvement in the development of the Basin Plan. Pierce County prepared citizen questionnaires, conducted a mail survey, held two public meetings, and contacted a variety of organizations and agencies. Public involvement is described in detail in Chapter Three of the Basin Plan.

Stakeholders are defined as those individuals and organizations with a "stake" or interest in the outcome of the basin planning process. Key stakeholders have included basin residents; local businesses; citizen and environmental groups; the Puyallup Tribe of Indians (PTI); the Muckleshoot Indian Tribe (MIT); the Alliance; towns and cities; and federal, state, and local agencies. Stakeholder involvement has been focused on addressing storm drainage, flooding, water quality, and aquatic/riparian habitat issues in the unincorporated Pierce County portions of the basin.

During the basin characterization phase, Pierce County held a public meeting to describe the basin planning process and to solicit information from interested parties. The meeting was held on January 12, 2005, at North Tapps Middle School, in Sumner, Washington. Additional briefings were held with the Lake Tapps Task Force, PTI, MIT, and public officials to describe the ongoing basin planning.

A second public meeting was held on September 25, 2007, at North Tapps Middle School to communicate to the community the results of the Phase I characterization report. Also, in September 2007, questionnaires were sent out to 2,400 property owners in the White River Basin planning area. Questionnaires were sent to all properties within 150 feet of Lake Tapps and all properties in Greenwater. The questions focused on land use, septic system use, use of pesticides and fertilizers, water quality, flooding, and habitat issues.

10.1.5 Comparison of Alternatives

Table 10-1 summarizes and compares probable significant adverse 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	• Basin-specific projects, studies, and programs would address identified water quality and flooding problems in portions of the White River, its tributaries, and Lake Tapps. The proposed Basin Plan would improve water quality and reduce flooding problems, at a higher level than the No Action Alternative would. • A basin-specific project would reduce localized flooding of residences, roadways, and other properties in the basin. • A capital improvement project to install culverts would eliminate or significantly reduce flooding along Mountain Side Drive East. • The Lower White River Property Acquisition CIP would purchase undeveloped property along the White River mainstem, which would maintain flood storage, preserve riparian function, and benefit water quality. • Lake Tapps water quality would be addressed by programs to monitor water quality, identify pollution sources, and reduce septic tank failures. • LID techniques and updated stormwater standards would reduce stormwater impacts	No	• Few basic-specific projects, studies, and programs to address water quality and flooding conditions, if any, would be proposed for the basin planning area. Any potential improvements to flooding and water quality would occur on a lower level compared to the Proposed Action. • Many of the flooding and water quality problems identified in the White River Basin would not be addressed. No Action may result in future degradation of water quality from new development, particularly around Lake Tapps. • Stormwater from existing and future development would be controlled by current policies and regulations. • There is a potential for short term impacts during construction of future projects, if any projects. Construction would include mitigation measures similar to the	The No Action Alternative would be inconsistent with the County's updated goals for basin planning to improve water quality and reduce flood hazards. The No Action Alternative would also be inconsistent 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?
	from existing and future development. • Several programs would increase inspection and maintenance activities, develop an acquisition and land management plan, establish monitoring programs, and implement public education and outreach on water resource problems and solutions. • There is a potential for short term impacts during construction of individual projects on or near 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.		Proposed Action.	

Table 10-1
Comparison of Alternatives

Element	Proposed Action Basin Plan	Probable Significant Adverse Environmental Impact?	No Action Alternative	Probable Significant Adverse Environmental Impact?
Fishery Resources	• The basin-specific projects, studies, and programs would address fishery and aquatic habitat problems identified in portions of the White River Basin. The Basin Plan would result in long term net improvements in fisheries and aquatic habitat in the basin, at a higher level than the No Action Alternative would. • A capital improvement project to install culverts along Mountain Side Drive East would allow for fish passage and improve aquatic habitat. Projects and programs to improve the water quality of the White River would benefit fishery resources. The Lower White River Property Acquisition CIP would benefit aquatic/riparian habitat. • Several programs and studies to monitor and assess water quality in Lake Tapps would improve aquatic habitat in the long term. • Several programs would address stormwater runoff and nonpoint pollution from existing and future development, which would result in long term improvements for fishery resources in the basin. • Aquatic/riparian habitat would be protected or enhanced by programs for	No	• Few basin-specific projects, studies, and programs, if any, would be proposed. Any improvements to fish and aquatic habitat would occur at 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.	The No Action Alternative would be inconsistent with many of the County's updated basin-planning goals to improve aquatic habitat and water quality. The No Action Alternative also would be inconsistent 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?
	land acquisition and management, habitat monitoring, public education, vegetation enhancement, and invasive species control • There is a potential for short term impacts during construction of individual projects, by temporarily impairing water quality. Capital improvement projects would include BMPs and mitigation measures to reduce construction impacts, and would obtain applicable permits and approvals.			
Plants and Animals	• The proposed projects, studies, and programs would address habitat problems in portions of the White River Basin, which would generally benefit plant and animal resources in the long term. The projects and programs would restore and protect plant and animal habitat, at a higher level than the No Action Alternative would. • Several programs would restore and protect riparian habitat. The Lower White River Property Acquisition CIP would purchase undeveloped property to benefit aquatic/riparian habitat. Monitoring programs would evaluate the effectiveness of improvements in the White River Basin. • Several programs would improve water quality in	No	• Few basin-specific projects and programs to improve habitat, if any, would be proposed for the White River Basin. Any improvements to plant and animal habitat would occur at a lower level compared to the Proposed Action. • The No Action Alternative would not address many of the habitat problems identified in the White River Basin. The No Action Alternative may result in continued degradation of plant and animal habitat in the long term. • Future projects, if any, could result in site-specific impacts,	The No Action Alternative would be inconsistent with the County's updated basin planning goals to improve habitat. The No Action Alternative also would be inconsistent 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?
	Lake Tapps and the White River, which would result in long term improvements for plant and animal resources. • Programs to control invasive plants and restore native vegetation would improve plant diversity and 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.		although future impacts would be relatively small. Similar to the Proposed Action, any future project would include BMPs and revegetation.	
Soil and Geology	• Projects and programs to restore riparian areas and control stormwater would reduce soil erosion in the long term, at a higher level than No Action. • Future projects could require excavation, filling, or grading activities. 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 BMPs, and stream banks would be stabilized and revegetated.	No	• Limited erosion control would occur at a lower level than the Proposed Action. • Future projects, if any, could result in excavation, grading, or filling. Similar to the 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

Table 10-1
Comparison of Alternatives

Element	Proposed Action Basin Plan	Probable Significant Adverse Environmental Impact?	No Action Alternative	Probable Significant Adverse Environmental Impact?
Land Use	• Basin Plan would be consistent with the Comprehensive Plan and its land use and surface water policies. • Basin-specific projects and programs would address identified flooding of residences and other land uses. • The Basin Plan would not induce new growth or development, and is not anticipated to change existing and planned land uses. • The Proposed Action would reduce development-related stormwater impacts, by accommodating planned growth better and providing required stormwater facilities. • 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.	No	• Few basin-specific projects and programs, if any, would address flooding of residences and other land uses. • The No Action Alternative would not change existing and planned land uses or induce growth. • Development-related stormwater impacts from planned growth would be addressed by current regulations, but at lower level than the Proposed Action. • Future projects, if any, would be consistent with land and shoreline regulations and policies, and would obtain all applicable permits.	No
Historic and Cultural Resources	• Future projects would be located and designed to avoid any identified historic or cultural resources. During future project review, Pierce County would conduct site surveys, evaluate potential impacts and mitigation, and coordinate with appropriate tribes and agencies. • Projects and programs to	No	• The location and design of future projects, if any, would be coordinated with appropriate officials, similar to Proposed Action. • There would be limited basin-specific erosion control and fishery restoration,	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?
	control stormwater, reduce erosion, and restore stream banks would be a benefit to streamside historic and cultural resources. • Basin-specific water quality and habitat projects and programs would protect and restore fisheries and other natural resources that are important cultural resources for the Puyallup and Muckleshoot Tribes. • If any archaeological or cultural resources were encountered during construction of future projects, the County would immediately consult with appropriate officials and tribes regarding appropriate measures.		which would provide a lower level of cultural benefits than the Proposed Action. • If any archaeological or cultural resources were discovered during construction activities, the County would immediately consult with appropriate officials and tribes regarding appropriate measures.	
Public Services and Utilities	• Projects and programs would not substantially increase the long term demand for public services and utilities. Implementation of the Basin Plan would affect the services provided by SWM, 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 flood-related services. • A basin-specific program would coordinate septic tank problems with the Tacoma-	No	• Future projects and programs, if any, would not require substantial new utilities or services. • Few projects and programs, 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?
	Pierce County Health Department (TPCHD).TPCHD would reduce discharges from failing septic systems into basin receiving waters, particularly Lake Tapps. • The projects, studies, and programs to improve water quality, habitat, and fisheries would benefit recreational areas as well. • Construction of future projects may temporarily affect roadways and driveways, and disrupt local services and utilities. Pierce County would coordinate mitigation measures with local service providers and utilities to maintain access and services during construction.			

10.2 ALTERNATIVES, INCLUDING THE PROPOSED ACTION

This section describes the FSEIS alternatives to achieve the goals for basin planning in Pierce County. The alternatives evaluated are the Proposed Action, which is the adoption of this Basin Plan (Basin Plan), and the No Action Alternative, which is the continued use of the 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 SWM, which is responsible for surface water management in unincorporated Pierce County. SWM plans, designs, builds, and maintains storm drainage and surface water management facilities. SWM also identifies nonstructural solutions to surface water problems, such as monitoring needs, enforcement, or services.

SWM prepares basin plans to identify and prioritize capital improvement projects and other County programs in individual drainage basins. Basin plans comprehensively address the flooding, water quality, and 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 SWM activities.

10.2.1 Introduction and Background

SWM has prepared the Basin Plan to comply with applicable regulatory and planning requirements, which have evolved over time. The original 1991 Plan and subsequent changes in requirements for basin planning are summarized below.

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 adopting Ordinance 87-205. Three years later, the County adopted the 1991 Plan, which was intended to provide a comprehensive program for surface water management 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. It 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 comprised 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 programs (nonstructural activities) to accomplish its goals for surface water management. The programs 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 CIP. The 1991 Plan did not identify any CIP projects within the White River Basin.

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 2 years of plan development. The four short term goals are as follows:

- Adopt the 1991 Plan,

- Establish a permanent Storm Drainage and Surface Water Management Utility,
- Provide a funding mechanism to implement the entire plan, and
- Implement all the nonstructural 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; and
- Coordinate with public and private sectors.

SWM has continued to pursue 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 goals in the 1991 Plan have been met.

Use of the 1991 Plan as Principal Focus of ClP Has Evolved

Pierce County has been using the 1991 Plan as the basis for its CIP proposals since 1991. Projects have been selected every year and adopted by the County Council as part of the County's 6-year Capital Facilities Plan. Other projects outside of 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, land use and growth patterns, and flooding problems existing at that time. Since 1991, flooding conditions in Pierce County have changed. Land use and growth patterns also have changed in some areas of the county, and the future growth estimates used to develop the 1991 CIP list are no longer valid.

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 surface water management in Pierce County are described in Chapter Two of the Basin Plan.

The 1991 Plan was developed before passage of Washington's GMA. The GMA directed Pierce County to prepare a comprehensive plan; establish urban growth areas (UGAs); and designate and protect "critical areas" such as flood hazard areas, fish and wildlife habitat, and wetlands. The GMA also requires planning documents, including basin plans, to be internally consistent with the policies and future land use map in a comprehensive plan. In response to the GMA requirements, the County prepared the Comprehensive Plan, which became effective in 1995 as PCC Title 19A. Land uses designations and policies under the Comprehensive Plan have changed development patterns in some areas of the County, and the future growth estimates used to develop the 1991 Plan are no longer valid.

In 1995, jurisdictions with populations over 100,000, including Pierce County, were required by Ecology to create stormwater management programs under the federal CWA's NPDES program. In response to the NPDES requirements, Pierce County adopted its Stormwater Management Program (SWMP) in 1998. Pierce County obtained its Phase I Municipal Stormwater NPDES Permit in July 1995, and then a reissued Phase I NPDES Permit in January 2007. Ecology modified the permit in June 2009 to implement outcomes of appeals.

The federal ESA directs the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) to promulgate a list of endangered and threatened fisheries and to designate critical habitat for these species. In Pierce County waters, Chinook salmon and bull trout were listed as threatened in 1999, steelhead trout were listed as threatened in 2007, and Coho salmon were listed as a "species of concern" in 2004. The basin planning area also includes sockeye, chum, and pink salmon and cutthroat trout, none of which are currently considered to be at risk by NMFS.

The requirement to maintain consistency with these current laws and policies has led SWM 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 applicable laws, regulations, and policies enacted since the 1991 Plan, including the GMA, status under the federal Community Rating System (CRS) for flood hazard reduction, NPDES municipal stormwater permit, total maximum daily load (TMDL) requirements for water quality under the federal CWA, fish listings under the ESA, and the Comprehensive Plan.

This proposed Basin Plan is one of 10 basin plans being developed by SWM. Basin plans describe flooding, water quality, and habitat problems; forecast future hydrological conditions; identify existing and potential problems; and evaluate alternative solutions based on technical, environmental, and cost considerations. SWM employs a comprehensive basin planning approach, which is based on the multiple benefits of surface water management with environmentally sensitive practices. The basin plans ensure the financial accountability of SWM by directing expenditures collected within individual basins to the surface water management priorities in those basins.

10.2.2 Goals and Objectives

Under SEPA, the alternatives are developed to meet goals and objectives for basin planning in Pierce County. The goals and objectives for basin planning have changed since the 1991 Plan was issued, because of the new legal and policy requirements for surface water management that have been identified in the previous section. The development of the goals and objectives for basin planning in Pierce County is described in Chapter One.

The goals and objectives for the Basin Plan are provided in Table 10-2. These goals and objectives form the basic criteria for the selection and prioritization of the actions recommended in the Basin Plan. Goals refer to the desired outcomes of implementing a basin plan, while objectives describe measureable indicators.

Table 10-2
Goals and Objectives of the White River Basin Plan

Goal	Objectives
Reduce flood hazards	• Incidents of property loss and repeat damage are reduced • Streams will not be adversely impacted by flood events • Pierce County's standing under the Federal Emergency Management Agency (FEMA)'s CRS is improved • New development is located outside flood-prone areas
Improve aquatic and riparian habitat	• Number of stream miles available for wild, native fish populations is increased • Population numbers of species listed as endangered or threatened under the federal ESA are maintained or increased • Quality and quantity of available wetland, riparian, and upland habitat is improved
Improve water quality	• State Surface Water Quality Standards (WAC 173-201a) are met or exceeded • Number of impaired water bodies (as listed in Section 303[d] of the CWA) is reduced • The terms and commitments in Pierce County's NPDES permit for stormwater are in compliance • Risk of groundwater contamination is reduced • Rates of erosion are reduced
Coordinate use of public resources responsibly	• Cost of maintaining stormwater facilities is reduced • Project value is favorable when measured against costs and benefits • Polls demonstrate that public awareness of flooding, habitat, and water quality issues has increased • Monitoring and enforcement programs demonstrate an increase in services per dollar spent • Basin plan implementation also implements elements of other Pierce County plans
Influence location and methods for new development	• New development in flood-prone, riparian, or significant habitat areas is prohibited • LID techniques are widely used • Effective BMPs are identified and widely used

Source: *Guidance for Basin Planning, Pierce County Water Programs*, Pierce County Public Works & Utilities, Water Programs; Pierce County Storm Drainage and Surface Water Management Advisory Board, June 2000.

10.2.3 Proposed Action: White River Basin Plan

The Proposed Action is the adoption of this Basin Plan. The proposed Basin Plan would address surface water management of the White River Basin and its tributaries including Lake Tapps, for non-federal lands within unincorporated Pierce County. The Basin Plan includes recommendations for basin-wide capital projects, studies, and programs to remedy identified problems and to prevent future degradation of water quality and

habitat. The projects and programs in the Basin Plan would achieve the County's updated goals 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 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, surface water management planning, and public education programs in the basin.

The Basin Plan has been prepared in accordance with *Guidance for Basin Planning*, which was issued by Pierce County in 2000. This guidance document lists the tasks for the preparation of a basin plan and the directions for completing the tasks.

Citizens in the basin planning area were provided information about the basin; and they commented on problems and solutions in questionnaires, public meetings, and other public outreach efforts (see Chapter Three). Their concerns regarding flooding, drainage, habitat, and water quality issues have been evaluated within the Basin Plan.

The Basin Plan planning area includes unincorporated areas of the White River Basin including Lake Tapps and those areas that have influence on surface water within unincorporated Pierce County. Portions of the mainstem White River and its tributary Greenwater River are covered by the *Pierce County Rivers Flood Hazard Management Plan*, and therefore are not included in this Basin Plan. The Basin Plan does not include areas within incorporated towns and cities, most commercial timberlands regulated by the state DNR, King County, and federal lands. The White River Basin is shown in Figure 1-1.

This proposed Basin Plan is a set of recommended solutions in the form of capital improvement projects, basin-specific programs and studies, and countywide programs that would address identified flooding, water quality, and habitat problems. The Basin Plan proposes 3 capital improvement projects, 18 programmatic measures, and 2 studies for the White River Basin. The proposed recommendations in the Basin Plan are described in detail in Chapter Nine.

The Basin Plan contains capital improvement projects that are designed to deal with basin-specific flooding, water quality, and aquatic/riparian habitat issues. The proposed capital improvement projects would include the following:

- Purchase undeveloped properties along the lower White River to preserve riparian function and maintain flood storage
- Improve drainage and alleviate roadway flooding for residences at 185th Avenue East.
- Install culverts to eliminate flooding on Mountain Side Drive East and abutting private properties, and to allow for fish passage.

The proposed Basin Plan includes programs and studies, which are nonstructural measures. The programs and studies specific to the White River Basin would include:

- A program to develop a Lake Tapps water quality monitoring plan in coordination with the Alliance,
- A program to identify pollutant sources at Lake Tapps,
- A program to address septic system problems in shoreline areas,
- A program to enhance the capacity of the PRWC,
- A study to identify pollution sources that could enter Lake Tapps via the White River diversion canal, and
- A study to determine if the lower White River meets state water quality standards.

The proposed Basin Plan also includes other programs that would be countywide but would benefit the White River Basin. The countywide programs would include:

- A program to develop and implement a Lake Water Quality Management Program;
- Programs to reduce stormwater runoff from future development, by implementing LID techniques and by adopting the updated Stormwater Management Manual;
- A program for education, outreach, and technical assistance with landowners, residents, business owners, and community groups in the basin;
- Programs to increase inspection and maintenance activities for surface water management facilities;
- Programs for long term monitoring of surface water quality and of fish and wildlife habitat;
- A program to restore and enhance degraded riparian habitat and water quality;
- Programs to control invasive species and to restore native vegetation;
- A program for acquisition and management of properties for floodplain, water quality, and habitat protection; and
- A program to enhance cooperation with cities and other agencies.

10.2.4 No Action Alternative

Adoption of the No Action Alternative would mean that the proposed Basin Plan would not be adopted. Under the No Action Alternative, surface water in portions of the White River, its tributaries, and Lake Tapps would continue to be managed under the 1991 Plan and other current County programs. Because the 1991 Plan does not include any projects for the basin planning area, future projects are not planned for the basin. County efforts would continue to focus on serious drainage complaints rather than adopting a more proactive, comprehensive approach specific to the White River Basin.

Capital projects, if any, would be selected based on the identification of problems as they arise. Few, if any, basin-wide projects and programs for surface water management would likely be proposed for the basin planning area. Stormwater from existing and future development would be managed by current Pierce County policies and regulations. Periodic maintenance of ditches, culverts, and other County drainage facilities by County crews would continue.

The No Action Alternative would not address many of the flooding, water quality, and aquatic/riparian habitat problems identified in the basin planning area. Adoption of the No Action Alternative would be inconsistent with many of the County's updated goals for basin planning in Table 10-2. The No Action Alternative also would be inconsistent with many of the new legal and policy requirements for Pierce County surface water management, 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 surface water management within basin	✓	
Countywide comprehensive surface water planning		✓
Focus on identified flooding, water quality, and aquatic/riparian habitat problems within basin	✓	
Basin-specific flooding projects	✓	
Basin-specific water quality projects	✓	
Basin-specific aquatic/riparian habitat projects	✓	
Annual capital facilities element	✓	✓
Countywide programs or nonstructural recommendations	✓	✓
Basin-specific programs or nonstructural recommendations	✓	
Meet updated goals and objectives for Pierce County basin planning	✓	

Table 10-3
Comparison of the Alternatives

Feature	Proposed Action (Basin Plan)	No Action Alternative
Consistent with current legal and policy requirements for surface water management	✓	
Basin-wide public education, outreach, and technical assistance	✓	

10.3 AFFECTED ENVIRONMENT, SIGNIFICANT IMPACTS, AND MITIGATION MEASURES

This Basin Plan focuses on the unincorporated, non-federal portions of the watershed that are under Pierce County's jurisdiction, along with those areas that have influence on surface water within unincorporated Pierce County. The Basin Plan does not cover areas within other jurisdictions such as incorporated cities, most commercial timberlands regulated by the state DNR, Mount Rainier National Park, and Mt. Baker-Snoqualmie National Forest. Portions of the mainstem White River and its tributary Greenwater River are covered by the *Pierce County Rivers Flood Hazard Management Plan*, and therefore are not included in this Basin Plan. The White River Basin is shown in Figure 1-1.

The White River Basin comprises the Upper White River, Lower White River, and Mud Mountain basins. Because most of the upper basin lies within national forest and park lands, the Basin Plan focuses primarily on the Lower White River including Lake Tapps and Mud Mountain basins.

To allow for more detailed analyses, the White River Basin has been subdivided into smaller subbasins based on existing topographic and hydrographic data. The 10 subbasins are shown in Figure 4-1 and are described in detail in Chapter Four.

10.3.1 Water Resources and Water Quality

This section describes the affected environment of the White River 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

Surface water hydrology, water quality, and flooding in the White River Basin are assessed in detail in Chapters Four through Seven of the Basin Plan. Water resources and water quality conditions and problems within the basin planning area have been identified from published data, questionnaires and interviews, and stream surveys.

Watershed

The White River Basin originates at the glacial headwaters of Mount Rainier, and drains into the Puyallup River near the city of Sumner. The White River Basin encompasses approximately 496 square miles of Pierce and King Counties. Approximately 75 percent of the basin is within Pierce County; the remainder is in King County.

Steep-walled valleys dominate drainage patterns in the eastern portion of the basin. In many places valley walls can rise more than 6,000 feet above the valley floor. Topography in the western half of the basin consists of low rolling hills and valleys formed during the last period of glaciations.

Major rivers and streams in the basin include the Greenwater River, White River, West Fork White River, Clearwater River, and Huckleberry Creek. The dominant water bodies are the Mud Mountain Reservoir during periods of flood control and Lake Tapps. The characteristics of the streams in the individual subbasins are described in detail in Chapter Four.

Mud Mountain Dam, located on the White River east of Buckley, provides flood control for the lower White and Puyallup River valleys. As a single-purpose flood-control dam, it passes all inflow, except during times of flood or maintenance, and does not store water during low flow periods. Mud Mountain Dam is operated by the U.S. Army Corps of Engineers (Corps), and its operation is outside the scope of Pierce County basin planning.

Lake Tapps is the largest surface water body in the basin. Lake Tapps has approximately 46 miles of shoreline, with many shallow embayments. Lake Tapps was built to create storage for the White River hydroelectric project. Lake Tapps is filled mostly by a diversion dam on the White River. The 21-mile stretch of White River between the diversion dam and the return canal is referred to as the bypass reach or the reservation reach.

Residential land uses dominate the shorelines and islands of Lake Tapps, and more than 3,000 houses are located near the lake. Many of the shoreline residences have private docks. Lake Tapps is used heavily for boating, water skiing, swimming, fishing, and other recreational activities. Public parks and boat ramps allow general public access to the lake.

Drainage and Flooding

Flooding in the White River Basin is a natural phenomenon that has been mitigated by means of engineered structures such as dams and levees, and in some cases exacerbated by development and the increase in impervious surfaces. Existing and future flooding problems in the White River Basin are analyzed in Chapters Five and Six.

The White River Basin includes man-made structures to control or limit flooding. The Mud Mountain Dam is the primary flood-control structure on the White River. While the Mud Mountain Dam provides flood control for the lower White and Puyallup River

valleys, several downstream locations have been identified as threatened by higher discharges from the Mud Mountain Dam.

Other major engineered structures are the existing levees. SWM maintains a system of flood-control levees along the White River. According to the 2005 CIP prepared by SWM, 6 percent or 1,840 of 29,209 linear feet of the White River levee system is currently "adequate." Adequate means that it provides 100-year protection.

The existing levees and revetments are located on both sides of the White River, from its mouth to where it crosses the Pierce/King County line northwest of Lake Tapps. The levees and revetments originally were built to provide flood protection and bank protection, respectively, for public infrastructure and residents along the White River. These levees are located in the reach of the river that will be included in the *Pierce County Rivers Flood Hazard Management Plan*. These levees and revetments are outside the scope of this Basin Plan.

Portions of the White River Basin have been subject to flooding along rivers and streams. The Federal Emergency Management Agency (FEMA) has produced flood insurance rate maps (FIRMs) for many areas in the basin, which delineate the 100-year and 500-year floodplains. Table 4-9 shows the acreage in each subbasin of the White River Basin that falls within the 100-year and 500-year floodplains.

The natural drainage system of the White River Basin has been modified substantially as a result of development. Some of the natural drainage ways, tributaries to the White River, have been straightened or enlarged to accommodate development. Development has resulted in a network of stormwater pipes, ditches, detention facilities, and infiltration facilities intended to deal with the changed hydrologic regime created by the development. Culverts and bridges also have been constructed throughout the basin at driveway, road, highway, and railroad crossings.

Stormwater flooding refers to the flooding resulting from changes in land use and modifications to the natural drainage systems. Culverts and ditches along several tributaries have resulted in loss of associated wetlands and their capacity to temporarily store stormwater runoff. Changes in land use have increased the amount of impervious surfaces, which can exacerbate runoff. Figure 4-6 shows the areas in the White River Basin with the greatest potential to experience stormwater flooding due to changes in impervious surface.

Localized flooding can occur when drainage facilities are blocked temporarily or are undersized. Localized flooding within the basin planning area has been reported by residents and observed in field investigations. Respondents to a County questionnaire reported local road flooding at 13 locations in the basin planning area.

Flooding problems may be exacerbated, and new problems may emerge, as future development occurs in the White River Basin. The analyses of flooding problems and recommendations are described in Chapter Six.

Water Quality

The federal CWA requires Washington to periodically prepare a list of all surface waters in the state for which beneficial uses (such as drinking, recreation, aquatic habitat, and industrial use) are impaired by pollutants. This list is called the 303(d) list. For each listed water body that cannot meet the water quality standards through technology-based controls, Ecology must develop a Total Maximum Daily Load (TMDL). The TMDL is the maximum amount of the pollutant that can be discharged into the water body without violating the State standard. The 303(d) listings and TMDLs for the White River Basin are described in Section 2.1.1 and are summarized in Table 7-1.

Sections of the lower White River are on Ecology's 303(d) list for temperature, pH, and fecal coliform bacteria. In addition, Ecology has designated some reaches as "impaired by a nonpollutant" because of low flows. Flows in the lower White River have increased since 2004 as the result of converting Lake Tapps from hydropower to other uses. The increased flow is expected to improve water quality, and the TMDLs might no longer be necessary.

Upper tributaries of the White River have an Ecology-approved TMDL implementation plan for sediment and temperature. Both temperature and sediment have exceeded state water quality standards, which could affect salmon spawning and rearing. Most of the measures in the implementing plan are for the U.S. Forest Service (USFS).

Lake Tapps has generally good water quality, based on recent monitoring data (Section 4.7). Nitrogen-to-phosphorus ratios indicated that phosphorus is the primary nutrient limiting algal growth in the lake. The total phosphorus and chlorophyll-a values were relatively low, indicating that eutrophication is not currently a problem despite the shallow depths and reduced water circulation in the embayments. Fecal coliform bacteria concentrations also were generally low, even in the embayments with numerous shoreline septic systems.

Lake Tapps recently was converted from hydropower to municipal water supply, which has resulted in lower flow rates through the lake. The future water quality of Lake Tapps could be affected by this change in operation by the Alliance (Section 4.7). Initial monitoring data suggest that the lower flow rates have not degraded water quality in the lake, while stakeholders have expressed concern about future degradation.

Total phosphorus and fecal coliform concentrations in the embayments were relatively low, which suggests that septic systems and stormwater discharges currently are not major sources of phosphorus or bacteria. Septic systems and stormwater discharges from additional development, however, could affect lake water quality in the future.

More than 2,000 septic systems exist around Lake Tapps. Septic system effluent typically contains high concentrations of phosphorus and bacteria. Lack of maintenance can lead to inadequate treatment. Septic system drain fields tend to clog over time, which can result in surface failures and allow inadequately, treated effluent to flow overland into the lake, with little contaminant removal en route. In general, the risk of

failures is greater for older septic systems. Septic systems also can contribute phosphorus to the lake via groundwater.

The main source of phosphorus entering Lake Tapps currently appears to be the White River diversion canal. Lake Tapps receives water from the White River via an 8-mile diversion canal, which receives runoff from adjacent agricultural and residential areas. A 2005–2006 study of the canal found elevated phosphorus, nitrogen, and fecal coliform bacteria, which could adversely affect the water quality in Lake Tapps.

Significant Impacts and Mitigation Measures

Proposed Action (Basin Plan)

The Proposed Action recommends a series of capital improvement projects, studies, and programs to address water resource and water quality problems identified in portions of the White River, its tributaries, and Lake Tapps. These can be found in Chapter Nine. The proposed Basin Plan is anticipated to result in long term, net improvements in water quality and flooding for the basin, at a higher level than the No Action Alternative would. Improved water quality also would result in positive benefits for fishery resources, plant and animal habitat, scenery, and recreation. The Basin Plan includes measures to reduce localized flooding of residences, roadways, and other properties in the basin. The 185th Avenue East Drainage Improvements CIP would alleviate roadway flooding at a residential cul-de-sac. The White River Drainage Problem Investigation would identify flooding problems and develop recommendations for basin locations identified in responses to County questionnaires. The Lower White River Property Acquisition CIP would purchase undeveloped property to maintain flood storage. The Basin Plan would install culverts to reduce localized flooding of roadways and adjacent properties. Both Mountain Side Drive East and abutting private property to the east have been flooded during high flows. The flooding results from insufficient conveyance capacity in the driveway culverts on the west side of Mountain Side Drive East. A CIP would install 18-20 culverts along Mountain Side Drive East. This proposed CIP would eliminate flooding on Mountain Side Drive East and abutting private properties, while allowing for fish passage

Several countywide programs also would address flooding and drainage problems. Pierce County would develop a land acquisition and management program to reduce flood hazards. Countywide programs would increase inspection and maintenance of existing and future surface water facilities under Pierce County jurisdiction. Development and implementation of a Best Management Practice (BMP) Manual for Pierce County maintenance activities would preserve flood control functions of County stormwater management facilities and levees.

Several basin-specific projects, programs, and studies would improve water quality in the White River Basin. The Lower White River Property Acquisition CIP would purchase undeveloped property along the White River mainstem. This CIP would maintain flood storage and preserve riparian function, which would benefit water quality and habitat.

Another study would assess the lower White River for fecal coliform, temperature, pH, and in-stream flow. This study would determine if water quality in the lower White River currently meets state standards, and whether TMDLs would still be required.

The Basin Plan includes several programs and studies to improve water quality in Lake Tapps. One program would develop a Lake Tapps water quality monitoring program, in coordination with the Alliance. This program would monitor future water quality trends, which could occur in response to lower flow rates from operating the lake for water supply rather than hydropower.

One study would identify pollutant sources that could enter Lake Tapps via the White River diversion canal, in coordination with the Alliance. This study would provide a better understanding of pollution source(s) in the diversion canal that could affect the water quality of Lake Tapps.

A basin-specific program would address septic tank problems, especially in shoreline areas. The program would reduce failures of septic tanks that are a source of nutrients and bacteria in lakes and streams. SWM would coordinate programs to address septic tank problems with the TPCHD.

Several countywide programs would address water quality in Lake Tapps and the White River. Pierce County would develop and implement a Lake Water Quality Management Program. One program would restore and enhance degraded riparian habitat and water quality, and another program would monitor surface water quality. A program to acquire and manage properties would protect the floodplain, water quality, and habitat.

Pierce County would implement an LID program to promote the use of LID in new development and redevelopment. Inspection and maintenance programs for stormwater facilities would improve treatment of runoff. Adopting the updated Stormwater Management Manual also would address stormwater problems. LID techniques and improved surface water treatment would reduce stormwater impacts from existing and future development.

Several basin-specific and countywide measures would provide education, outreach, and technical assistance with landowners, farmers, government agencies, and community groups in the White River Basin. These programs would increase public awareness of water quality and flooding issues in the basin and around Lake Tapps, and would encourage landowners to voluntarily implement water quality and riparian 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, 2003b).

Although the Basin Plan would improve the overall water resources and water quality in the White River Basin, future projects have the potential for site-specific adverse impacts, particularly those constructed within or adjacent to streams, lakes, and wetlands. The types of projects anticipated under the Basin Plan would result in relatively minor construction activity. Pierce County has developed the proposed Basin

Plan to emphasize nonstructural, programmatic measures rather than larger structural measures.

Construction sites are typically sources of elevated sediment loads during rainfall events. Site preparation and construction activities could result in short term impacts from erosion, which would temporarily degrade water quality. Measures to minimize construction-related impacts for individual projects would include temporary erosion and sediment control (TESC) measures and related BMPs. Standard erosion control measures such as silt fencing, coverage of exposed earth, and permanent seeding of disturbed areas following construction, would 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 ensure 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 (SMA) compliance, critical areas compliance, ESA assessment, NPDES compliance, water quality (Corps 404 Permit and Ecology 401 Certification), and Hydraulic Project Approval (HPA).

The Basin Plan would meet the County's updated goals for basin planning to improve water quality and reduce flood hazards (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 surface water management (see Section 10.3.8, Plans and Policies). The Basin Plan includes multiple projects and programs that would be consistent with the current requirements of the NPDES stormwater permit. 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.

Overall, the projects, studies, and programs under the proposed Basin Plan are expected to result in long term benefits to the flooding, drainage, erosion, and water quality conditions within portions of the White River, its tributaries, and Lake Tapps. The types of projects under the Basin Plan would require minimal construction and minor structures, which would not result in long term adverse impacts. All future projects would include site-specific mitigation, comply with all applicable regulations, and obtain necessary permits and approvals. No unavoidable significant adverse impacts or cumulative adverse impacts on water resources and water quality would occur under the Proposed Action.

No Action Alternative

Under the No Action Alternative, water resources and water quality in the Basin Plan would continue to be managed under the 1991 Plan and other current County programs. County efforts would continue to focus on serious drainage complaints rather than assuming a more proactive, comprehensive approach for the basin. Few future basin-specific projects and programs to improve water resources and water quality, if any, would likely be proposed for the basin. Stormwater from existing and future development would be controlled by current Pierce County policies and regulations. Periodic maintenance of ditches, culverts, and other County drainage facilities by County crews would continue. If any future projects were proposed, then short term impacts and mitigation measures during construction would be similar to those discussed under the Proposed Action.
The No Action Alternative would not address many of the flooding and water quality problems in the White River Basin. Many of the identified water quality and flooding problems in the basin planning area might continue. As future development occurs, water resource problems are expected to intensify. Adoption of the No Action Alternative may result in future continued degradation of water quality from new development, particularly around Lake Tapps.

The No Action Alternative also would be inconsistent with many of the County's updated basin-planning goals to improve water quality and reduce flood hazards (Table 10-2). The No Action Alternative would not be consistent with many of the new laws, regulations, programs, and policy requirements for surface water management in unincorporated Pierce County, which have developed since the 1991 Plan was issued (see Section 10.3.8, Plans and Policies). Compared to the proposed Basin Plan, the No Action Alternative would result in few long term benefits to the flooding, drainage, and water quality conditions within the White River Basin.

10.3.2 Fishery Resources

This section summarizes the existing fisheries resources and habitat conditions of the White River Basin, and evaluates potential impacts on fisheries 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. Other species and habitats are evaluated in Section 10.3.3, Plants and Animals.

Affected Environment

Fisheries and Aquatic Habitat

Fishery habitat conditions and problems within the basin planning area have been identified from published data, questionnaires and interviews, and stream surveys. The existing fisheries resources and habitat conditions for the White River Basin are described in detail in Section 4.6. The overall aquatic and riparian conditions of the White River mainstem and tributaries are summarized in Tables 4-10 to 4-15, with details of the reach characterizations given in Appendix F.

The White River contains anadromous runs of steelhead and coastal cutthroat trout; fall- and spring-run Chinook, Coho, chum, and pink salmon; and a small run of riverine sockeye salmon. Resident coastal cutthroat trout and bull trout also are present, and sea-run bull trout may occur in the system. Fall-run Chinook, chum, and pink salmon spawning occurs primarily below the diversion dam, while steelhead trout and spring-run Chinook salmon primarily spawn above Mud Mountain Dam. Coho salmon and coastal cutthroat trout spawn and rear primarily in tributary streams throughout the basin. Bull trout spawning occurs only in snowmelt-fed tributaries in the upper White River Basin above Mud Mountain Dam.

Human activity has degraded fish, wildlife, and plant habitat in many reaches of the White River and its tributaries. Major aquatic habitat alterations include loss of in-stream cover and woody debris, channelization and other direct modifications, reduced riparian vegetation, man-made barriers to fish passage, impaired water quality, elevated stream temperatures, and altered flows. The stream habitat and riparian areas analysis with specific locations of habitat degradation are presented in Chapter Eight.

The primary fisheries issues on the White River mainstem are related to low stream flows in the bypass reach between the diversion dam to Lake Tapps and the return canal, and poor aquatic habitat conditions. Low flows may result in elevated stream temperatures in the bypass reach. The low flows and elevated water temperatures have the potential to limit rearing capacity for juvenile salmonids and affect passage of anadromous fish. Flows in the lower White River have increased since 2004 as the result of converting Lake Tapps from hydropower to other uses. Sections of the lower White River are also on Ecology's 303(d) list for temperature, pH, and fecal coliform bacteria.

The White River mainstem has been channelized in many locations and is affected by agriculture, rural development, and some light industrial activities. Urbanization along the lower White River has eliminated much of the stream bank vegetation, which in turn has reduced bank stability, canopy cover, and potential large woody debris (LWD) recruitment. The aquatic habitat conditions for each reach on the mainstem of the lower White River are summarized in Table 4-10.

In several tributaries, development has degraded water quality, altered flows, modified channels, or reduced riparian vegetation, all of which have adversely affected aquatic habitat and fishery resources. Untreated stormwater runoff can carry nutrients, pesticides, and herbicides from agricultural and residential areas, and dissolved metals and other toxic chemicals from roads and parking lots. Development activities have led to channelization of many of the larger tributaries west of Lake Tapps into straight ditches with no channel capacity.

Anadromous fish travel great distances during juvenile outmigration to estuarine and ocean feeding grounds, and during their return trip as adults to their breeding grounds to spawn. Some man-made barriers block fish passage in the White River Basin. Man-made barriers have impaired or eliminated access by anadromous fish to habitat that historically has been occupied by such fish. Potential fish barriers within the basin have been identified by field surveys (see Appendix F). Barriers on each stream reach are

identified in Section 4.6. The identified man-made barriers are located outside the basin planning area or are not under the jurisdiction of Pierce County, and therefore are not addressed in this Basin Plan.
The Mud Mountain Dam and the Lake Tapps diversion dam on the White River also are potential fish barriers. A trap-and-haul system currently is being used to transport fish around these barriers. Operation of these dams is regulated by the federal government and is outside the scope of Pierce County basin planning.

Endangered Fish Species

In Pierce County waters, NMFS has listed the Puget Sound evolutionarily significant unit (ESU) Chinook salmon and Puget Sound distinct population segment (DPS) steelhead as threatened, and the Puget Sound Strait of Georgia ESU of Coho salmon as a species of concern. The USFWS has listed the Coastal-Puget Sound DPS bull trout as threatened under the ESA. A species listed as threatened is likely to become endangered within the foreseeable future. The White River Basin contains runs of steelhead trout and Coho and Chinook salmon; bull trout are also present.

Significant Impacts and Mitigation Measures

Proposed Action (Basin Plan)

The Proposed Action includes a series of projects, programs, and studies that would address fishery, aquatic habitat, and water quality problems identified in the White River Basin. These can be found in Chapter Nine. Other programs to enhance riparian habitat and improve water quality would benefit fishery resources. The proposed Basin Plan is anticipated to result in long term, net improvements in fisheries, aquatic habitat, and water quality in the basin planning area, at a higher level than that of the No Action Alternative. Fishery and habitat restoration also would benefit vegetation, wetlands, wildlife, water quality, and recreation.

The Basin Plan would include the Lower White River Property Acquisition CIP, which would purchase undeveloped property along the mainstem of the lower White River. This CIP would maintain flood storage and preserve riparian function on these properties, which would benefit aquatic/riparian habitat.

The Basin Plan would include a CIP to install culverts that address fish passage problems. Currently, the existing driveway culverts along Mountain Side Drive East are not fish passable. A CIP would install 18-20 culverts along Mountain Side Drive East. The proposed culverts would allow for fish passage, as well as eliminate localized flooding. Improving passage would increase habitat for fish and other aquatic resources. Several basin-specific projects, programs, and studies addressing water quality problems in this plan would benefit fishery and aquatic habitat (see Section 10.3.1, Water Resources and Water Quality). Several programs and studies to assess water quality in Lake Tapps would improve aquatic habitat in the long term. Pierce County would monitor water quality and identify pollutant sources in Lake Tapps and the diversion canal, in cooperation with the Alliance.

Several countywide programs would improve or protect aquatic habitat. A habitat monitoring program would evaluate the long term effectiveness of aquatic and riparian habitat improvement projects and programs, in cooperation and coordination with other entities. A land management program would protect aquatic and riparian habitats, reduce future degradation of water quality, and make areas available for future habitat restoration. Another program would address septic tank problems at shoreline residences, which have been a source of water pollution in basin receiving waters.

Other countywide programs would address stormwater runoff and nonpoint pollution from existing and future development, which would result in long term improvements for fishery resources in the White River Basin. The water quality could be improved by programs that promote LID techniques in future development projects, update stormwater management standards, and increase inspection and maintenance of stormwater facilities under Pierce County jurisdiction.

Although the proposed projects would likely result in an overall positive benefit on water quality and fishery resources, the construction of future projects has the potential for short term adverse impacts, particularly those constructed within or adjacent to streams, lakes, or wetlands. Measures to minimize construction-related impacts for individual projects would include TESC measures and related BMPs to reduce erosion and sedimentation that could temporarily impair water quality. Impacts on fisheries during construction would be minor if appropriate erosion control BMPs is properly implemented. As discussed previously under Water Resources and Water Quality, the construction and design of each project would meet Pierce County and Washington State erosion control requirements, and all projects would obtain any applicable federal, state, and local permits and approvals.

Overall, the implementation of the multiple projects and programs in the Basin Plan is expected to result in long term benefits for the fishery resources and aquatic habitat within the White River Basin. Any projects would include site-specific mitigation, comply with all applicable regulations, and obtain necessary federal, state, and local permits and approvals prior to construction. The Basin Plan would be consistent with the County's basin planning goals for improving aquatic habitat and water quality (Table 10-2) and with the new laws and policies related to habitat protection (Section 10.3.8, Plans and Policies). No unavoidable significant adverse impacts or cumulative adverse impacts on fishery resources would occur under the Proposed Action.

Endangered Species Act

The White River Basin supports populations of Chinook salmon and steelhead and bull trout. All three of these salmonid species are listed as threatened under the ESA. The proposed Basin Plan includes a number of basin-wide projects and programs that are designed to protect or restore habitat and improve water quality for listed and non-listed salmonids alike. Implementing the Basin Plan in combination with other habitat improvement efforts would likely have positive, cumulative impacts on the listed

salmonid species in the White River Basin. The consistency of the Basin Plan with the ESA is evaluated in Section 10.3.8, Plans and Policies.

No Action Alternative

Under the No Action Alternative, surface water in the basin planning area would continue to be managed under the 1991 Plan and other current County activities. Stormwater from existing and future development would be controlled by current Pierce County policies and regulations. Few basin-specific projects and programs to improve fish habitat, if any, would be proposed for the White 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 with construction would be similar to those discussed under the Proposed Action.

The No Action Alternative would not address many of the fishery and habitat problems identified in the White River Basin. Problems associated with habitat and water quality would continue. Adoption of the No Action Alternative may result in the continued degradation of fish habitat and water quality, which would adversely affect fish and other aquatic species. Monitoring of fish habitat and water quality would not occur in the basin planning area, which would not allow Pierce County to evaluate the effectiveness of its projects and programs.

The No Action Alternative would not achieve many of the County's updated basin-planning goals to improve aquatic habitat and water quality (Table 10-2). The No Action Alternative also would be inconsistent 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 (see Section 10.3.8, Plans and Policies). Compared to the proposed Basin Plan, the No Action Alternative would result in fewer long term benefits to the fisheries resources and aquatic habitat within the White River Basin.

10.3.3 Plants and Animals

Affected Environment

Habitat

The White River Basin has a mix of plant and animal habitats. The major habitats include wetlands, riparian, terrestrial, forest, and aquatic. Aquatic habitat related to fish is discussed in the previous section on Fishery Resources. The habitats in the upper White River Basin are mostly undeveloped. In the lower White River Basin, portions of the natural habitats have been altered in areas of logging and by residential and agricultural development.

Pierce County has evaluated habitat conditions of streams within the White River Basin. Existing habitats and problems have been identified from Pierce County inventories, published data, questionnaires, interviews, and field surveys. Riparian and aquatic habitats within the basin are described in detail in Section 4.6, and the habitat conditions in each stream reach are summarized in Tables 4-10 to 4-15.

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, 2003b).

In the White River Basin, development has substantially reduced the presence of wetlands west of Lake Tapps. Many wetlands have been altered by residential and agricultural development and by modifications to the natural drainages. Wetland alteration has directly and indirectly affected water quality, wildlife, and fishery resources. The existing wetlands are shown in Figure 4-8.

Riparian Habitat

Riparian habitat occurs in areas adjacent to rivers, streams, seeps, and springs. Riparian habitat is an important transitional zone between aquatic and terrestrial habitats. Suitable riparian habitat is essential for fish and aquatic species, 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 in-stream habitat through recruitment of 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, 2003b).

Riparian habitat in the basin has been altered along the White River and in its floodplain. The clearing of streamside vegetation has directly affected riparian plant communities and associated wildlife, and affected water quality and fishery resources.

Terrestrial Habitat and Forestland

Terrestrial habitat in the White River Basin includes primarily coniferous and deciduous forestland, grassland or prairie, and landscaped areas associated with residential development. These habitats provide breeding, feeding, and migration areas for a variety of terrestrial species. Development has disturbed many of the uplands in the lower basin, leaving fragmented patches of forestland and grassland.

Much of the upper White River Basin is forestland. Forestland provides habitat for wildlife and plays an important role in the hydrological cycle. Most forest activities in the upper basin are regulated by the USFS or DNR, and are outside the scope of Pierce County basin plans.

Vegetation

The White River Basin supports several plant communities that include conifer, deciduous, and mixed conifer-deciduous forests; grassland; and shrub land. Generally, the upper basin 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 basin as the result of land clearing for agriculture and development. Invasive plant species include Scot's broom and Himalayan blackberry.

Wildlife

Wildlife found in the White River Basin consists of native wildlife associated with the wetland, riparian, terrestrial, and forest habitats, and with the area's streams and lakes. Much of the upper basin is relatively undeveloped and supports a greater diversity of native animals. In the upper portion of the basin, the diversity of Mount Rainier National Park's ecosystem provides a broad assortment of invertebrates, mammals, birds, fish, amphibians, and reptiles.

Wildlife within the basin planning area is not as diverse as within the National Park and forestlands, because of the planning area's development and habitat alteration. The mammals and birds within the basin planning area are typical of rural residential areas in the Pacific Northwest, with beavers, squirrels, chipmunks, deer, and other mammals as well as numerous species of birds and invertebrates in the open spaces and parks. In areas of residential development, wildlife includes species that can tolerate or benefit from close association with humans and habitat fragmentation.

The White River Basin contains a variety of wildlife, including large and small mammals, amphibians, reptiles, bird species, and invertebrates. Much of the upper basin is undeveloped and supports the habitat required for large mammal species such as cougar, bobcat, bear, elk, and deer. River otter, muskrat, and beaver can be found along the White 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 White River Basin contains raptor habitat and active nests, including bald eagle nesting areas. Riparian areas and wetlands provide nesting, migratory, and wintering areas for migratory bird species. Lake Tapps is an important resource for waterfowl.

Endangered Plants and Animals

The White River Basin includes several plant and animal species considered threatened or endangered by federal and state agencies. Besides the Chinook salmon and bull and steelhead trout discussed under Fisheries, listed and candidate species likely within the basin include the bald eagle, spotted owl, marbled murrelet, pileated woodpecker, peregrine falcon, and western pond turtle. The state and federal endangered species and requirements are discussed in Section 10.3.8, Plans and Policies.

Under its Critical Areas Ordinance, Pierce County has established Regulated Fish and Wildlife Species and Habitat Conservation Areas in PCC Chapter 18E.40. The purposes of this chapter are to identify regulated fish and wildlife species and habitats and to establish habitat protection procedures and mitigation measures that are designed to achieve "no net loss" of species and habitat due to new development or regulated

activities. Future projects under the Basin Plan, where applicable, would undergo a habitat assessment, which is a site investigation process to evaluate the potential presence or absence of a regulated fish or wildlife species or habitat affecting a subject property. The Pierce County Critical Areas Ordinance also is evaluated in Section 10.3.8, Plans and Policies.

Significant Impacts and Mitigation Measures

Proposed Action (Basin Plan)

The Proposed Action includes projects and programs to improve habitat and water quality, which would generally benefit plant and animal resources in the long term. Several of the programs would restore or protect plant and animal habitat, at a higher level than the No Action Alternative would. Many of the habitat restoration programs also would benefit water quality, fishery, scenic, and recreational resources.

The Basin Plan includes several measures to restore and protect riparian habitat. The Lower White River Property Acquisition CIP would purchase undeveloped property to benefit aquatic/riparian habitat and water quality. A countywide program would restore and enhance degraded riparian habitat, as well as water quality. Another program would develop and implement a vegetation management plan, which would restore and manage riparian vegetation. Pierce County would develop an education program to encourage landowners to voluntarily improve riparian habitat.

In general, restoring streamside vegetation tends to improve both riparian and aquatic habitats. Streamside vegetation provides riparian habitat for wildlife, shade for streams, bank stabilization, and runoff filtration, and it is a source of LWD recruitment in streams. Restored riparian habitat would provide additional filtration of runoff from adjacent lands, which would improve water quality through a reduction in nutrients, pathogens, and sediments reaching streams and lakes.

Restoration programs that revegetate stream banks would directly benefit riparian habitat for plants and animals. The development of expanded riparian corridors also could provide migration corridors for terrestrial species (Ecology, 2003b). Restoring riparian areas would also benefit raptors and other bird species.

Several programs would improve water quality in the White River Basin, which would result in long term improvements for plant and animal resources (see Section 10.3.1, Water Resources and Water Quality). Multiple programmatic measures would address stormwater runoff and nonpoint pollution from existing and future development. Monitoring programs would evaluate the effectiveness of habitat and water quality improvements in the White River Basin.

Another program would develop a plan to manage properties for habitat protection. Potential acquisition would protect riparian and wetland habitats, preserve the floodplain, reduce future degradation of habitat, and make areas available for future habitat restoration. Acquisition of property also could preserve aquatic habitat, open space, and scenic and recreational resources.

The Basin Plan also would include programs to control invasive species. The potential programs could inventory the invasive plant problems, develop a guidance manual, and coordinate efforts with other agencies and volunteers. Removal of invasive plant species and restoration of native vegetation would improve plant-species diversity and wildlife habitat in the long term. Control of invasive species would enhance riparian, wetland, and terrestrial habitats.

Although the long term impacts on plants and animals are likely to be positive for the White River Basin, construction of future 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 and Water Quality, 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 future permitting.

Taken together, the various projects and programs under the Basin Plan are expected to result in long term benefits to plant and animal habitat within the White River Basin. The Basin Plan would be consistent with the County's updated basin-planning goals to improve aquatic/riparian habitat (Table 10-2) and with the new laws and policies related to habitat protection (Section 10.3.8, Plans and Policies). Individual projects would be relatively small and would not permanently convert large areas of natural habitat to developed uses. Potential short term impacts during construction would be mitigated with BMPs, revegetation, and other site-specific mitigation. All projects would be located, designed, and operated to comply with applicable regulations, and would obtain required permits prior to construction. No significant unavoidable adverse environmental impacts or cumulative adverse impacts on plants and animals would occur under the Proposed Action.

No Action Alternative

Under the No Action Alternative, surface water would continue to be managed under the 1991 Plan and other current County surface water management activities. Few basin-specific projects and programs to improve plant and animal habitat would be proposed for the White River Basin. Any improvements to plant and animal habitat would occur at a lower level compared to the Proposed Action. If any future 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 many of the plant and animal habitat problems identified in the White River Basin. Many of the problems associated with

animal habitat and water quality would continue in the basin. If projects or programs are not proposed in the basin and the identified habitat problems remain, then taking no action may result in continuing degradation of plant and animal habitats in the long term. Adoption of the No Action Alternative also would not achieve many of the County's updated basin-planning goals to improve habitat (Table 10-2). The No Action Alternative would be inconsistent 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). Compared to the proposed Basin Plan, the No Action Alternative would result in fewer long term benefits to plants and animals within the White River Basin.

10.3.4 Soils and Geology

Affected Environment

Geology and soils can affect surface water management. The existing geology and soils of the White River Basin are described in Section 4.4.

The geology of the White River Basin is composed of volcanic and sedimentary rocks, a drift plain with glacial till and outwash material, alluvium, and mudflow deposits with various overlying soils. The glacial deposits forming the current topography were deposited during the most recent glaciation in the region, which is known as the Vashon Glaciation of about 15,000 years ago. About 5,700 years ago, the Osceola mudflow spread across the Puget Sound lowlands, forming a flat plain extending westward to about the eastern shore of Lake Tapps and occupying the White River valley.

Soil associations present in the western portion of the basin include the Kapowsin, Alderwood-Everett, Puyallup-Sultan, and Buckley associations. Much of the soil drains poorly and tends to retard infiltration of water. This condition, along with the presence of glacial till which has low permeability, tends to increase ponding of water and runoff rather than deep infiltration and recharge of deep aquifers. These conditions also create a high potential for septic system failures. Figure 4-7 shows the distribution of the hydrologic soil groups, and Table 4-7 describes the properties of hydrologic soil groups.

Pierce County has designated volcanic, landslide, seismic, and erosion hazard areas under its Critical Areas Ordinance (PCC Title 18E). Portions of the White River Basin include landslide, seismic, and erosion hazard areas. Volcanic hazards in the basin occur along the river valleys leading from Mount Rainier.

Significant Impacts and Mitigation Measures

Proposed Action (Basin Plan)

The Basin Plan includes programmatic measures to address flooding, drainage, and water quality problems, which generally would reduce soil erosion and sedimentation in the White River Basin. The overall projects and programs under the Basin Plan would address erosion problems at a higher level than the No Action Alternative would.

Several programs would reduce erosion in the planning area. Programs to preserve and restore riparian areas would stabilize stream banks, which would reduce erosion. Revegetation programs also would reduce erosion and sedimentation in streams.

Other programs would address soil erosion by promoting LID techniques, updating stormwater management standards, increasing inspection and maintenance of stormwater facilities, and providing public education. Many future programs would rely on natural systems for stormwater control rather than new structures, which would minimize grading and filling activities and the installation new impervious surfaces.

Future projects could require excavation, filling, or grading activity. In general, the amounts of filling or grading would be relatively small. The Basin Plan would promote natural systems for stormwater control rather than new structures. This in turn, would minimize grading and filling activities and the installation of new impervious surfaces. In addition, some projects could be located in geological hazard areas regulated under the Pierce County Critical Areas Ordinance. Specific information on grading and 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.

In the short term, construction of future projects could 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, 2003b). Potential construction impacts and site-specific mitigation would be determined during future environmental review and permitting of individual projects.

As mitigation measures during construction of individual projects, standard erosion control measures and 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, surface water would continue to be managed under the 1991 Plan and other current County programs. Limited erosion control would

continue in the White River Basin, but at a lower level compared to the Proposed Action. Few basin-specific projects and programs, if any, would likely be proposed for the basin planning area. If any projects were proposed, short term impacts and mitigation measures associated during construction would be similar to those discussed under the Proposed Action. Compared to the proposed Basin Plan, the No Action Alternative would result in fewer long term benefits to soil conditions within the White River Basin.

10.3.5 Land and Shoreline Use

This proposed Basin Plan focuses on lands within unincorporated Pierce County, which are under Pierce County jurisdiction. Unincorporated areas of Pierce County are present in both the western and eastern portions of the basin. Most of the overall White River Basin is within incorporated cities and undeveloped national forest and national park lands, which are not the focus of this Basin Plan. The unincorporated areas in the basin are shown in Figure 4-1.

Land and shoreline use in the basin planning area is guided primarily by Washington's GMA, the SMA, Pierce County zoning regulations, and the Comprehensive Plan. Applicable land use regulations, plans, and policies are evaluated in Section 10.3.8, Plans and Policies, of this FSEIS. Existing land uses and zoning are described in Section 4.3 and are summarized in Tables 4-4 and 4-5.

Affected Environment

Land use and population density can affect surface water drainage, flooding, water quality, and plant and animal habitat. Undeveloped forestland allows for maximum infiltration of rainwater, has the least potential for causing water pollution, and provides natural habitat for native species. Highly developed areas, which are characterized by large areas of impervious surfaces, can alter natural habitat and increase the surface runoff of stormwater.

The White River Basin includes urban areas primarily in the west, while forestlands and parklands are predominant in the east. A large portion of the eastern basin is within the Mount Baker-Snoqualmie National Forest or Mount Rainier National Park. Lands owned by the USFS are managed for timber harvest and recreational use and are not available for private development.

In the upper portion of the basin are the communities of Greenwater, Crystal Village, Crystal Village II, and Crystal River Ranch, as well as residences along the major roads. Zoning is primarily Forest and Rural Residential. The upper basin is predominantly zoned as "Designated Forest Land," which is mostly private land used for commercial timber activities.

Most development has occurred in cities in the western portion of the basin. These urban areas include the cities of Algona, Auburn, Bonney Lake, Buckley, Edgewood, Pacific, Sumner, and Enumclaw; the population currently is concentrated in these cities and the adjacent areas in unincorporated Pierce County. Future population growth is

expected to be greater in the urban areas in the western portion, while the eastern basin is expected to retain its rural character. Existing and future population estimates for Pierce County are discussed in Section 4.3.2.

Lake Tapps has long been a popular area for water recreation, and the land use surrounding the lake is mostly residential or vacant. Much of the Lake Tapps shoreline is within unincorporated Pierce County, although portions of the shoreline are within Auburn to the northwest and within Bonney Lake to the south. Residential land uses dominate the shoreline of Lake Tapps.

Lake Tapps is surrounded predominantly with moderate- to high-density single-family residential land uses. Lake Tapps has several islands, all of which are developed with single-family residences. Some developments are associated with golf courses, which in areas border the shoreline.

Agricultural lands are scattered throughout the basin planning area, although most are located east of Lake Tapps between the lake and the diversion dam. In response to GMA requirements, Pierce County created the designation for Agricultural Resource Lands, and applied it to prime farmlands in the County.

Pierce County has designated UGAs, which are areas in which urban growth is encouraged and where adequate public facilities exist or can be efficiently provided. UGAs have been designated in the western basin around the cities. The eastern portion of the White River Basin is located outside the UGAs.

Shoreline uses generally include larger streams and lakes, associated wetlands and floodplains, and uplands within 200 feet (see Section 2.2.4). Shorelines are designated and regulated by the Pierce County Shoreline Master Program (SMP) in PCC Title 20. Regulated water bodies within the basin planning area include Lake Tapps, which is designated as a Freshwater Shoreline of Statewide Significance under the SMP. The existing shoreline environment designations of Lake Tapps are Rural Residential and Conservancy. Shorelines along the White River and its tributaries within the basin planning area are designated mostly as Conservancy. Pierce County is currently updating its SMP to comply with state requirements for increased resource protection and preservation.

Shoreline modifications associated with residential uses are prevalent throughout the Lake Tapps shoreline area. Analysis of 2006 aerial photography shows that the majority of residential parcels along the lake shoreline have bulkheading, predominantly made of concrete, and many of these parcels have private-use docks (PALS, 2007).

Projected future land uses, based on zoning, indicate a conversion of open space to residential and some commercial uses, predominantly in the Lake Tapps and Lower White River Subbasins, and some increase of residential uses in the Mud Mountain Subbasin (Figure 4-6). These changes in land use to more intense development have the potential for future stormwater-related impacts on water quality, flooding, and habitat.

As land uses change in a basin, hydrologic characteristics could be altered because of impervious surfaces. Impervious surfaces can include roads, buildings, and parking areas because they block precipitation from soaking into the ground and reduce the amount of vegetated areas available to absorb precipitation. Estimates of impervious surfaces within each subbasin have been based on the current and projected future land uses (Table 4-6). The analyses indicate the potential for increased impervious areas, which could result in related surface water impacts on the water courses west of Lake Tapps.

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 basin planning area, which would result in long term benefits on associated land and shoreline uses. The Basin Plan would reduce flooding of residences and destruction of property and structures. The improvements to flooding, drainage, and water quality conditions are evaluated in Section 10.3.1, Water Resources and Water Quality.

The proposed projects and programs are not anticipated to result in changes to existing and planned land uses in the White River Basin. The Basin Plan would not encourage any new growth or development in addition to planned uses in the 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 surface water facilities and services. To analyze impervious surfaces and other hydrological conditions, the Basin Plan is based on the current adopted land use and zoning designations in the Comprehensive Plan. The Basin Plan therefore would be internally consistent with the Comprehensive Plan, as required under the GMA (see Section 10.3.8, Plans and Policies). Because the Basin Plan is consistent with the Comprehensive Plan and accommodates planned growth better than the status quo, the Basin Plan would result in a greater reduction of development related stormwater impacts than the No Action Alternative.

Because the Basin Plan does not propose 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 surface water management projects.

The Lower White River Property Acquisition CIP would purchase properties that are undeveloped. A countywide program would develop and implement a land management program, which might include future acquisition of property. 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.

The location, design, construction, and operation of future surface water facilities 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 SMP. Individual projects could require future land use permits and approvals, and site-specific mitigation measures. Shoreline, zoning, and other land use reviews would occur when future 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 proposed Basin Plan. The Basin Plan would be consistent with the Comprehensive Plan and its land use and surface water policies. The consistency with applicable plans and policies is evaluated in detail in Section 10.3.8, Plans and Policies. Implementation of the Basin Plan is expected to result in long term benefits to land and shoreline uses within the White River Basin, at a higher level than No Action.

No Action Alternative

Developed from the 1991 Plan, the No Action Alternative is a continuation of the current County programs. The No Action Alternative would not address many of the basin-specific flooding problems and destruction of property within the basin planning area. Many identified drainage and flooding problems would continue. Development-related stormwater impacts from planned development would be addressed by current programs, which would not adequately address future development-related stormwater impacts from planned land uses. Future projects under the No Action Alternative, if any, would comply with site-specific land and shoreline regulations, and would obtain all applicable permits.

The 1991 Plan was based on previous land use designations and growth estimates available at that time, which now are out of date. Continued use of the 1991 Plan may be inconsistent with the current land use designations in the Comprehensive Plan, as evaluated in Section 10.3.8, Plans and Policies.

10.3.6 Public Services and Utilities

Affected Environment

The basin planning area has public services typical for a rural residential area. Depending on location, existing services and utilities include fire and police protection, schools, libraries, health care, electricity, refuse service, telephone, cable, and water

and sewer. The developed areas in the western portion of the basin generally have more available services than the undeveloped eastern portion.

Much of the urban areas in the western basin are served by public water and sewer systems. Sewer service is provided in urban areas by the local cities. Rural areas of the basin within unincorporated Pierce County are not served by a public sewer system. Most residences within the basin planning area rely on on-site septic tanks, which can contribute to water quality concerns (see Section 10.3.1, Water Resources and Water Quality). The basin planning area is not within the Pierce County Wastewater Utility Service Area.

The more developed areas of the White River Basin have constructed surface water facilities. Development has resulted in an extensive network of stormwater pipes, ditches, detention facilities, and infiltration facilities. Stormwater facilities are built and maintained by SWM. Culverts and ditches within County road rights-of-way are maintained by the Transportation Services Division of Pierce County Public Works and Utilities.

The rural areas in the eastern basin rely on private wells for drinking water. To protect groundwater from contamination, Pierce County has designated aquifer recharge and wellhead protection areas. The basin includes a number of aquifer recharge areas and wellhead protection areas, most of which are in the western portion of the basin. Aquifer recharge and wellhead protection areas are areas that have a critical recharging effect on groundwater used for potable water supplies, or those that demonstrate a high level of susceptibility or vulnerability to groundwater contamination from land use activities.

Numerous parks and recreational areas are located within the White River Basin. Lake Tapps is a major recreational resource that is heavily used for boating, water skiing, swimming, and fishing. Many of its shoreline residences have private docks, while the public has access at Lake Tapps North Park, Church Lake Park, and Allen Yorke Park. The Tapps Island Golf Course is a public facility on an island of Lake Tapps. In the lower basin, numerous parks and recreational facilities are located in the cities of Auburn, Bonney Lake, and Sumner. In the upper basin, the Mount Baker-Snoqualmie National Forest and Mount Rainier National Park are major recreational resources.

Significant Impacts and Mitigation Measures

Proposed Action (Basin Plan)

The projects and programs of the Basin Plan would not result in a substantial increase in the long term need for public services and utilities. Implementation of the Basin Plan would affect the services provided by SWM, 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 or cumulative impacts on public services and utilities are not expected in the long term under the Proposed Action.

The Proposed Action recommends a series of capital improvement projects and programs to reduce localized flooding and property destruction. Reducing the risk of flooding in the basin would improve public safety and reduce the need for flood-related emergency services. A CIP to install culverts along Mountain Side Drive East would eliminate flooding on Mountain Side Drive East and abutting private properties, and would reduce the amount of maintenance needed to keep culverts clear of debris.

One program would increase inspection and maintenance activities of surface water facilities such as culverts and ditches. Under a basin-specific program, SWM would coordinate septic-tank problems with the TPCHD. Improved performance of septic systems from existing and future development would reduce discharges from septic systems into basin receiving waters, particularly Lake Tapps.

The projects and programs to improve water quality, habitat, and fisheries also would benefit recreational opportunities in the White River Basin.

Construction of future 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. Installation of culverts under roadways could affect traffic and access to property during construction. Potential impacts during construction would be short term and site-specific, and would be determined when future 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 localized flooding would continue to be managed under the 1991 Plan and other current County programs. Few, if any, projects and programs would be proposed in the White River Basin under the No Action Alternative. Many of the identified flooding problems in the basin would continue. The No Action Alternative would provide a lower level of surface-water-related benefits to public services and utilities, compared to the Proposed Action.

Similar to the Proposed Action, any projects or programs under the No Action Alternative would not result in a substantial increase in the long term need for public services and utilities, but could result in temporary construction impacts. Potential projects would undergo future environmental review and include site-specific mitigation, and would be designed, built, 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. The White River Basin has the potential for historic and cultural resources that are listed on, or proposed for, national, state, or local preservation registers. The basin also has potential for Native American artifacts.

Cultural resources within the White River Basin include recorded pre-contact materials and campsites. Native American use included seasonal hunting and gathering campsites near the White River, with villages and camps frequently occurring at convergences with smaller tributary streams. Recorded artifacts include lithic scatters, charcoal deposits, and calcined bones. Substance harvest of anadromous fish and supplemental hunting of upland mammals occurred throughout the basin (PALS, 2007).

Site-specific information on the potential to encounter historic, cultural, or archaeological resources would be assessed when individual projects are proposed and undergo future environmental review. Several state and local databases identify the historic and archaeological sites that are listed on the state and national registers. Pierce County would consult with state and local preservation registers, such as the Washington State Department of Archaeology and Historic Preservation (DAHP) database and the Pierce County Register of Historic Places.

In addition, the White River and its associated natural resources are important to the PTI and the MIT. The salmon of the White River have been the mainstay of their diet, and are the foundation of their culture as well. The tribes have a longtime connection to the White River Basin, and are committed to improving water quality and habitat for fish and wildlife.

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 known historic or cultural resources. Individual capital improvement projects would be located and designed, where possible, to avoid any identified historic or cultural resources. If a project had the potential to affect to 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. This would occur 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.

During construction of future projects, the potential exists to encounter archaeological or cultural resources. If any archaeological or cultural resources were discovered during excavation, Pierce County would immediately consult with the state and local officials and with affected tribes regarding appropriate measures. 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.

Archaeological, historic, and cultural resources, particularly those located along streams, could be affected by erosion, uncontrolled stormwater runoff, and flooding. The Basin Plan includes projects and programs to control stormwater and reduce erosion at a higher level than the No Action Alternative would. Reduced flooding and stream bank restoration generally would be a benefit to historic and cultural resources.

The water quality and habitat programs under the Basin Plan would help protect and restore fisheries and other natural resources that are important cultural resources for the PTI and MIT. The potential impacts and benefits on fisheries of the Basin Plan are evaluated in Section 10.3.2, Fishery Resources.

No Action Alternative

Under the No Action Alternative, surface water would continue to be managed in the White River Basin as it is today. Limited erosion control and fishery restoration, if any, would continue under the No Action Alternative, but at a lower level of historic and cultural benefits than the Proposed Action. Fewer projects and programs would be proposed in the basin planning area under the No Action Alternative. 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 affect the planning and management of stormwater, water quality, and habitat in unincorporated Pierce County. Under SEPA, the review of a nonproject proposal, such as this Basin Plan, should include a consideration of existing regulations, plans, and policies. This section considers the various laws and policies that are related to surface water management in the White River Basin planning area. This section evaluates the major plans and policies applicable to surface water management by Pierce County, and is not intended to be an exhaustive list.

The federal, state, and Pierce County requirements pertinent to this Basin Plan are described in Chapter Two. It should be noted that laws, regulations, and policies are subject to change over time. The evaluations in this section are based on those in effect at the date of publication of this Basin Plan and DSEIS.

The original 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 relevant laws and policies have changed. Pierce County has developed the Basin Plan to meet the updated laws and policies for surface water management.

NPDES Stormwater Permit

Under the federal CWA, municipal stormwater discharges are subject to federal regulations under the 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 July 1995, 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. In response to NPDES requirements, Pierce County adopted its SWMP in 1998. Ecology then reissued the Phase I NPDES Permit in January 2007, and modified the permit in June 2009 to implement the outcomes of appeals. The next version of the NPDES permit is due to be issued in 2012.

Recommendations in Pierce County basin plans must be consistent with the current NPDES Permit and provisions of the SWMP. Major elements of the County's NPDES Permit and SWMP include controlling runoff from new development, extensive monitoring, more comprehensive inspections and maintenance of stormwater facilities, enforcement, outreach, record keeping, and coordination among jurisdictions. The elements of the current NPDES Permit and SWMP are described in greater detail in Section 2.1.1.

Proposed Action (Basin Plan)

This Basin Plan includes multiple programs that help address the current requirements of the County's NPDES Permit and SWMP. Some of the County's stormwater management activities may need to be modified when the next version of the NPDES Permit is issued in 2012. Programs in the Basin Plan allow for updates to existing manuals and activities to ensure compliance with future NPDES permits.

Under the proposed Basin Plan, Pierce County would update its Stormwater Management Manual if needed to maintain compliance with future NPDES permits. One countywide program would increase the inspection of public and private stormwater facilities under Pierce County jurisdiction, to ensure compliance with current stormwater regulations and NPDES requirements. Another program would include updating the maintenance manual containing BMPs for Pierce County's surface water management facilities. The BMP manual would be updated if needed to maintain compliance with the future NPDES permits. A monitoring program for surface water quality would continue to assess the conditions and effectiveness of various Pierce County projects and programs.

No Action Alternative

In comparison, the No Action Alternative would not propose multiple programs to address stormwater and surface water problems identified in the White River Basin. Under the No Action Alternative, surface water in the basin planning area would continue to be managed under the 1991 Plan and other current County programs. The No Action Alternative would not be consistent with many of the requirements in the

2007 NPDES Permit, its 2009 modifications, and County SWMP, which have developed since the 1991 Plan was issued.

Section 303(d) List and Total Maximum Daily Loads

Section 303(d) of the CWA requires Ecology to prepare a list of water bodies that are not meeting, or not expected to meet, water quality standards. If a water body is not in compliance with standards for a particular pollutant and implementation of technological approaches are insufficient, the CWA requires that a TMDL of that 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 application of BMPs. Section 303(d) requirements and TMDLs for the White River Basin are described in Section 2.1.1 and Chapter Seven.

Portions of the White River and several of its tributaries are on the 303(d) list. Most are impaired for temperature and fecal coliform bacteria, both of which can be associated with stormwater runoff. Stream segments on the 303(d) list within the White River Basin are listed in Table 7-1.

Sections of the lower White River are on Ecology's 303(d) list for temperature, pH, and fecal coliform bacteria, and are "impaired by a nonpollutant" because of low flows. Conversion of Lake Tapps from hydropower to other uses has increased flows in the lower White River, which is expected to improve water quality. The Basin Plan includes a study to assess the lower White River for fecal coliform, temperature, pH, and in-stream flow. This study would determine if water quality in the lower White River currently meets state standards, and whether TMDLs would still be required.

Upper tributaries, primarily in Designated Forest Land or King County, also have been placed on the 303(d) list. The upper White River has an Ecology-approved TMDL implementation plan for sediment and temperature. Both temperature and sediment have exceeded state water quality standards, which could affect salmon spawning and rearing. Most recommendations in the TMDL plan were assigned to the USFS, for activities to plant riparian areas and remove forest service roads.

Proposed Action (Basin Plan)

Overall, the proposed Basin Plan would improve discharges into water bodies with established or pending TMDLs, which would be consistent with the Section 303(d) requirements of the CWA. In the long term, the proposed Basin Plan is anticipated to reduce the number of 303(d) listed water bodies in the White River Basin.

No Action Alternative

The No Action Alternative would not result in basin-specific programs to address water quality in 303(d)-listed water bodies in the White River Basin. Under the No Action Alternative, surface water in the basin planning area would continue to be managed under the 1991 Plan and other current County programs. The No Action Alternative

would not be consistent with requirements for TMDLs under Section 303(d) of the CWA, which have developed since the 1991 Plan was issued.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) makes affordable flood insurance available to communities that adopt approved floodplain management regulations that meet or exceed FEMA standards. The FEMA process includes a Community Rating System (CRS) that offers the potential for reduced insurance rates in areas where flood protection measures are implemented. Pierce County participates in the NFIP, and has adopted flood hazard management regulations that meet FEMA standards. The NFIP and CRS programs are described in Section 2.1.2.

Basin plans serve as part of the flood hazard mitigation plan for Pierce County. Improvement projects and programs under a basin plan should, if possible, reduce flood hazards and improve the County's rating under the CRS.

Proposed Action (Basin Plan)

The Basin Plan includes projects and programs that would reduce flooding in the basin planning area. A basin-specific project would reduce localized flooding of residences, roadways, and other properties in the basin. The Lower White River Property Acquisition CIP would purchase undeveloped property to maintain flood storage. Another CIP to install culverts would eliminate flooding on Mountain Side Drive East and abutting private properties.

Several countywide programs also would address flooding and drainage problems. Pierce County would develop a land acquisition and management program to reduce flood hazards. Other programs would increase inspection and maintenance of existing and future surface water facilities under Pierce County jurisdiction. Development and implementation of a BMP manual for Pierce County maintenance activities would preserve flood control functions of County stormwater management facilities and levees.

The projects and programs under the proposed Basin Plan would reduce overall flood hazards, which would possibly improve the County's CRS rating and contribute to making the area eligible for reduced flood insurance. , The Basin Plan has been developed according to the CRS planning steps to improve the County's chances of reducing flood insurance rates (see Section 2.1.2).

No Action Alternative

In comparison, the No Action Alternative would result in fewer projects and programs that would address flooding problems in the White River Basin. The No Action Alternative would not likely improve the County's CRS rating.

Regional Watershed Planning

The regional watershed planning process is related to basin planning in Pierce County. The 1998 Watershed Management Act provides the framework for locally based watershed planning (see Section 2.2.6). Under the act, the White River is part of

watershed resource inventory area (WRIA) 10, the Puyallup-White River Basin. Watershed planning for WRIA 10 has a broader focus for the entire Puyallup-White River watershed within Pierce and King Counties.

The watershed planning process for WRIA 10 has assembled a large collection of information related to water quality and habitat conditions. Pierce County generally has considered the available information when developing this proposed Basin Plan.

Endangered Species Act

The federal ESA directs the USFWS and NMFS to promulgate a list of endangered and threatened species and to designate critical habitat for these species. The ESA regulates activities that kill, injure, or harass the listed species or destroy their habitat. County actions requiring a federal permit or receiving federal funding that would also likely to affect an ESA-listed species may require consultation with USFWS or NMFS. The ESA process is described in Section 2.1.4.

Federally listed species with the greatest potential to affect surface water management in Pierce County are the Chinook salmon and bull and steelhead trout. The ESA status of each ESA listed species is:

- Chinook salmon in the Puget Sound ESU were listed as a threatened species by NMFS on March 24, 1999 (64 Federal Register 14308–14328). The Puget Sound Chinook ESU includes all naturally spawned Chinook populations in the Puget Sound region from the Elwha River eastward, as well as 26 artificial hatchery propagation programs.
- Bull trout in the Coastal and Puget Sound DPS were listed as a threatened species by the USFWS on November 1, 1999 (64 Federal Register 58910–58933). The Coastal and Puget Sound bull trout DPS encompasses all Pacific coast drainages north of the Columbia River in Washington, including those flowing into Puget Sound.
- Steelhead trout in the Puget Sound DPS were listed as a threatened species by NMFS on May 11, 2007 (72 Federal Register 26722–26735). The Puget Sound steelhead DPS includes all naturally spawned steelhead in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, bounded by the Elwha and Nooksack Rivers.
- Coho salmon in the Puget Sound and Georgia Strait ESU were listed as a "species of concern" by NMFS on April 15, 2004. The Puget Sound and Georgia Strait ESU includes all naturally spawned populations of coho salmon from drainages of Puget Sound and Hood Canal, the eastern Olympic Peninsula east of Salt Creek, and the Strait of Georgia.

The ESA requires recovery plans for the conservation and survival of federally listed threatened species. Federal recovery plans in draft or final versions are available for the

Puget Sound Chinook salmon ESU and Coastal and Puget Sound bull trout DPS. Critical habitat for Chinook salmon and bull trout has been designated within the White River.

In addition to the federal ESA listings, several Washington state agencies maintain lists of rare or endangered plant and animal species and habitat. The Washington Department of Fish and Wildlife (WDFW) publishes Priority Habitats and Species (PHS) and Species of Concern (SOC) lists. 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 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 HPAs, reviewing proposals under SEPA, protecting critical areas under the GMA, and other conservation planning.

The White River Basin contains runs of steelhead trout and coho and Chinook salmon; bull trout are also present. Other listed and candidate species likely within the basin include the bald eagle, spotted owl, marbled murrelet, pileated woodpecker, peregrine falcon, and western pond turtle.

Proposed Action (Basin Plan)

The proposed Basin Plan is anticipated to protect or restore habitat for Chinook and coho salmon, bull and steelhead trout, and other plant and animal species. Projects and programs to improve fish passage, restore riparian habitat, control erosion, improve water quality, restore native vegetation, acquire property to preserve active floodplains, and monitor habitat would benefit endangered species. Implementing the proposed Basin Plan in combination with other habitat improvement efforts likely would have positive, cumulative impacts on the aquatic and terrestrial communities and would improve habitat for federal and state listed species in the White River Basin.

No Action Alternative

In comparison, the No Action Alternative is based on continuing implementation of the 1991 Plan and other County programs, which would result in limited basin-specific habitat restoration and protection for the White River Basin. The 1991 Plan was adopted before the ESA listing of Chinook salmon and bull 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 basin planning area, 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, 2003b).

Although the proposed Basin Plan likely would result in overall long term benefits for endangered species, future 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 under the proposed Basin Plan. Future projects would be located and designed to avoid impacts on listed species and habitats, where possible, and would include mitigation for all permanent, unavoidable impacts. Measures to minimize construction related impacts for individual projects would include TESC measures and related BMPs to reduce erosion and sedimentation that could temporarily impair water quality. Pierce County would coordinate individual projects under the proposed Basin Plan with appropriate agencies and tribes that regulate endangered species, to identify site-specific mitigation measures and obtain required permits and approvals. Similarly, under the No Action Alternative, future projects, if any, 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.

Growth Management Act

Washington's GMA establishes goals for land use planning, and directs Pierce County to adopt plans and regulations for managing growth and for coordinating land use development with adequate infrastructure to support planned development. In response to the GMA, the County prepared the Comprehensive Plan, which became effective in 1995. The GMA is described in Section 2.2.2.

The GMA planning goals that directly apply to surface water management are to encourage development in urban areas, to ensure adequate public facilities and services to support development, and to protect the environment. The GMA requires planning documents, such as basin plans, to be internally consistent with the policies and future land use map in a comprehensive plan. Basin plans also should be coordinated with the County's ongoing land use and GMA planning efforts.

Proposed Action (Basin Plan)

Pierce County has developed this Basin Plan to meet the GMA planning goals. The proposed Basin Plan includes projects and programs to protect the environment by improving water quality, reducing flooding, and restoring habitat. The proposed Basin Plan would support existing and planned land uses by providing adequate surface water facilities and services for areas under Pierce County jurisdiction.

Pierce County has developed the proposed Basin Plan to be internally consistent with the Comprehensive Plan and other County land use planning efforts. In particular, the analyses of impervious surfaces and other hydrological conditions in the proposed Basin Plan have been based on the current adopted land use designations in the Comprehensive Plan.

No Action Alternative

In comparison, the No Action Alternative may not adequately meet the overall GMA planning goals applicable to surface water management. Under the No Action Alternative, the existing public facilities and services for surface water management may not adequately support future development. The 1991 Plan was prepared before

adoption of the Comprehensive Plan in 1995, and was based on previous land use designations and population estimates available at that time, which now are out of date. Continued use of the 1991 Plan under the No Action Alternative would be internally inconsistent with the current land use designations in the Comprehensive Plan. The No Action Alternative would be inconsistent with the planning goals and requirements of the GMA.

Pierce County Comprehensive Plan and Zoning

Development of future surface water facilities must be consistent with adopted County land use plans, zoning designations, and development regulations. The Comprehensive Plan guides 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. The PCC includes the zoning regulations as Title 18A and the Comprehensive Plan as Title 19A.

Under the adopted land use designations in the Comprehensive Plan and the County's zoning, the White River Basin is zoned mostly for forestland in the eastern portion and for rural residential development in the western portion. The majority of the basin planning area is located outside the Pierce County UGAs. Figure 4-3 shows current land use and Figure 4-4 shows current zoning.

Under the Basin Plan, future capital projects would be located and designed to comply with adopted land use policies, zoning designations, and development regulations. Once future projects are proposed, Pierce County would conduct a review of potential projects against the County zoning and development regulations.

Future projects would obtain applicable land use permits and approvals at the time they are proposed. Similarly under the No Action Alternative, future projects, if any, would be consistent with the County land use, zoning and development regulations and would obtain applicable permits.

The 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 Comprehensive Plan. In comparison, the few projects and programs under the No Action Alternative, if any, would be unlikely to meet the goals concerning surface water management in the Comprehensive Plan.

Pierce County Critical Areas Ordinance

The GMA requires Pierce County to designate critical areas and to adopt regulations to protect these areas. Pierce County's Critical Areas Ordinance (PCC Title 18E) establishes development standards for sites that contain or are adjacent to identified critical areas. The Pierce County critical areas 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 includes basin-specific projects and programs that would protect and enhance critical areas in the White River Basin. A CIP to install culverts would increase fish habitat and reduce flood hazards. Several programs would restore and acquire riparian areas and fish and wildlife habitat. Other programs to improve and monitor water quality would benefit wetland and fish and wildlife habitat. In addition, projects and programs under the proposed Basin Plan are anticipated to reduce flood and erosion hazards.

While the proposed Basin Plan avoided recommendations that would substantially impact critical areas, some future projects could affect critical areas. Any future projects in the proposed Basin Plan would be located and designed to avoid critical areas where possible. If a surface water 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 proposed Basin Plan would be determined during future review under the Critical Areas Ordinance. Similarly, under the No Action Alternative, future projects, if any, would avoid critical areas where possible and would comply with the Critical Areas Ordinance.

Project-Specific Permits and Approvals

Future projects under the proposed Basin Plan may require federal, state, and local government approvals and permits. Future projects would complete environmental review under SEPA and 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 under the proposed Basin Plan would comply with all applicable federal, state, and Pierce County regulations and policies. Similarly, any future projects under the No Action Alternative, if any, would comply with applicable regulations and would obtain required permits and approvals.

A number of environmental and permitting programs could apply, depending on a project's location and characteristics. The major permits and approvals, described in Chapter Two, are listed below:

- Section 401 Water Quality Certification,
- Corps Section 404 Wetland Permit,
- ESA Consultation,
- HPA,
- NPDES Construction Stormwater General Permit,
- Archaeological and Cultural Coordination,
- SMA and SMP,
- Pierce County Critical Areas Ordinance,

- Pierce County Zoning and Development Regulations,
- SEPA Environmental Review, and
- NEPA Environmental Review (if federal funding or permit).

Sustainability

Pierce County recently established the Office of Sustainability, which works to establish strategic partnerships with other Pierce County organizations, citizen groups, and businesses to coordinate education, outreach, and sustainability efforts. The benefits of sustainable programs in Pierce County include the following:

- Better health by reducing air, water, and soil contaminants;
- Taxpayer savings through energy and water conservation, waste reduction programs, and life-cycle analysis;
- Job creation through public works and energy efficiency upgrade projects; and
- A cleaner environment through programs and operations that minimize adverse environmental impacts.

The Pierce County Office of Sustainability recently published *Implementing Sustainability (2010–2015)*, which provides the County's sustainability goals, programs, and actions (Pierce County, 2010). Over the next 5 years, Pierce County will focus on three components of sustainability: education and public outreach, partnerships, and leading by example. *Implementing Sustainability (2010–2015)* includes several goals and programs potentially applicable to Pierce County surface water management and basin planning:

- Address sustainability in comprehensive planning, programming, and County projects;
- Minimize the negative effects of stormwater on Puget Sound through improved LID standards for construction and road building;
- Continue purchasing properties that play a critical role in providing ecosystem services and controlling flooding;
- Incorporate sustainability into our communications with Pierce County residents;
- Create sustainability partnerships with other Pierce County cities, tribes, and special-purpose districts that have a major effect on Pierce County's sustainability; and
- Continue grading the water quality of our stream health using a County-created scorecard.

This proposed Basin Plan includes multiple projects, studies, and programs that would be consistent with Pierce County's sustainability goals. SWM developed the Basin Plan to promote sustainability by taking actions described in the following pages.

Address Sustainability in County Planning. SWM has addressed sustainability during the development of the Basin Plan. The Basin Plan overall would reduce flooding, improve water quality, and enhance habitat in the White River Basin, which would result in a cleaner environment and better health for Pierce County.

The proposed Basin Plan emphasizes nonstructural, natural systems for stormwater control rather than new structures. Relying on natural systems would minimize impacts on land use and habitat. Any future stormwater projects would be relatively small, which would minimize grading and filling activities and the installation of new impervious surfaces. Use of natural systems also would reduce costs for construction and operation of surface water facilities, which would result in taxpayer savings.

Any future surface water projects under the Basin Plan are not anticipated to require electricity or other energy sources for the long term operation of the facility. Similarly, surface water projects typically do not consume large amounts of water. Programs for inspection and maintenance of surface water facilities, monitoring of water quality and habitat, and education and outreach would result in limited vehicle and equipment use by County employees. During construction, future projects could require energy for construction equipment and vehicles. Because the types of projects proposed for the White River Basin would be relatively small, energy and water consumption would be minor.

Pierce County will make this Basin Plan and FSEIS available online and on CD, which would reduce printing and cut postage costs. Any printed copies will be double-sided and will use recycled paper, when possible. Mailings to some customers could be reduced by using social media.

Low-Impact Development. Pierce County would implement an LID program to promote the use of LID in new development and redevelopment. LID techniques rely on natural systems to control and treat stormwater runoff, and minimize the use of constructed detention facilities. Future LID efforts could focus on lakeshore areas, which would help protect and enhance lake water quality. The LID program would minimize the negative effects of stormwater on Puget Sound.

Purchasing Properties. The Lower White River Property Acquisition CIP would purchase undeveloped property along the White River mainstem. This CIP would maintain flood storage and preserve riparian function, which would benefit water quality and habitat. Under another countywide program, SWM would acquire and manage properties for floodplain, water quality, and habitat protection.

Incorporate Sustainability into Communications. Several basin-specific and countywide measures would provide education, outreach, and technical assistance with landowners, farmers, government agencies, and community groups in the White River Basin. These programs would increase public awareness of water quality and flooding issues in the

basin and around Lake Tapps, and would encourage landowners to voluntarily implement water quality and riparian improvements.

Develop Partnerships. SWM would develop several studies and programs in partnership with other Pierce County agencies. Developing partnerships to implement the Basin Plan would improve water quality and aquatic/riparian habitat in the basin. In coordination with the Alliance, SWM would develop a monitoring plan for Lake Tapps water quality and a study to identify pollutant sources that could enter Lake Tapps via the White River diversion canal. SWM would report septic system problems, which are a source of nutrients and bacteria in lakes and streams, to the TPCHD so that it can take appropriate action.

A countywide land management program for flood hazard reduction, water quality, and habitat impact mitigation, would be developed in coordination with other departments, agencies, citizen groups, and entities that have a stake in property acquisition sites or the overall program. Education and outreach programs would include a coordination element with other agencies, groups, or jurisdictions. Other programs would enhance cooperation with cities and other agencies, as well as the capacity of the PRWC.

Water Quality Monitoring. The Basin Plan would include programs to monitor water quality and aquatic habitat. Water quality monitoring would be performed as outlined in the *Countywide Water Quality Monitoring Plan*. Where appropriate, monitoring would include a County scorecard that grades the water quality of stream health. The water quality monitoring program also would include a status check, as well as a trend analysis on the water quality in the monitoring streams.

Invasive Species Control. The Basin Plan would include programs to control invasive species and restore native vegetation. Non-native and invasive plants, such as Scot's broom and Himalayan blackberry, have established themselves in the basin as the result of land clearing for agriculture and development. The proposed programs would 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 improve plant-species diversity and wildlife habitat in the long term. Control of invasive species would enhance riparian, wetland, and terrestrial habitats.

10.3.9 Climate Change

This section evaluates potential greenhouse gas (GHG) emissions and climate change impacts for this proposed Basin Plan. It describes climate change, qualitatively evaluates GHG emissions and mitigation, and discusses habitat restoration and changes in land use.

Climate Change

Climate change, also referred to as global warming, is an increase in the overall average atmospheric temperature of the earth. Many scientists believe that most of the

increase in observed global temperatures since the mid-twentieth century is likely due to human activities. The primary source of climate change is increased levels of GHGs. Many scientists also anticipate that if GHGs continue to increase in the coming decades, average global temperatures will increase, sea levels will rise, and precipitation patterns will change.

In the Northwest, climate change is expected to result in reduced snowpack, changes in winter flooding patterns, reduced summer streamflows for fish, and altered habitat for other wildlife.

Climate change poses a risk to human health because of increased heat-related illnesses and deaths, transmission of food- and water-borne diseases, extreme floods and storms, and potentially higher ozone levels that could cause or exacerbate heart and lung diseases. Communities in the United States could be affected by coastal and river flooding; water scarcity; population movements; energy demand; and changing economies that are based on agriculture, forestry, water resources, or tourism.

Greenhouse Gases

Greenhouse gases, which come from natural sources and human activity, generally include six types of gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). These GHGs can contribute to cumulative effects on global climate change. CO_2 is the primary GHG emitted by vehicles.

Emissions of GHGs typically are expressed in a common metric so that their impacts can be directly compared. The international standard practice is to express GHGs in carbon dioxide equivalents (CO_2e), because CO_2 is the most prevalent of all GHGs.

The major sources of GHGs in Washington State include transportation, electricity, industry, residential and commercial buildings, waste management, and agriculture. In Washington, transportation accounts for nearly half of GHG emissions because most electricity is generated by hydropower rather than fossil fuels.

Policies and Methods

Ecology is currently preparing guidance on evaluating climate change when evaluating proposals under SEPA. Agency decision-making that includes a SEPA analysis is an important part of reducing GHG emissions. Ecology has yet to issue guidance for non-projects under SEPA, which includes Pierce County decisions on basin plans.

Currently, quantitative modeling tools for evaluating the emissions of GHGs in Washington are limited. Greenhouse gas emissions cannot be accurately quantified for projects and programs because of the lack of modeling tools and guidelines for surface water facilities. Due to limited information, a quantitative assessment of the GHG emissions and potential climate change impacts cannot be made at the basin planning level. Better tools and guidance are currently being developed, but will not be available before the environmental documentation has been completed for the proposed Basin Plan. Emissions of GHGs, therefore, have been evaluated qualitatively.

Significant Impacts and Mitigation

Pierce County is actively pursuing goals and objectives that are designed to reduce the County's contribution to, and minimize the significant impacts of, climate change in the White River Basin. Some of these activities are summarized below.

Basin Planning and Programs

Pierce County has developed the proposed Basin Plan to emphasize nonstructural, natural systems for stormwater control rather than new structures. Relying on natural systems would minimize emissions of GHGs and alteration of habitat. Any future projects anticipated under the Basin Plan would be relatively small.

Under the Basin Plan, SWM would acquire and manage properties for floodplain, water quality, and habitat protection. The Lower White River Property Acquisition CIP would purchase undeveloped property along the White River mainstem. This CIP would maintain flood storage and preserve riparian function, which would benefit water quality and habitat.

Pierce County also would implement a LID program to promote the use of LID in new development and redevelopment. LID techniques rely on natural systems to control and treat stormwater runoff, and minimize the use of constructed detention facilities. Implementing LID techniques to reduce the area of new pavement and concrete would also reduce GHG emissions associated with construction. The LID program would minimize the negative effects of stormwater on lakes and rivers in the White River Basin.

The Basin Plan includes several basin-specific and countywide measures that would provide education, outreach, and technical assistance with landowners, farmers, government agencies, and community groups in the White River Basin. One measure is to develop and implement an education, outreach, and technical assistance program. This program would include educating the residents on potential climate change impacts on water resources.

Construction

Construction of any future projects under the Basin Plan could involve activities that could temporarily increase emissions of GHGs. Potential construction impacts would include GHG emissions from the manufacture of paving materials, exhaust from construction equipment and vehicles, and temporary traffic delays that reduce travel speeds. As mitigation, Pierce County would use BMPs, where possible, to reduce exhaust emissions during construction.

Operation

Surface water management facilities typically are not long term sources of GHGs. Projects anticipated under the proposed Basin Plan would not require electricity or other energy sources to operate the surface water facilities. Surface water facilities do not require full time employees on site.

Programs for inspection and maintenance of surface water facilities, monitoring of water quality and habitat, and education and outreach would increase vehicle and equipment use by County employees. Vehicle and equipment use would increase emissions of GHGs.

Future emissions from County vehicles would be partially mitigated by Pierce County's commitment to invest in fuel efficient vehicles to limit the County fleet's emissions and reduce contaminants in the air and in the Puget Sound (Pierce County, 2010). One of the County's sustainability goals is that 50 percent of Pierce County general use fleet will be hybrid, electric or alternative fuel vehicles by 2015.

Habitat and Land Use

Climate change will affect natural ecosystems and species diversity. Stress on plant and animal species will increase due to vegetation changes, food web disruption, streamflow changes, and increased freshwater and marine water temperatures. Climate change might alter regional distributions of many species, including marine and freshwater phytoplankton, zooplankton, and salmonids. The biodiversity of various ecosystems is vulnerable to climate change.

The proposed Basin Plan includes multiple projects, studies, and programs that would restore and protect habitat in the White River Basin. Programs to control invasive species, improve fish passage, and restore native vegetation would improve plant species diversity and riparian, wetland, and terrestrial habitats. Other measures would address water quality issues in the basin. Improving water quality, controlling invasive species, and restoring native vegetation and habitat would help maintain biodiversity within the basin. Maintaining biodiversity would help Pierce County ecosystems adapt to climate change.

Land use and land cover are linked to climate and other environmental changes. Changes in land use will release carbon stored in trees and soils, and also will reduce the number of trees available to store carbon in future years. SWM developed the Basin Plan to minimize land clearing. The Basin Plan would emphasize nonstructural, natural systems for stormwater control rather than new structures that would clear land. Other programs in the Basin Plan would restore vegetation and habitat.

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Response to Comments

This section provides comments and responses to comments received on the proposed White River Basin Plan and DSEIS. The proposed White River Basin Plan (Basin Plan) and DSEIS were issued on June 6, 2012 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 6, 2012. A single comment letter was received during the 30-day comment period. This comment and response are below:

Comment:

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
PO Box 47775 • Olympia, Washington 98504-7775 • (360) 407-6300
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

July 6, 2012

Adonais Clark, Responsible Official Designee
Pierce County Planning and Land Services
2401 South 35th Street, Suite175
Tacoma, WA 98409

Dear Mr. Clark:

Thank you for the opportunity to comment on the draft supplemental environmental impact statement for the White River Basin Plan project (WP58928). The Department of Ecology (Ecology) reviewed the information provided and has the following comment(s):

WATER QUALITY: Cindy James (360) 407-6556

Salmon Creek and Boise Creek both have fecal coliform Total Maximum Daily Loads (TMDLs). They are part of the Puyallup River Basin TMDL which includes the White River.

Ecology's comments are based upon information provided by the lead agency. As such, they may not constitute an exhaustive list of the various authorizations that must be obtained or legal requirements that must be fulfilled in order to carry out the proposed action.

If you have any questions or would like to respond to these comments, please contact the appropriate reviewing staff listed above.

Department of Ecology
Southwest Regional Office

(SM:12-2652)

cc: Cindy James, WQ

Response: Thank you for the information you provided on the Puyallup River Basin TMDL. The Basin Plan indicates these streams require a TMDL, as the TMDL and Basin Plan were being developed concurrently. Pierce County is aware the TMDL has been developed and that the Phase I Municipal Stormwater General Permit for 2013-2018 (Phase I Permit) will require specific TMDL compliance actions. Pierce County will

implement these actions as part of its Stormwater Management Program for the Phase I Permit.

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Pierce County, Sumner Branch

Cascade Water Alliance

Interested Parties List

Due to the length of the interested parties list, it is not included here. It is available for viewing during business hours at:

Pierce County Surface Water Management Offices
2702 South 42nd Street, Suite 201
Tacoma, WA 98409

CHAPTER ELEVEN
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