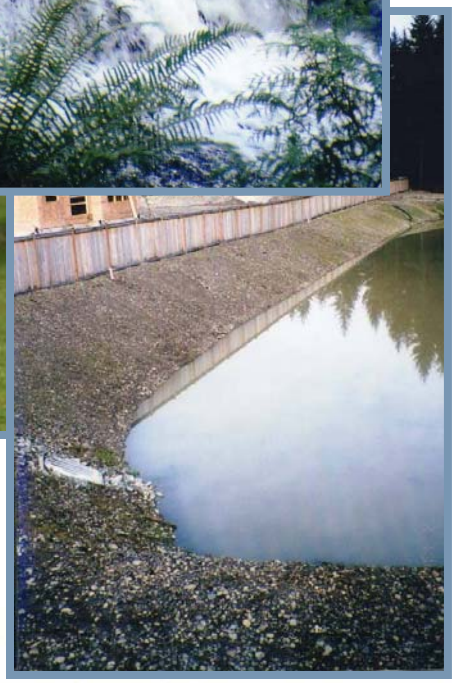
Mid-Puyallup Basin Plan

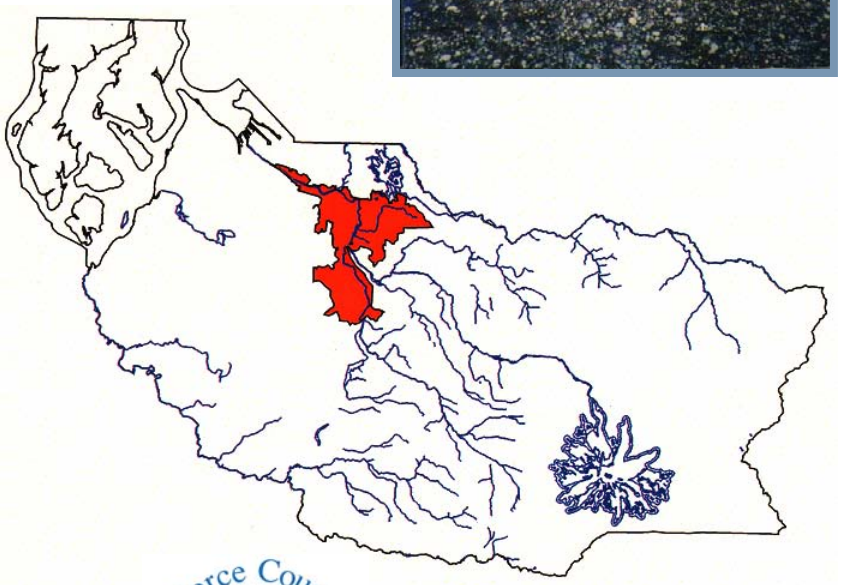
Volume 1 - Basin Plan & SEIS

MID-PUYALLUP BASIN PLAN

Volume 1 - Basin Plan & SEIS

As Adopted PCC 2005-72
November 2005





Pierce County
Public Works & Utilities
Water Programs Division

Sponsored by: Councilmember Terry Lee
Requested by: County Executive/Public Works & Utilities Department

File No. 21A

ORDINANCE NO. 2005-72

An Ordinance of the Pierce County Council Amending Chapter 19D.60 of the Pierce County Code, "Storm Drainage and Surface Water Management Plan; and Adopting the "Mid-Puyallup Basin Plan" for the Unincorporated Area of Pierce County as an Area Update to Pierce County's Storm Drainage and Surface Water Management Plan.

Whereas, the Pierce County Council adopted Ordinance No. 87-205 on March 15, 1988, which was amended by Council Ordinance No. 88-200 on December 20, 1988, thereby establishing the Pierce County Storm Drainage and Surface Water Management Utility; and

Whereas, the Pierce County Council adopted Ordinance No. 91-113 on November 5, 1991, which adopted the "Pierce County Storm Drainage and Surface Water Management Plan (Master Plan), codified as Chapter 19D of the Pierce County Code (PCC) for the unincorporated areas of Pierce County; and

Whereas, the Master Plan focused on county-wide flood hazard reduction with the Mid-Puyallup Basin addressed as part of the rural area without identification of specific storm drainage problems in the Mid-Puyallup Basin; and

Whereas, the County Council adopted Ordinance No. 91-197 in January 1992, which adopted the "Puyallup River Basin Comprehensive Flood Control Management Plan"; and

Whereas, the "Puyallup River Basin Comprehensive Flood Control Management Plan" applied to the main stem of the Puyallup River, White River, and Carbon River and did not address flooding and storm drainage problems in the drainage basins of tributaries flowing to the Puyallup River; and

Whereas, since the Master Plan was adopted, the Pierce County Council adopted the Comprehensive Plan for Pierce County Washington in November 1994 pursuant to the State Growth Management Act; and

Whereas, the Growth Management Act requires consistency between the Comprehensive Plan for Pierce County Washington and capital improvement plans for public Since facilities; and

Whereas, since adoption of the Master Plan, Pierce County has been issued a National Pollutant Discharge Elimination System (NPDES) stormwater permit under the

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930 Tacoma Avenue South
Tacoma, WA 98402

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federal Clean Water Act, which imposes water quality requirements and standards on stormwater discharges; and

Whereas, Chinook salmon and Bull Trout that exist in Pierce County waters have been listed as endangered species since adoption of the Master Plan; and

Whereas, Pierce County participates in the federal Flood Insurance Program for reduced flood insurance for County residents and receives additional benefits as a Federal Emergency Management (FEMA) Community Rating System participant, which favors comprehensive surface water management plans; and

Whereas, the Pierce County Council has received the recommendation for approval of the Mid-Puyallup Basin Plan and Final Supplemental Environmental Impact Statement from the Pierce County Storm Drainage and Surface Water Management Advisory Board; and

Whereas, the Pierce County Council has received the Findings of Fact, Staff Report, and recommendation for approval of the Mid-Puyallup Basin Plan from the Pierce County Planning Commission; and

Whereas, the Economic Development and Infrastructure Committee of the County Council conducted a public hearing on the proposed Mid-Puyallup Basin Plan on September 20, 2005; and

Whereas, the Pierce County Council has determined that the proposed Mid-Puyallup Basin Plan implements the Comprehensive Plan of Pierce County Washington, and protects the public health, safety, and welfare; **Now Therefore,**

BE IT ORDAINED by the Council of Pierce County:

Section 1. The Pierce County Council hereby adopts the "Mid-Puyallup Basin Plan" dated August 2005 as set out in Exhibit "A," attached hereto and incorporated herein by this reference.

Section 2. Chapter 19D.60 PCC is hereby amended as shown in "Exhibit B," attached hereto and incorporated herein by reference, to include the Mid-Puyallup Basin Plan.

Pierce County Council
930 Tacoma Avenue South
Tacoma, WA 98402

Section 3. The Pierce County Council hereby adopts the "Findings of Fact" as shown in "Exhibit C," attached hereto and incorporated herein by reference.

PASSED this 1st day of November, 2005.

ATTEST:

Denise D. Johnson
Clerk of the Council

PIERCE COUNTY COUNCIL
Pierce County, Washington

Shawn Bunney
Council Chair

John W. Ladenburg
Pierce County Executive
Approved ✓ Vetoed _____, this 4 day of Nov, 2005.

Date of Publication of Notice of Public Hearing: October 12, 2005

Effective Date of Ordinance: November 14, 2005

Pierce County Council
930 Tacoma Avenue South
Tacoma, WA 98402

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MID-PUYALLUP BASIN PLAN EXECUTIVE SUMMARY

ES.1 Introduction and Purpose

The 2005 Mid-Puyallup Basin Plan (Basin Plan) serves as a comprehensive guide to surface water management in unincorporated areas of the Mid-Puyallup Basin. The Basin Plan focuses on multiple aspects of surface water management with an emphasis on flooding, water quality, and habitat issues.

This Basin Plan was developed as part of Pierce County's basin planning program that takes a focused approach to watershed management in each of the County's major drainage basins. Previously, the Pierce County Storm Drainage and Surface Water Management Plan (1991 Plan) addressed surface water management countywide for over a decade. Under the 1991 Plan, Mid-Puyallup was combined with several other rural basins and given only minor consideration. Mid-Puyallup is one of 26 Pierce County basins (see *Figure ES-1*).

The purpose of the Mid-Puyallup Basin Plan is to establish the actions Pierce County will take that are needed to reduce flood hazards, to protect water quality, and to protect fish and wildlife habitat in the Mid-Puyallup drainage basin given the physical characteristics of the basin; the laws, policies and regulations that apply to surface water management in Pierce County; the preferences of citizens in the County and in the Mid-Puyallup Basin; and the character of existing land use and planned growth as set out in the Comprehensive Plan for Pierce County, Washington.

The Basin Plan supports or furthers Pierce County's:

- Compliance with its federal "Clean Water Act" National Pollution Discharge Elimination System (NPDES) municipal stormwater permit
- Compliance with the "Endangered Species Act" (ESA) by eliminating or reducing existing potential habitat issues that could cause "jeopardy" for listed species
- Upgrade to a "Class 4," rating or better, under the Federal Emergency Management Agency's (FEMA) "Community Rating System" (CRS)

ES.2 Goals of the Mid-Puyallup Basin Plan

Specific goals and objectives of the Mid-Puyallup Basin Plan are:

Reduce Flood Hazards

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

FIGURE ES-1

Improve Water Quality

- State Surface Water Quality Standards (WAC 173-201a) are met or exceeded
- Number of impaired (303d listed) water bodies is reduced
- Pierce County is in compliance with its NPDES permit for stormwater by meeting permit terms and conditions to the maximum extent practicable
- Risk of groundwater contamination is reduced
- Rates of erosion are reduced

Improve Associated 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 Endangered Species Act are maintained or increased
- Quality and quantity of available wetland, riparian, and upland habitat is improved

ES.3 Basin Description

The Mid-Puyallup Basin comprises the drainage areas of tributaries to the Puyallup River between river mile (RM) 7 and RM 26.5. It excludes the Carbon River and White River drainages and the main stem of the Puyallup River (see *Figure ES-2*). The main stem of the Puyallup River is covered in other plans. The entire Mid-Puyallup planning area encompasses 57.6 square miles (36,333 acres), of which 41.8 square miles (74%) is within unincorporated Pierce County. The remaining 15.8 square miles (26%) are within areas incorporated by various cities; Bonney Lake, Fife, Orting, Puyallup, and Sumner. For a description of the roles of the cities and the Puyallup Tribe, refer to Chapter 3, Stakeholder Involvement.

The Mid-Puyallup Basin is part of "Washington State Water Resource Inventory Area"(WRIA) 10, the Puyallup-White River Basin. Mid-Puyallup Basin contains six primary tributaries:

- **Alderton Creek**, tributary 0399, confluence at Puyallup RM 12.2
- **Van Ogles Creek**, tributary 0400, confluence at Puyallup RM 13.1
- **Ball Creek**, tributary 0405, confluence at Puyallup RM 14.9
- **Fennel Creek**, tributary 0406, confluence at Puyallup RM 15.5
- **Canyon Falls Creek**, tributary 0410, confluence at Puyallup RM 16.2
- **Horsehaven Creek**, tributary 0589, confluence at Puyallup RM 20.2

In addition, 18 square miles (11,560 acres) drain directly to the river and are not associated with the creeks. Descriptions of the tributary drainage basins are located in Chapter 4, Current Conditions.

Figure ES-1
Study Area

repeat of County figure 1-2 from Chapter 1

ES.4 Problems, Proposed Solutions and the Prioritization Process

Problems identified in the Basin Plan are from flooding caused by surface water or groundwater, surface water impairment, stream degradation, and riparian habitat degradation due to stormwater. The Basin Plan also addresses the impacts associated with these problems and issues, such as: property damage from flooding; inadequate drainage; violations of federal, state and local regulations; and threats to public health and safety.

Each potential Capital Improvement Project (CIP) and programmatic recommendation was evaluated for its net natural resource management benefit and then prioritized based on cost-to-benefit considerations.

In determining net benefit, each project and program was scored using a system that assigned points for the project or program's potential for various aspects of flood reduction, water quality protection or improvement, natural resource improvement, and other factors such as economic development, multiple use, education, and recreation. Each project and program was reviewed and scored using approximately 40 specific criteria. Recommended CIPs and programs were then put in rank order, based on their numeric benefit score, and grouped by "High," "Medium," and "Low" priority order. In total, the Basin Plan recommends $16,488,700 of projects and programs for the Mid-Puyallup Basin. This includes $1,091,000 "High Priority"; $14,317,200 "Medium Priority"; and $1,080,500 "Low Priority" projects.

ES.4.1 Recommended Actions

Capital Improvement Projects

For the Mid-Puyallup Basin, 23 CIPs have been recommended to improve drainage, solve flooding problems, protect floodplain, and protect water quality. These CIPs are summarized in *Table ES-1* and grouped by "High," "Medium," and "Low" priority.

CIPs include a variety of culvert replacements, stormwater pond enhancements, channel capacity improvements, storm drain construction, riparian corridor restoration and protection, maintenance activities, and property acquisitions. Detailed descriptions of each CIP and its associated links are provided in Chapter 9 - Basin Plan.

The recommended CIPs total is $14,851,200. Of that amount:

- $205,000 is identified as "High Priority"
- $13,733,200 is identified as "Medium Priority"
- $913,000 is identified as "Low Priority"

ES.4.2 Programmatic Recommendations

Most of the recommended programs apply countywide. Cost estimates for implementing the programs in the Mid-Puyallup Basin have been calculated based on a 10.2% share of the overall countywide costs over a 10-year period. A period of 10 years was chosen for estimating costs although most programs are expected to continue indefinitely. Programmatic recommendations total $1,637,500 over this 10-year period and are prioritized as follows: $886,000 "High Priority"; $726,000 "Medium Priority"; and $25,500 "Low Priority".

Specific programmatic activities are:

- Low Impact Development (LID) Pilot Study
- Update Stormwater Quality Standards
- Inspection Increases for Stormwater Compliance and NPDES permit
- Land Acquisition Program
- Restoration and Enhancement Program
- Education, Outreach, and Technical Assistance Program
- Monitoring Program
- Best Management Practices (BMPs) for Maintenance Manual
- Invasive Species Management Program
- Flood Disclosure Statements in Property Titles
- Enhanced cooperative arrangement with cities and other jurisdictions

Table ES-1 summarizes Capital Improvement Projects (CIP) and Programmatic recommendations. Detailed descriptions of each CIP and Programmatic recommendation are provided in Chapter 9 - Basin Plan.

Table ES-1 Summary Recommendations

"HIGH-PRIORITY" RECOMMENDATIONS			
Project Name	Project No	Score	Estimated Cost
Update Stormwater Management Standards	PRG-00-02	380	$3,000
BMP Maintenance Manual	PRG-00-08	427	$21,000
Invasive Species Management Program	PRG-00-09	437	$21,000
Develop Land Acquisition Program	PRG-00-04	389	$27,000
Jansky Road Channel Stabilization	CIP-23-HH8-RST02	331	$99,000
LID Pilot Study	PRG-23-01	346	$100,000
Education, Outreach, and Technical Assistance	PRG-00-06	397	$102,000
106th Street E Culvert Replacement	CIP-23-BC1-C07	332	$106,000
Inspection Increases for Stormwater Compliance Requirements and NPDES Permit	PRG-00-03	398	$612,000
Total estimated cost of "High-Priority" Projects			$1,091,000

Table ES-1 Summary Recommendations *- continued*

"MEDIUM-PRIORITY" RECOMMENDATIONS			
Project Name	Project No	Score	Estimated Cost
Ball Creek Fish Barrier Culvert Replacements	CIP-23-BC2-C01-C06	234	$39,000
Horsehaven Riparian Property Acquisition	CIP-23-HH1-AC02	297	$79,200
188th Street E Culvert Replacement	CIP-23-HH5-C07	302	$87,000
Mouth of Ball Creek Fish Passage	CIP-23-BC2-RST01	198	$131,000
Enhanced cooperative arrangement with cities and other jurisdictions	RRG-00-11	315	$150,000
150th Avenue Culvert Replacement	CIP-23-HH4-C05	206	$151,000
Fir Ridge Infiltration Pond	CIP-23-FC5-DP01	274	$205,000
Mouth of Horsehaven Creek Property Acquisition	CIP-23-HH1-AC01	300	$264,000
Mouth of Ball Creek Property Acquisition	CIP-23-BC2-AC01	220	$264,000
Restoration and Enhancement Program	PRG-00-05	325	$102,000
McCutcheon Road Bridge Replacement	CIP-23-FC1-BRG01	197	$345,000
Monitoring Program	PRG-00-07	265	$474,000
Van Ogles Creek Replacement	CIP-23-V01-RST01	262	$2,362,000*
Fennel Creek Restoration	CIP-23-FC1-RST01	294	$2,494,000*
Ball Creek Restoration	CIP-23-BC2-RST02	272	$2,494,000*
Horsehaven Creek Restoration	CIP-23-HH1-RST01	289	$4,676,000*
Total estimated cost of Medium-Priority Projects			$14,317,200

LOW-PRIORITY RECOMMENDATIONS			
Project Name	Project No	Score	Estimated Cost
Flood Disclosure Statements in Property Titles	PRG-00-10	85	$25,500
Military Road Culvert Replacement	CIP-23-BC1-C11	120	$44,000
Pioneer Way Conveyance Improvements	CIP-23-A1-RF01	132	$53,000
Freeman Road Conveyance Improvements	CIP-23-D17-RF03	62	$86,000
Railroad Culvert Replacement	CIP-23-BC1-C09	132	$96,000
Pioneer Way Culvert Replacement	CIP-23-BC1-C08	142	$142,000
Riverside Drive E Culvert Replacement	CIP-23-V01-C01	75	$148,000
Flooded Property Acquisition	CIP-23-D1-AC01	72	$197,000
Kelly Lake Road Bridge Replacement	CIP-23-FC3-BRG02	80	$289,000
Total estimated cost of Low-Priority Projects			$1,080,500

* These costs are total cost of multiphase projects; see CIP descriptions in 9.3.2 for breakdown.

ES.4.3 Implementation Strategy

Implementation of the recommended actions will generally follow the prioritization groupings of high, medium, and low and a logical order of sequencing. To ensure that the full benefits of all projects are realized, implementation will not follow the exact sequence of the first project to the last project in the High category, followed by the first action in the Medium category, and so forth. Several factors exist that will result in implementation of actions that are not in the exact sequence as depicted in the projects and programs prioritized by the benefit and ranked by cost table. These factors include the following:

- Available funds
- Contingent projects[1]
- Available staff and professional service needs
- Cooperation from private landowners
- The best implementer may be an agency other than Pierce County Public Works and Utilities
- New information, regulations or emerging issues

Economic Development Criteria

Implementing projects and programs recommended in the Basin Plan is expected to reduce flood hazards, and preserve or protect water quality and floodplain habitat. Collectively and individually, these projects are aimed at protecting Pierce County's quality of life. Projects and programs in the Basin Plan will:

- Afford resource protection as the community develops
- Preserve, enhance or protect natural floodplain functions
- Balance structural and 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 stay in Pierce County.

In addition to the above, Water Programs will consider the following criteria in developing its annual proposed capital facilities plan updates:

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[1] Contingent projects include projects such as stream restoration projects intended to reduce flood hazards and improve aquatic habitat, and culvert replacement projects intended to improve fish passage. These projects will provide their full benefit after all downstream fish passage barriers are removed, and should be sequenced accordingly.

- Is the project located in an employment center zone (or handle flow from those zones)?
- Is the project located in another type of commercial zone (or handle flow from those zones)?
- Will the project reduce permitting timelines for industrial/commercial projects?
- Will the project assure access to an employment center via road and /or rail?
- Will the project increase the supply of developable property?
- Will the project reduce overall development costs?
- Are there partners willing to contribute to the development costs of the project?
- Does the project allow / provide for land development?

In light of these and other factors, following action on the Basin Plan, Pierce County will develop an implementation strategy designed to sequence, schedule and assign resources for the various recommended actions. This implementation strategy will be developed in collaboration and coordination with other potential implementers and in consideration with available financial and staff resources. The implementation strategy will include performance measurements and provide for periodic evaluation of progress. A potential implementation sequence that primarily considers contingent projects is shown in Chapter 10 - Environmental Impact Statement.

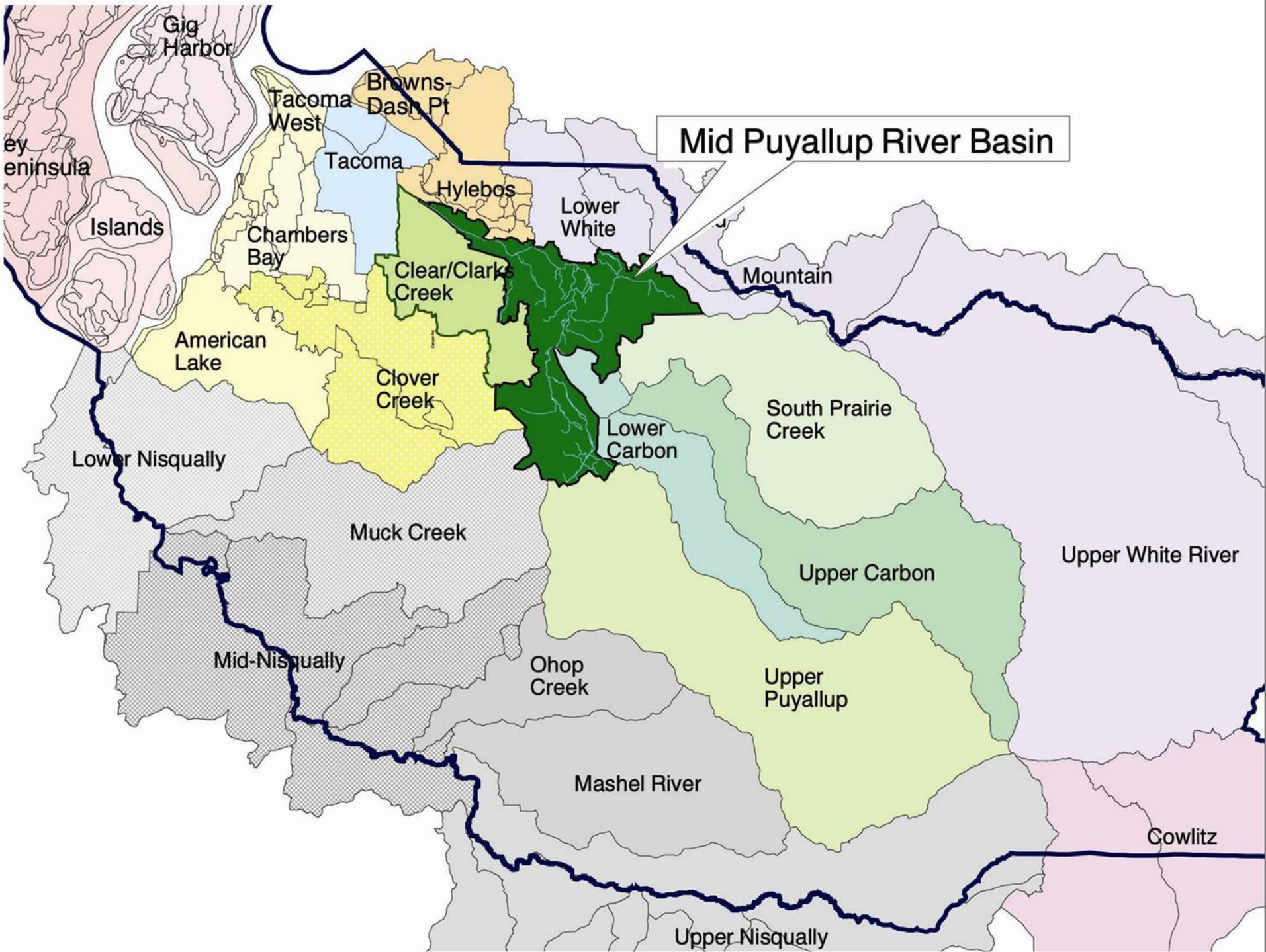
1. INTRODUCTION

The Pierce County Water Programs Division within the Public Works and Utilities Department (Water Programs) is responsible for surface water management in unincorporated Pierce County. In carrying out this responsibility, Water Programs plans, designs, secures permits for, builds and maintains storm drainage and surface water management facilities. Water Programs also identifies non-structural solutions to surface water problems such as monitoring needs, enforcement, regulatory changes, or services. Related responsibilities include compliance with requirements for participation in the NFIP, the stormwater quality requirements of the federal Clean Water Act, the County's Stormwater National Pollution Discharge Elimination System (NPDES) Permit, and the prohibitions of "take" under the federal Endangered Species Act. Other related responsibilities consist of river levee maintenance, participation in FEMA's "Community Rating System," stream gauging, water quality monitoring, gathering of rainfall data, emergency response during floods, water supply planning and public information. Fees paid by property owners in unincorporated Pierce County and grant funds pay for these facilities and services.

1.1 Basin Planning Program

Pierce County Water Programs is preparing a series of basin plans to identify and prioritize facilities improvements projects and other Water Program activities in individual drainage basins. Basin plans comprehensively address flooding, water quality and floodplain habitat aspects of surface water management in the major stream systems of the non-federal lands within the unincorporated portions of the county. The basin plans will update the county-wide Pierce County Storm Drainage and Surface Water Management Plan (Montgomery Engineers Inc., 1991) (a.k.a., 1991 Plan). Basin plans identify and address the flooding, water quality and stream habitat problems in a particular drainage basin in more detail than was possible in 1991. They incorporate the requirements of major federal, State and Pierce County laws, regulations and policies enacted since the 1991 Plan, such as the State Growth Management Act, stormwater NPDES Permit requirements of the federal Clean Water Act, and the fish listings under the federal Endangered Species Act (ESA). The basin plans will be implemented primarily through Water Programs activities. Drainage facilities within cities and towns, national forests, parks, and military bases are not within the scope of basin plans, unless they affect drainage conditions in unincorporated areas. The Mid-Puyallup Basin Plan addresses the Mid-Puyallup Drainage Basin.

Figure 1-1 shows the location of the Mid-Puyallup Basin relative to the other 25 drainage basins in the county. The Muck Creek Basin, Clover Creek Basin, Clark Creek Basin, Hylebos Basin, Lower White River Basin, Lower Carbon River Basin, and Upper Puyallup Basin lie adjacent to the Mid-Puyallup Basin. Basins plans have been prepared for the Muck Creek Basin, Clover Creek Basin, Gig Harbor Basin, and Clear/Clarks Creek Basin. Plans for the remaining basins will follow.


Mid Puyallup River Basin
Gig Harbor
ey
eninsula
Islands
Tacoma West
Browns-Dash Pt
Tacoma
Hylebos
Lower White
Chambers Bay
Clear/Clarks Creek
Mountain
American Lake
Clover Creek
South Prairie Creek
Lower Carbon
Lower Nisqually
Muck Creek
Upper Carbon
Upper White River
Mid-Nisqually
Ohop Creek
Upper Puyallup
Mashel River
Cowlitz
Upper Nisqually

Basin plans are used to develop capital improvement, maintenance and repair, property acquisition, and program schedules and budgets. The planning process is divided into three phases:

"Phase 1" is the basin characterization phase. It consists of inventorying and documenting existing conditions, such as flooding, water quality and habitat problems; existing storm drainage and surface water management facilities; the regulatory environment; existing and future land use; stream flow characteristics; stream reaches and associated wetlands; other critical areas; the creek's ability to support various fish species; and the fish species present.

"Phase 2" is the plan development and adoption phase. It builds on the findings of "Phase 1" by correcting information, performing hydrologic and hydraulic analyses based on planned future conditions, filling information gaps, investigating problems, and identifying solutions. This document is the culmination of "Phase 2."

"Phase 3" is the implementation, monitoring and plan update phase.

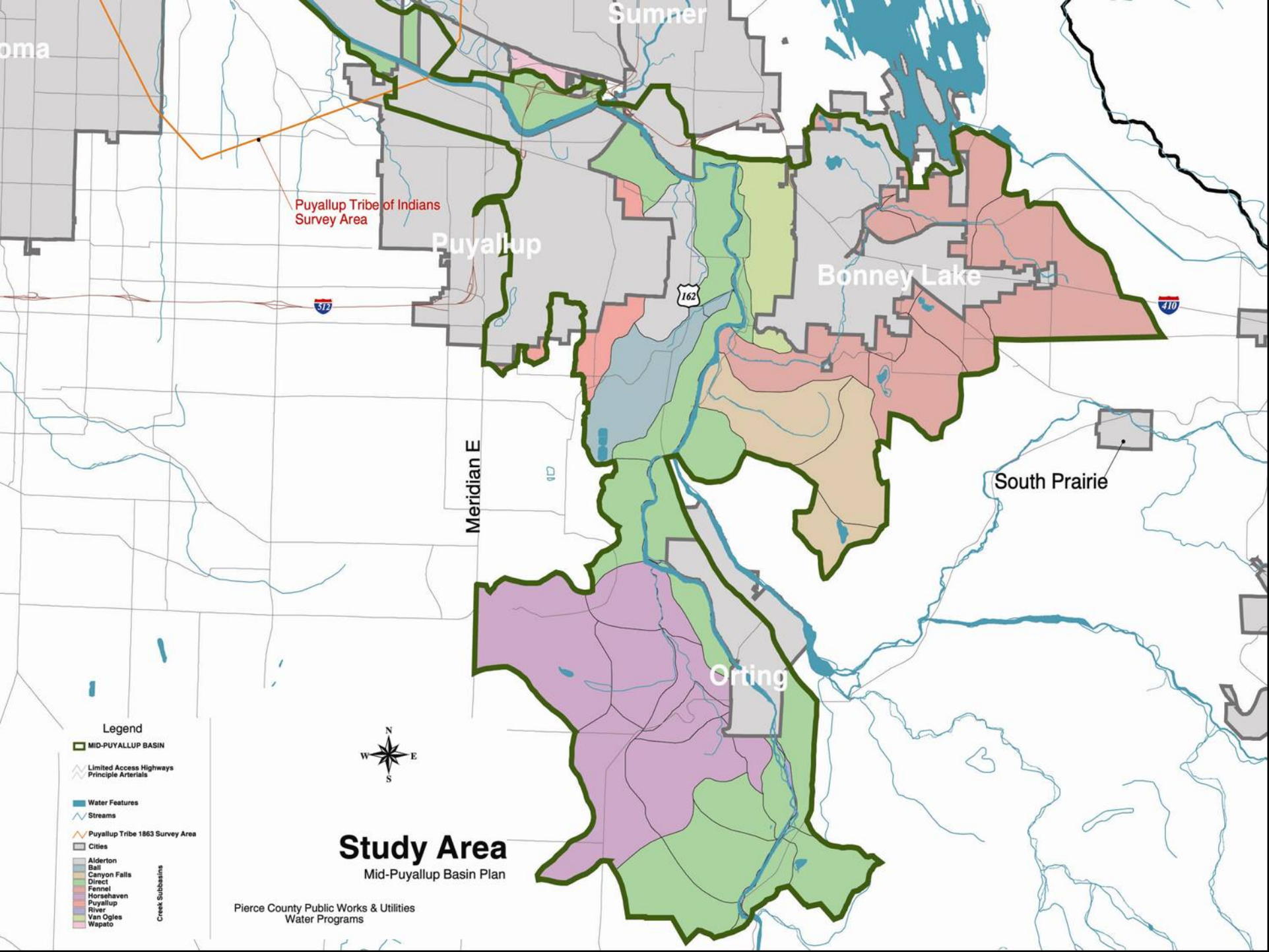
1.2 Mid-Puyallup Basin Plan

The Mid-Puyallup Basin Plan contains the results of the Characterization Report from "Phase 1," as Chapters 1 through 5. Added are Chapters 6, 7 and 8 that document the analysis of problems, such as the results of hydrologic and hydraulic modeling used to estimate the amount of stormwater and stormwater volume peaks where flooding or other problems occur. Chapter 9 recommends capital improvement projects and programmatic solutions (non-structural measures) to solve existing and projected future stormwater problems.

1.2.1 Study Area

The Mid-Puyallup Basin is comprised of the drainage areas of tributaries to the Puyallup River between river mile (RM)-7 and RM-26.5. It excludes the Carbon River and White River drainages and the main stem of the Puyallup River. (See *Figure 1-2, Study Area*) The main stem of the Puyallup River is covered in other plans, particularly the Puyallup River Basin Comprehensive Flood Control Management Plan adopted in 1991.

The entire Mid-Puyallup planning area encompasses 57.6 square miles (36,889 acres), of which 41.8 square miles (74%) exist within unincorporated Pierce County. The remaining 15.8 square miles (26%) is comprised of areas incorporated by various cities, including Bonney Lake, Fife, Orting, Puyallup, and Sumner. For a description of the roles of the cities and the Puyallup Tribe in development of this Plan, refer to Chapter 3, Stakeholder Involvement.


Sumner
oma
Puyallup Tribe of Indians
Survey Area
Puyallup
Bonney Lake
162
312
410
Meridian E
South Prairie
Orting
Legend
MID-PUYALLUP BASIN
Limited Access Highways
Principle Arterials
Water Features
Streams
Puyallup Tribe 1863 Survey Area
Cities
Alderton
Ball
Canyon Falls
Direct
Fennel
Horsehaven
Puyallup
River
Van Ogles
Wapato
Creek Subbasins
N
W
E
S
Study Area
Mid-Puyallup Basin Plan
Pierce County Public Works & Utilities
Water Programs

The Mid-Puyallup Basin is part of Washington State Water Resource Inventory Area (WRIA) 10), the Puyallup-White River Basin. It contains six primary tributaries:

- **Alderton Creek**, tributary 0399, confluence at Puyallup RM 12.2
- **Van Ogles Creek**, tributary 0400, confluence at Puyallup RM 13.1
- **Ball Creek**, tributary 0405, confluence at Puyallup RM 14.9
- **Fennel Creek**, tributary 0406, confluence at Puyallup RM 15.5
- **Canyon Falls Creek**, tributary 0410, confluence at Puyallup RM 16.2
- **Horsehaven Creek**, tributary 0589, confluence at Puyallup RM 20.2

In addition, 18 square miles (11,560 acres) drain directly to the river and are not associated with the creeks. Descriptions of the tributary drainage basins are located in Chapter 4, Current Conditions.

1.2.2 Description of Mid-Puyallup Subbasins

Subbasins are derived by dividing the Mid-Puyallup Basin into stream reaches. For Mid-Puyallup Basin planning purposes, five individual creek drainage areas are included: Ball Creek, VanOgles Creek, Fennel Creek, Canyon Falls Creek, and Horsehaven Creek; and the direct drainage area. Stream reaches for each of major drainage subbasins were identified by map and field check, then the areas draining to each of the reaches was determined. The areas draining to each of the reaches are the minor subbasins.

1.2.3 Key Elements of the Mid-Puyallup Basin Plan

Key elements addressed in the Mid-Puyallup Basin Plan are:

4 **Existing Conditions**
- Characterization of topography, soils, current and future flow volumes, water quality, habitat and land cover factors influencing surface water runoff

4 **Problems**
- Flooding due to surface water and groundwater
- Surface water quality impairment related to stormwater runoff
- Stream and riparian habitat degradation due to stormwater

4 **Impacts**

- Loss of beneficial uses (recreation, water supply, floodplain or riparian habitat, and drinking water, etc.)
- Negative effects of stormwater runoff on the ability to meet federal, state and local regulations
- Property damage from flooding, inadequate drainage or high groundwater
- Threats to public health and safety (road inundation, impaired surface water quality and drinking water quality, etc.)

4 **Solutions**

- Capital projects (e.g., flood control facilities, creek and watershed restoration, etc., related to storm drainage)
- Direct or indirect of land use impacts (e.g., stormwater runoff design standards, etc.)
- Storm drainage system maintenance activities
- Additional research or on-going monitoring
- Outreach and education
- Others as appropriate

1.3 Statement of Purpose

The purpose of the Mid-Puyallup Basin Plan is to establish the actions Pierce County Water Programs will take that are needed to reduce flood hazards, to protect water quality, and to protect fish and wildlife habitat in the Mid-Puyallup drainage basin given the physical characteristics of the Basin; the laws, policies and regulations that apply to surface water management in Pierce County; the preferences of citizens in the county and in the Mid-Puyallup Basin; and the character of existing land use and planned growth as set out in the Comprehensive Plan for Pierce County, Washington.

1.4 Goals, Objectives, and Strategies

Pierce County Water Programs has established general goals and objectives for all of its basin plans to promote consistency among its 26 basins. These are shown on *Table 1-1*. The goals and objectives focus on protecting hydrology, water quality, and habitat as required by federal, State and local laws. The goals and objectives form the base evaluation criteria for selection of recommended facilities, policies, and surface water management program modifications from among the various alternatives. They also permit the facilities recommended by basin plans to be compared and ranked with one another.

Table 1-1
Goals of Mid-Puyallup 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 standing under the Federal Emergency Management Agency Community Rating System is improved. ▪ New development is located outside of flood-prone area.
Improve fish & wildlife habitat	▪ Number of stream miles available for wild, native fish populations are increased. ▪ Population numbers of species listed as endangered or threatened under the Federal Endangered Species Act (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 (303d listed) waterbodies are reduced. ▪ Pierce County is in compliance with its NPDES permit for stormwater by meeting permit terms and conditions to the maximum extent practicable. ▪ Risk of groundwater contamination is reduced. ▪ Rates of erosion are reduced.
Demonstrate coordinated & responsible use of public resources	▪ Cost of maintaining stormwater facilities are 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 & methods for new development	▪ New development in flood-prone, riparian, or significant habitat areas is prohibited. ▪ Low Impact Development techniques are widely used. ▪ Effective BMPs are identified and widely used.

Source: *Framework Document for Basin Plans,* Pierce County Public Works & Utilities, Water Programs

2. APPLICABLE REGULATIONS, POLICIES & PROGRAMS

Numerous federal, State of Washington and local regulations, laws, policies and programs affect how stormwater and surface water are managed in unincorporated Pierce County. This chapter describes those pertinent to the Mid-Puyallup Basin with emphasis on coordination with other programs and consistency with adopted policies and plans.

2.1 Federal Clean Water Act

Section 402 National Pollutant Discharge Elimination System (NPDES)

The goal of the Clean Water Act is to restore all of the nation's waters to a "fishable and swimmable" condition. To meet this goal, a nationwide regulatory program called the National Pollutant Discharge Elimination System (NPDES) was established. In 1987, amendments to the Clean Water Act required the Environmental Protection Agency (EPA) to promulgate regulations for storm water discharges. The regulations defined certain stormwater discharges as point source discharges subject to the NPDES Permit Program. Two broad areas were created as follows:

1. "Stormwater Discharges Associated with Industrial Activity"

2. "Municipal Separate Storm Sewer Systems" in two phases. "Phase I" applies to municipalities with populations greater than 100,000 people. "Phase II" requirements, expected to be implemented by 2005, apply to municipalities with populations of 10,000 people or more and certain urban areas.

EPA delegated responsibility for implementation of the NPDES permit program to the Washington State Department of Ecology (Ecology).

Ecology issued the "Phase I" NPDES Permit for the South Puget Sound Water Quality Management Area (which includes Pierce County) in July 1995. Ecology administratively extended the "Phase I" Permit in 2000 pending development of a "Phase II" permit. All permit requirements remain legally binding in an administratively extended permit.

The NPDES stormwater permit requires that permit holders control pollutants in stormwater to the maximum extent practicable, primarily by implementing a stormwater management program, a functional component of which is the basin plans. Ecology approved the Pierce County's Stormwater Management Program 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 flood management projects
- A program to reduce pollutants from pesticide and fertilizer use
- A program to detect, remove, and prevent illicit discharges to the municipal separate storm sewer system
- A program to reduce stormwater pollution from industrial facilities that discharge into the separate storm sewer system. An educational program for residents, businesses, industries, construction contractors, government employees, and others
- A monitoring plan to determine the effectiveness of program activities
- Reporting requirements
- Coordination among jurisdictions sharing water bodies
- Actions to meet waste load allocations of adopted "Total Maximum Daily Loads" (TMDL's)

Effect of the Current Stormwater NPDES Permit on the Mid-Puyallup Basin Plan
Recommendations of the Basin Pan must adhere to the County's Stormwater NPDES Permit requirements cited above and provisions of the County Stormwater Management Plan. For a description of inter-jurisdictional coordination, see Chapter 3. Chapter 4 describes existing water quality conditions. Chapter 6 analyzes water quality problems and presents alternative solutions. Chapter 9 contains the recommendations for addressing water quality problems most cost-effectively.

2.1.1 Section 303(d) List & Total Maximum Daily Loads (TMDL's)

Section 303(d) of the Clean Water Act requires Ecology to prepare a list of water bodies that are not meeting, or will not meet water quality standards, after application of technology-based effluent limits. Ecology submitted its candidate Section 303(d) list for 2002 in early 2004. Until it is approved by EPA, the State's 1998 list is applicable. Under the 303(d) listing, a *Total Maximum Daily Load* (TMDL) must be calculated for out-of-compliance pollutants. A TMDL specifies the maximum load of the pollutant that can be discharged into the waterbody by regulated activities. Effluent limits for pollutant sources discharging to the waterbody are adjusted downward until the TMDL can be met.

The Puyallup River is the 1998 list for biochemical oxygen demand (BOD), ammonia, and residual chlorine. However, the does not include any of the waterways tributary to the river within the Mid-Puyallup Basin planning area. Waterbodies in the Basin included on the Candidate 2002/04 303d List (Category 4/Fish Habitat) are: Ball Creek, Fennel Creek, Canyon Fall Creek, Horsehaven Creek.

Effect of Section 303(d) Listings on the Mid-Puyallup Basin Plan
Although the Mid-Puyallup Basin does not contain streams with reaches on the 1998 303(d) list, care should be exercised to avoid contributing any additional BOD and ammonia to the Puyallup River. One way of preventing a 303(d) listing and TMDL is to monitor water quality according to Ecology protocols and document monitoring results. This provides a source of data on water quality against which to compare other agencies monitoring results. Another is to examine the various methods of reducing pollutants against water quality standards given the level of development planned for areas draining to the creeks and draining directly to the Puyallup River.

2.1.2 Section 404 Wetland Fill Permits

Placement of fill in waters of the United States is regulated under Section 404 of the CWA. Waters of the United States include wetlands adjacent to streams with flow greater than five (5) cubic feet per second and isolated wetlands greater than one acre that are hydraulically connected to regulated streams. Storm drainage projects that involve filling or work in small areas of wetlands may be permitted under one of several nationwide general permits. An individual permit must be obtained for projects that involve filling more than five (5) acres of wetlands.
Section 404 is administered by the U.S. Army Corps of Engineers (Corps); the Corps' Seattle District is responsible for issuing Section 404 permits in Pierce County. Because the goal of Section 404 is to avoid a net loss of wetlands, permits usually require compensatory mitigation for any loss of wetlands.

Some of the projects identified in Pierce County's earlier storm drainage and surface water management plan have proven more costly to build than estimated because they involved work in wetlands. In general, capital projects that adversely effect wetlands should be avoided.

Effect of Section 404 Regulations on the Mid-Puyallup Basin Plan
Wetland protections argue for several basin plan approaches. First, wherever possible wetlands can be acquired to conserve the natural stormwater runoff and flood storage capacities they provide. Second, the cost estimates of future storm drainage facilities should include the costs of compensatory mitigation. Third, new programs or program revisions designed to protect existing wetlands or create wetlands can be identified by basin plans. Fourth, basin plan recommendations can be prioritized in part upon the extent to which wetland protection and enhancement can be achieved.

2.2 Federal Endangered Species Act

The Endangered Species Act (ESA) directs the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) Fisheries[1] to promulgate a list of endangered and threatened species and designate critical habitat for the listed species. Listed species with the greatest potential to affect surface water management in Pierce County are the chinook salmon (listed as "threatened" in March 1999) and the bull trout (listed as "threatened" in

[1] NOAA Fisheries was previously called the National Marine Fisheries Service (NMFS).

October 1999). NOAA Fisheries has indicated that additional salmonid species may be listed in the next few years. Chinook salmon are found in the Mid-Puyallup Basin.

Section 9 of the ESA prohibits "taking" of listed species. To "take" means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The regulation explains that "harm" may include "*significant habitat modification where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.*"

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

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

Pierce County has policies and programs that help to preserve and restore salmon habitat. NOAA Fisheries has approved a set of transportation maintenance procedures that if followed protect transportation maintenance projects from liability under ESA. For Pierce County (and other jurisdictions), other actions include culvert replacements to improve fish passage and restoration and acquisition of key habitats.

Effect of ESA on the Mid-Puyallup Basin Plan

The listings of the Puget Sound chinook salmon and bull trout prompted local governments to include salmonid recovery efforts in all aspects of operations. The listings have a broad regulatory impact in that water quantity and quality, as well as other fish habitat conditions, must be addressed to protect the species. The Mid-Puyallup Basin Plan must identify existing habitat condition and problems, consider the effects of recommended capital projects on listed species, and identify projects and programs that can improve existing and protect future fish habitat conditions. Coordination with the varied agencies working on fish habitat initiatives should be reflected in recommended solutions to prevent overlap or duplication of effort.

2.3 National Flood Insurance Program

In 1968, the U.S. Congress initiated the "National Flood Insurance Program" (NFIP) (Chapter 44 CFR) under the National Flood Insurance Act to relieve the burden of disaster relief on the national treasury and State and local tax bases. The NFIP is administered by the Federal Insurance Administration (FIA), which is part of the Federal Emergency Management Agency (FEMA). The NFIP makes available affordable flood insurance to communities that adopt approved flood-

plain management regulations. Communities that do not participate in the NFIP do not qualify for certain flood disaster relief. FEMA's Flood Insurance Rate Maps (FIRMs) form the basis for critical area zoning for flood hazards.

2.3.1 NFIP

Pierce County participates in the NFIP. Flood hazard management regulations are codified in Title 17A.50 of the County Code and criteria and procedures are laid out in Chapter 9 of the Pierce County Stormwater Management and Site Development Manual. Federally subsidized flood insurance is available to local residents because of the County's participation. To continue coverage, the County must remain in the NFIP and maintain minimum floodplain management regulations. FEMA requires a certification letter for any revisions to a FIRM. Certification activities include stream channel modifications, installation of culverts, and bridge construction.

2.3.2 Community Rating System (CRS)

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

Effect of the NFIP and the CRS on the Mid-Puyallup Basin Plan
Basin plans serve as part of the flood hazard mitigation plan for Pierce County. To serve in meeting the prerequisites for a "Class 4" rating, the Mid-Puyallup Basin Plan has been developed to meet or exceed the following CRS prerequisites:

Floodplain Management Planning Elements - CRS Planning Steps

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

Table 2-1
Federal and State Laws and Regulations
and Mid-Puyallup Creek Basin Plan

Law or Regulation	Application to the Mid-Puyallup Basin
Federal Laws	
Clean Water Act. Section 402 National Pollutant Discharge Elimination System (NPDES)	Pierce County Stormwater NPDES Permit, consistency with coordination requirement,
Clean Water Act. Section 303(d) List. Total Maximum Daily Load (TMDL)	Must consider ways of reducing stormwater contributions to pollutant loads
Clean Water Act. Section 404 Permit Requirements for Wetland Filling	Pierce County provides direction for basin plans to avoid recommendations that would have negative impacts on wetlands
Endangered Species Act	Consistency between the basin plan & Tri-County Endangered Species Act Response Implementation of the Puyallup WRIA Conservation Plan
National Flood Insurance Program	Acknowledgement of the programs initiated with the Consistency with NFIP objectives and CRS standard Pierce County Flood Hazard Management Code
State Laws, Plans & Regulations	
Water Quality Standards	Analyze water quality and develop projects & programs toward maintaining water quality standards
Puget Sound Water Quality Management Plan	Drainage development standards; Stormwater Management Manual; Stormwater Pollution Control Manual
Growth Management Act	Critical areas regulations
State Environmental Policy Act	SEPA review for basin plan and individual projects
Shoreline Management Act	Pierce County Shoreline Master Program
State Hydraulic Code	Hydraulic Project Approvals required for in-stream work
The Non-Point Rule	Puyallup WRIA Watershed Action Plan

Source: Pierce County Water Programs

2.4 Settlement Agreement with the Puyallup Tribe

In 1989, the U.S. Congress passed the Agreement between the Puyallup Tribe of Indians, Local Governments in Pierce County, the State of Washington, the United States of America, and certain private property owners (Settlement Agreement). Pierce County signed the Settlement Agreement in 1988.

In the Settlement Agreement, the County agreed "The Tribe's treaty fishery must be managed to achieve increased salmon and steelhead production, including protection of necessary habitat, while providing for residential, commercial, industrial and other development, natural resource use, and protection of lives and property from flooding." The County promised to consult with the Tribe when amending land use and resource plans lying within the 1873 Survey Area. (See *Figure 1.2, Study Area*) Consultation consists of notifying the Tribe of the proposal, giving an

opportunity for consultation and discussion, and making good faith efforts to accommodate the concerns of the Tribe in rendering its decision.

Effect of the Settlement Agreement on the Mid-Puyallup Basin Plan
The Settlement Agreement underscores the Basin Plan objective of protecting and enhancing fish habitat through stormwater management activities. It imposes an obligation to consult with the Tribe in a formal consultation process as set out in Document 7 of the Settlement Agreement. To that end, Pierce County has conducted several briefings for the Tribe throughout the development of this Plan and has provided a copy of the preliminary draft to the Tribe for its review.

2.5 State Water Quality Standards

Washington Administrative Code (WAC) 173-201A (included in *Appendix A*) and 173-200 are the State's Water Quality Standards that determine the discharge of stormwater to surface water and groundwater, respectively, by establishing water quality standards for each of the different classes of water and articulating the federal anti-degradation policy. It classifies rivers and streams by the beneficial uses that they should be able to support and the level of support they should provide. It also specifies standards for water quality sampling. Classification identifies the standards that a stream *should* meet, and not whether it does so at the time of classification. WAC 173-200 also calls for designation of special groundwater protection areas based on unique characteristics (e.g., aquifer recharge areas, wellhead protection areas, or sole source aquifers). Chapter 4 describes how well the Mid-Puyallup Basin streams achieve the standards.

WAC 173-201A sets criteria for the following water quality parameters:

- Fecal coliform organisms
- Dissolved oxygen
- Total dissolved gas
- Temperature
- pH
- Turbidity
- Toxic material concentrations

The criteria vary based on the type of water body (e.g., lake or river), its classification, and whether it is fresh or saltwater. WAC 173-201A lists metals and organic compounds that are considered toxic and either provides numerical acute and chronic limits for each or defines a formula to derive the limits for a specific water body.

In July 2003, Washington adopted a new set of water quality standards. The new standards cannot be used until they are approved by EPA, which is expected in 2004. Updated rules establish standards for temperature to protect temperature-sensitive fish, such as bull trout and Dolly Varden. A new indicator (enterococci) will be used to measure the amount of bacteria in marine waters that are not used for shellfish harvesting. New values for ammonia in waters without salmon species have been added. Ecology will classify fresh waters by actual use (such as fish habitat, swimming and water supply), rather than by class (AA, A, B, C and Lake classes), to make the standards more closely linked to the uses of a water body evolve.

Effect of Water Quality and Standards on the Mid-Puyallup Basin Plan
Storm drainage planning is controlled by ground and surface water quality standards along with other factors when developing specific capital improvement alternatives, such as a large regional infiltration basin. This is largely because the standards are the foundation for other water quality programs such as NPDES permits, water clean-up plans (also known as TMDL's), and "401 Water Quality Certifications." Water quality standards are also used as benchmarks for developing recommendations for non-structural solutions.

2.6 Safe Drinking Water Act of 1974

The ***Safe Drinking Water Act of 1974*** (SDWA) transferred responsibility for regulation of drinking water to the EPA and called on the EPA to take a number of steps to protect the quality of the nation's drinking water supplies. EPA has set maximum contaminant levels (MCL) in drinking water for more than 100 substances. Section 1424(e) of the SDWA established a "Sole Source Aquifer Program." EPA was authorized to identify aquifers that are the only or principal source of drinking water for an area.

The program also calls for EPA to review all federally funded projects planned for the area. Based on the review, the EPA administrator may withhold federal financial assistance for projects determined to be potential threats to a designated aquifer. Part of the Mid-Puyallup Basin south and west of the Puyallup River lies in a designated sole source aquifer. The Fennel Creek Watershed encompasses the municipal water supply of the City of Bonney Lake.

In 1986, a new provision of the SDWA (Section 1428) required every state to develop a wellhead protection program to guard the quality of groundwater bodies used for water supply so that water arrives at a well uncontaminated. The Tacoma-Pierce County Health Department administers the wellhead protection program in Pierce County.

Effect of Aquifer & Wellhead Protection Regulations on the Mid-Puyallup Basin Plan
Basin plans take into account the locations of wells and wellhead protection requirements in siting new storm drainage facilities or recommending improvements to existing facilities. Stormwater infiltration facilities must be designed to meet groundwater quality standards or be sited to avoid areas where groundwater intersects aquifers providing potable water supplies.

2.7 The Growth Management Act & the Comprehensive Plan for Pierce County Washington

2.7.1 Growth Management Act

The Growth Management Act (GMA) directed local governments of fast-growing counties, cities, and towns to prepare and adopt comprehensive plans and implementing regulations for managing their growth. Pierce County was required to prepare a comprehensive plan that meets the GMA precepts. The Comprehensive Plan for Pierce County Washington **(**County Comprehensive Plan) became effective in December 1994. Development regulations to implement the comprehensive plan were adopted in 1995. Current law requires an update of these regulations by December 2004.

Three GMA planning goals directly apply to storm drainage planning:

- "Urban growth. Encourage development in urban areas where adequate public facilities and services exist or can be provided in an efficient manner."
- "Environment. Protect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water."
- "Public facilities and services. Ensure that those public facilities and services necessary to support development shall be adequate to serve the development at the time it is available for occupancy and use without decreasing service levels below locally established minimum standards."

In addition, the CMA requires jurisdictions to develop and adapt six-year capital facilities plans. The basin plans fulfill Pierce County's compliance for CFP, storm drainage facilities.

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

Local governments are required to classify and designate "resource lands of long-term commercial significance" and "critical areas." Resource lands of long-term commercial significance include agricultural, forest, and mineral resource lands. Critical areas include wetlands, fish and wildlife habitat areas, aquifer recharge areas, frequently flooded areas, and geological hazardous areas.

2.7.2 Pierce County Comprehensive Plan

The Pierce County Comprehensive Plan was developed and adopted in 1995 and is subject to updates every two years in response to the requirements of the GMA, and is codified in Title 19A of the County code. The Comprehensive Plan provides county-wide policies in 11 areas in cooperation with all cities and towns in the county. The community planning process uses the comprehensive plan as a foundation, with specific community elements for local conditions and objectives. Municipalities are required under the GMA to coordinate on matters of county-wide growth management policy.

Effect of the GMA on the Mid-Puyallup Basin Plan

The GMA mandates that comprehensive plans be internally consistent (RCW 36.70A.070) and that counties perform their activities and make capital budget decisions in conformity with their comprehensive plans (RCW 36.70A.120). Because basin plans recommend capital improvement projects and form the basis of the annual capital budget for the Pierce County Storm Drainage and Surface Water Management Utility, basin plan recommendations are required to be consistent with the county comprehensive plan.

Basin plans are also used to formulate the longer-term (six-year) capital improvement plan, required by the GMA, also known as the Capital Facilities Element of the County Comprehensive Plan. [The Supplemental Environmental Impact Statement in Chapter 10 examines the consistency of this plan's recommendations with the county comprehensive plan.]

Land use decisions drive stormwater management infrastructure needs. Adopted land use/zoning and current development regulations are used in this basin plan to model future hydrologic conditions and determine the type, size and location of facilities that will be needed to support planned growth.

Critical areas designations are used to indicate potential sites for stormwater facilities, such as infiltration ponds (aquifer recharge areas) or natural stormwater detention sites (wetlands and riparian corridors). Conversely, surface water management recommendations can influence land use density and intensity choices, for instance if a basin plan identifies stream reaches that must be protected from the adverse hydrologic effects of new development. Existing and planned land use is described in Chapter 4, Existing Conditions.

2.8 Shoreline Management Act

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

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

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

The SMA divides authority for compliance between local and State governments. Cities and counties are the primary regulators. Each city and county adopts a shoreline master program and use regulations that are based on State guidelines but tailored to the needs of the community. Pierce County adopted its "Shoreline Master Program" in 1974 and the Use Regulations in 1975 (amended in 1992). Shoreline use regulations set out a permit system for administering the program. The County is currently considering an update to its Master Program (2009).

Effect of the Shoreline Master Program & Use Regulations on the Mid-Puyallupk Basin Plan
Many of the proposed projects contained in this Basin Plan are likely to be located within a regulated shoreland and subject to permit requirements. In the Mid-Puyallup Basin, only the Puyallup River is a regulated shoreland. Projects within 200-feet of the Puyallup River must comply with County's Shoreline Use Regulations. The conditions that might be imposed on recommended projects are considered in Chapter 10, Supplemental Environmental Impact Statement, the Land and Shoreline Use section.

2.9 State Hydraulic Code

The Washington State Hydraulic Code (RCW 75.20.100-140) regulates any activity affecting the bed or flow of the state's fresh waters and salt waters for the protection of fish life. The Hydraulic Code is administered by the Washington State Department of Fish and Wildlife (WDFW). The WDFW requires any person, organization, or government agency whose construction project

affects the bed of flow of any surface waterbody to obtain a "Hydraulic Project Approval (HPA) Permit." The HPA Permit typically specifies how construction projects are designed, managed, sequenced, and conducted to minimize adverse effects on fish and shellfish.

Effect of the State Hydraulic Code on the Mid-Puyallup Basin Plan
Numerous projects are likely to involve work within regulated streams. Conceptual design and cost estimates for these facilities should take into consideration the conditions likely to be imposed on the project via the HPA Permit.

2.10 The Nonpoint Rule

WAC Chapter 400-12 establishes criteria and procedures for ranking watersheds in Washington state and for developing and implementing non-point source pollution control action plans for watersheds that need corrective and/or preventive actions. The purpose of WAC 400-12 is to reduce pollutant loading from nonpoint sources, prevent new sources from being created, enhance water quality, and protect beneficial uses. 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 agency (usually a county) convenes a committee to rank 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 both the Lower Puyallup and Upper Puyallup River watersheds, which includes the Mid-Puyallup Basin.

Effect of the Nonpoint Rule on the Mid-Puyallup Basin Plan
The objectives recommendations of the basin plan should be consistent with and implement the Lower Puyallup and the Upper Puyallup watershed action plans.

2.11 Pierce County Storm Drainage and Surface Water Management Master Plan (Volumes 1 and 2), James M. Montgomery, 1991 (1991 Plan)

The Pierce County Storm Drainage and Surface Water Management Master Plan (1991 Plan) is the original capital improvement program (CIP) and program plan for the Pierce County Storm Drainage and Surface Water Management Utility. It identified stormwater issues and recommended capital improvements for eight of the major drainage basins in Pierce County.

The Mid-Puyallup Basin was one of the rural basins that were not studied in detail. A general description of the rural basins in the 1991 Plan describes them collectively as primarily forested with some agricultural development and a few residential areas.

2.12 1997 Rate Structure Study

In 1997, Pierce County Water Programs prepared a Study on the authorities, drivers, programs, and funding of the surface water management function of the County. The Study recommended continuation of numerous programs and the enhancement of other programs. To that end, the Study recommended a new surface water management fee structure, based on levels of service needs for each of the County's 26 basins. It also recommended that due to the, "…significant changes in land use and the level of development…." In the County since the original program had been established, that Water Programs would update the overall 1991 Master Plan on a "basin-by-basin" basis. In 1997, the Pierce County Council adopted the recommended rate structure.

Effect of the 1997 Study on the Mid-Puyallup Basin Plan
This Basin Plan continues to implement the 1997 study by identifying projects and programs needed within the Basin to ensure funds generated in the Mid-Puyallup Basin stay within that basin. It also specifically implements the 1997 Study's recommendations to update the 1991 Master Plan on a basin basis.

2.13 Army Corps of Engineers General Investigation New Start Program

The "Army Corps of Engineers General Investigation New Start Program" funds large complex projects where there is a federal interest and when co-sponsored by a local government, agency or non-profit with local matching funds. Congressional approval is required to initiate a new start. Projects are managed by the Corps of Engineers. A New Start begins with research and study, a feasibility study, preliminary design and engineering. After the preliminary work is completed, but before construction of the identified projects, Congress must reauthorize the project and allocate funds.

Congress authorized a "General Investigation (GI) New Start" for the Puyallup/White Watershed area. The initial work for the GI New Start relies on work done by a group of scientists representing agencies and governments such as the Puyallup Tribe of Indians, Washington State Departments of Fish and Wildlife and Natural Resources, .the cities of Puyallup, Sumner and Fife, the Pierce County Conservation District, and Pierce and King counties. With the Puyallup/White River Watershed area in mind, they identified a number of potential projects that could help in restoring water quality and fish habitat in the Watershed.

Effect of the GI New Starts Program on the Mid-Puyallup Basin Plan
Each of the projects in the GI New Start program is acknowledged in the flooding, habitat and water quality analyses. The Pierce Conservation District identified barriers to fish passage augmented the field investigations performed by the consultant, ENTRANCO. Coordination with each of the local co-sponsors is included in basin planning outreach efforts.

2.14 Existing Studies and Reports

Data from relevant documents were reviewed for integration into this Basin Plan. The original sources (listed in the reference list at the end of this report) should be consulted for comprehensive presentations of the overview provided here. A substantial amount of the information summarized in this report is taken from the following sources:

Environmental Analysis of the Fennel Creek Corridor, Foster Wheeler Environmental Corporation, 1999.

Lower Puyallup Watershed Action Plan, Lower Puyallup Watershed Management Action Committee, 1993.

Lower Puyallup Watershed "Phase I" Report, Lower Puyallup Watershed Management Committee, 1992.

Pierce County Storm Drainage and Surface Water Management Plan, James M. Montgomery, 1991.

Pierce County River Improvement, Puyallup River Basin Comprehensive Flood Control Management Plan, James M. Montgomery, 1991.

3. STAKEHOLDERS' INVOLVEMENT

Chapter 3 identifies the main stakeholders and their stated interests in the Basin Plan. The chapter also describes efforts to involve the public and other stakeholders in the planning process.

3.1 Stakeholders and Relationship to Basin Plan

The Mid-Puyallup Basin Plan relies on the participation of many different federal, state and local agencies; cities; the Puyallup Tribe of Indians; citizen groups; environmental groups; the development industry, business interests and the general public. Citizens of the Mid-Puyallup Basin are the primary stakeholders. Pierce County Water Programs (Water Programs), as initiator and manager of the basin planning process and whose future activities will be guided by the Basin Plan, is a major stakeholder.

Others with an interest in this Basin Plan include the City of Puyallup, City of Tacoma, Port of Tacoma, Pierce County Planning and Land Services Department (PALS), Pierce County Public Works and Utilities — Transportation Division, Washington State Department of Fish and Wildlife (WDFW), Department of Ecology (Ecology), the Puyallup Tribe of Indians, the Federal Emergency Management Agency (FEMA), the Army Corp of Engineers, and the Puyallup River Watershed Council.

Water Programs incorporated considerable public information and public involvement in the development of the Mid-Puyallup Basin Plan to better respond to the varied interests of people living and working in the Basin. The following activities illustrate the core efforts undertaken to involve groups and individuals with a stake in the outcome of the basin plans.

- Water Programs staff identified people, groups and agencies with an interest in the outcome of the Basin Plan.
- Stakeholders assisted in identifying issues and important values to consider in the Mid-Puyallup Basin Plan at public meetings, completed questionnaires, and one-on-one meetings.
- Stakeholders provided data and information to use in the Basin Characterization.
- Interested people were sent a "Notice of Availability" to review and comment on the Draft Supplemental Environmental Impact Statement (DSEIS).
- The Pierce County Planning Commission and the County Council will conduct public hearings and take public comment on the Plan

3.1.1 Community Planning Groups

Two (2) major community planning groups are within the Mid-Puyallup Basin:

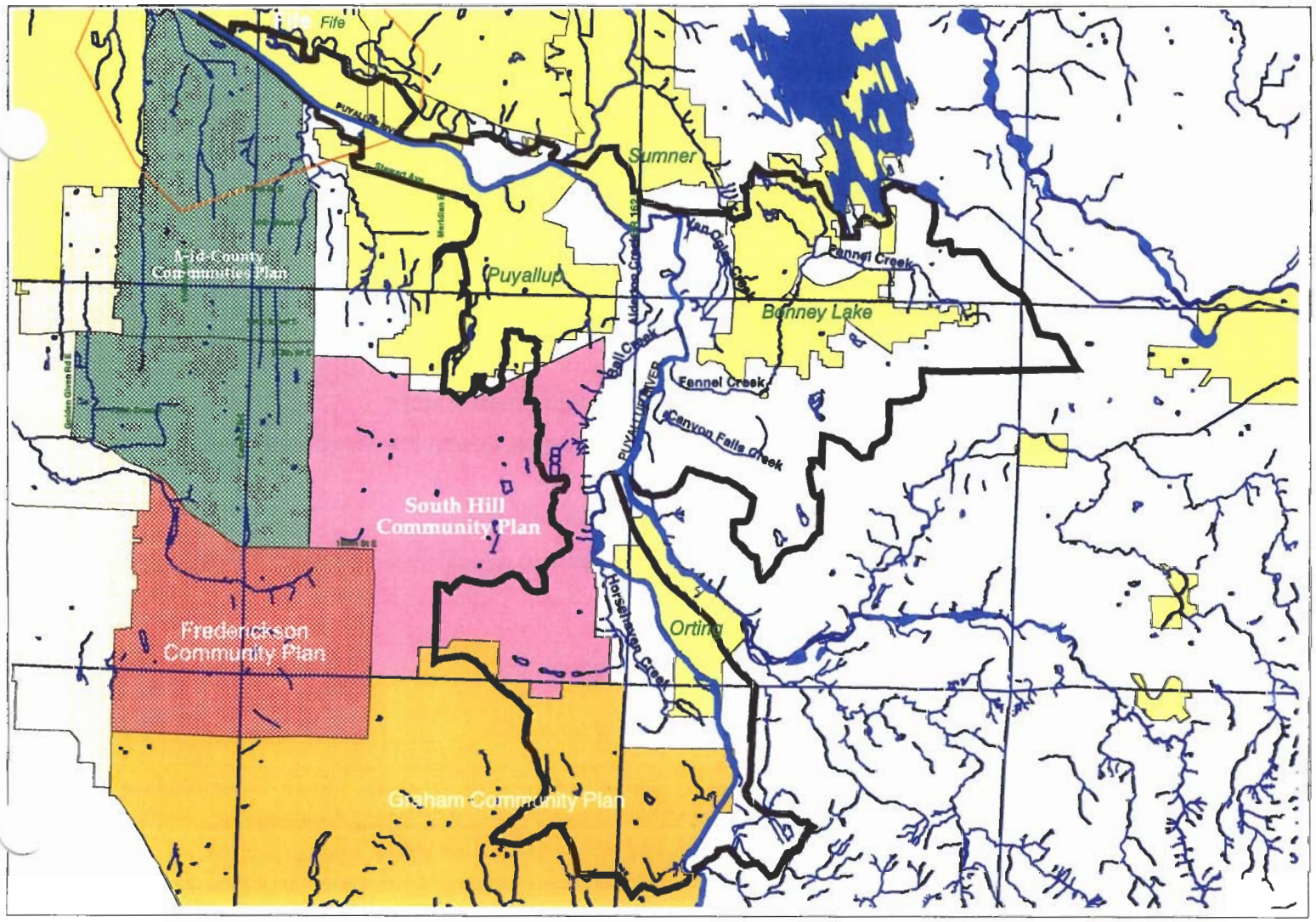
South Hill Community Plan. The Advance Planning Section within PALS helped the South Hill Community to develop a community plan for South Hill that was adopted in April 2003. *Figure 3-1, Relationship of Mid-Puyallup Basin to Community Planning Areas*, illustrates the South Hill Community Plan area in relation to the Mid-Puyallup Drainage Basin. During numerous meetings to develop the community plan, citizens of South Hill expressed the following desires regarding stormwater management:

- Design stormwater management facilities and retrofit existing facilities so they are visually part of the community's open space network.
- Design stormwater facilities in a way that protects people from safety concerns and allows them to function as part of the walkway and park and recreation system.
- Continue to reduce the severity and number of flood events.
- Provide information to PALS about the effects of development practices on the ability to manage stormwater effectively.

Pierce County Water Programs staff attended meetings to listen to the citizens as they identified the vision and needs of the community. Several citizens who reside within the South Hill Community Plan area and the Mid-Puyallup Basin commented on known stormwater-related problems. Stakeholder questionnaires were given to interested citizens to document problems and community perspectives.

County Water Programs staff also coordinated with the South Hill Community Plan Advisory Board by offering instruction in local hydrology, stormwater requirements for new development, current policies and law regarding surface water management, anticipated changes to policy and law regarding stormwater and surface water, and local stormwater facilities.

Graham Community Plan. The Pierce County Council authorized development of a community plan for the unincorporated community of Graham. The plan's schedule anticipates a draft community plan in the summer of 2004. Seventeen percent (17%) or 4,800 acres of the Graham planning area lies in the Horsehaven Creek drainage of the Mid-Puyallup Basin. Coordination with the Graham Community Planning Board and PALS will occur as described for the South Hill Community Plan. *Figure 3-1* illustrates the location of the Graham Community Plan area in relation to Mid-Puyallup Basin.



LEGEND

- Mid-Puyallup Basin Boundary
- 1873 Puyallup Tribal Survey Area
- Streams of Basin
- River & Other Streams

Community Planning Areas

- Mid-County Communities Plan
- Graham Community Plan
- South Hill Community Plan
- Frederickson Community Plan
- Roads - All*
- Cities in Pierce County*

1 0 1 Miles

N W E S

Figure 3.1 Basin Relationship to Community Planning Areas

Mid-Puyallup Basin Plan

Pierce County
Public Works & Utilities
Water Programs

3.1.2 Pierce County Planning and Land Services (PALS)

Within unincorporated areas of Pierce County, several divisions of County's Department of Planning and Land Services (PALS):

- Administer environmental regulations
- Enforce compliance with land use zoning and development codes
- Issue permits
- Conduct long-range planning within unincorporated county areas

Project team staff consulted with PALS staff whose project or permit review areas extend into the Mid-Puyallup Basin on the following subjects:

- Effect of surface water management activities on land use.
- Effect of land uses, density, and current development regulations on surface water management objectives.
- Identification and evaluation of alternatives.

3.1.3 Cities within the Mid-Puyallup Basin

Unincorporated Pierce County extends over 72 percent of the Mid-Puyallup Basin. Twenty-eight percent (28%) of the basin lies within five (5) cities. (See *Figure 3-2, Local Governments in the Mid-Puyallup Basin*, and *Table 3-1, Areas of Local Governments in Mid-Puyallup Basin*)

Table 3-1
Areas of Local Governments in Mid-Puyallup Basin

Local Governments	Acres of Jurisdiction in Basin	Total Acres of City	Percent (%) of City in Mid-Puyallup Basin	Percent (%) of Mid-Puyallup Basin in Jurisdictions
Pierce County	26,425	---	---	72
Bonney Lake	3,618	4,216	86	10
Fife	847	3,599	24	2
Orting	1,167	1,710	68	3
Puyallup	4,381	7,906	55	12
Sumner	451	4,354	10	1
Cities Total	---		---	*28*
Total	36,889			

Source: Pierce County Geographic Information System 3-2002

Although this Basin Plan focuses on unincorporated areas, surface water follows topography without regard for political boundaries. Stormwater runoff within cities frequently passes into unincorporated areas and vice versa. Drainage conditions and decisions in cities have potential to improve or worsen flooding and water quality in unincorporated areas. Conversely, stormwater management decisions for County governed areas can affect the surface water volume and quality in the cities. Drainage decisions made for unincorporated Pierce County are a legacy to the cities as well as affecting citizens of unincorporated areas.

Unlike many other drainage basins, the Mid-Puyallup Basin has experienced substantial growth of cities and rapid urban development within Pierce County's urban growth areas. Annexation of urban areas closest to cities often follows.

With these relationships in mind, city officials in each of the five cities in the Basin were briefed on the purposes, goals and time-frame of the Mid-Puyallup Plan. They were asked about flooding problems that have occurred in subbasins shared with the county and other drainage issues of concern to the city. All stated an interest in sharing data and information in Phase 1 and in collaborating to solve existing or projected shared drainage concerns during Phase 2.

City of Bonney Lake

Most of Bonney Lake (86%) lies in the Mid-Puyallup Basin. Headwaters of the main stem of Fennel Creek exist in the vicinity of 240th Avenue East and SR-410. Debra Jane Lake and a Lake Tapps overflow both discharge to a tributary of Fennel Creek. Fennel Creek flows through a grassy agricultural valley in the City before cascading to the Puyallup Valley at Victor Falls.

Future land use and development regulations (including critical areas protections) will be City decisions. The effects of these decisions will be manifest in the future volume of flow, water quality, and habitat value of Fennel Creek in unincorporated areas.

Of particular concern to the City of Bonney Lake, is protection of Bonney Lake Springs at Victor Falls from contamination.[1] Bonney Lake Springs serves as part of the City's municipal water supply. Other concerns regard the adequacy of stormwater controls placed on new developments in the county at the City's edge.

The proposed Cascadia development was cited as an example of the potential effects of developments in unincorporated areas. Its proposed stormwater facilities, including infiltration basins, are likely to become the responsibility of Pierce County Water Programs after they are constructed and tested.

City of Fife

Fife has recently prepared its first comprehensive plan for managing stormwater within the City. The most southerly 24 percent (24%) of the City lies within the Mid-Puyallup Basin. City officials recommended sharing information as it is generated and asked to be kept informed of project process and results.

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[1] Final Environmental Impact Statement, Cascadia, Employment Based Planned Community, August 1998.

City of Orting

Orting is situated near the southern end of the Mid-Puyallup Basin. The City of Orting has completed a comprehensive storm drainage plan and agreed to share modeling information on the parts of the City in the Basin. City officials reported concern with stormwater over SR-162 at the southern city limits, noting that the majority of flooding problems occur at the south end of the City. They asked to be kept informed of the Basin Plan's progress and requested coordination with City officials on storm drainage improvements being considered in the vicinity of Orting.

City of Puyallup

Fifty-five percent (55%) of the City of Puyallup is situated in the Mid-Puyallup Basin. The City is revising the Comprehensive Stormwater Management Plan for its stormwater utility and offered to share hydrologic modeling data generated for the subbasins in the City either draining to unincorporated areas or receiving drainage from the county. City Officials requested to be kept informed of the project's progress and participate/coordinate in identifying solutions for problems in shared subbasins.

City of Sumner

Sumner has only ten percent (10%) of its area in the Mid-Puyallup Basin. The area drains directly to the Puyallup River rather than to one of the area creeks. As an active leader of the Puyallup Watershed Council, Sumner is very interested in water quality and protection and enhancement of salmon habitat.

The City Public Works Director recommended that City representatives participate in identifying and evaluating alternative solutions to storm drainage problems in Sumner's Urban Growth Area.

City of Edgewood

Although the City of Edgewood is not in the Mid-Puyallup Basin, it lies adjacent to it. City officials provided comment on subbasin delineations and asked to be kept informed of the Basin Plan's progress and be notified when the Draft Basin Plan is available for interagency review.

3.1.4 Washington State Department of Ecology (Ecology)

Ecology is the permitting authority for NPDES permits. Pierce County Water Programs has a "Phase I" Stormwater NPDES Permit, which requires consistency of the Mid-Puyallup Basin Plan with permit terms.

Ecology also is responsible for many aspects of Washington State's program for salmon recovery, coordination of watershed protection grants and activities, administration of the State Environmental Policy Act (SEPA) and enforcement of groundwater and surface water standards. Ecology's interests reflect their statutory responsibilities.

Ecology is the State agency charged with identifying water bodies with compromised water quality or that are not expected to improve within the next two years. Ecology submits a program to the federal Environmental Protection Agency (EPA) for restoring water quality in the listed water bodies. Water segments with management plans likely to result in improvement of water quality sufficient to meet standards need not be listed. EPA requires states to set priorities to clean up threatened waters and establish *Total Maximum Daily Load* (TMDL) limits for each listed water body or stream segment. NPDES permits are written and revised on the basis of these listings. Operating specifications for the NPDES permit mandate that storm water runoff not contribute additional pollutant loads to the listed water bodies.

3.1.5 Washington State Department of Fish & Wildlife (WDFW)

The Washington State Department of Fish and Wildlife (WDFW) is the State agency responsible for issuing Hydraulic Project Approval (HPA) Permits for in-stream work in state waters. Primary interests in the Mid-Puyallup Basin are:

- Salmon recovery
- Watershed conservation
- Coordination among other State agencies and Pierce County

3.1.6 Puyallup Tribe of Indians

The Puyallup Tribe of Indians (Puyallup Tribe) has been an on-going advocate of protecting water quality within the Puyallup River Watershed. The Tribe conducted water quality sampling at several locations in the Mid-Puyallup Basin and they assisted in characterizing conditions by sharing data on the water quality of Fennel Creek and Canyon Falls Creek.

The Puyallup Tribe maintains no fish hatcheries in the Mid-Puyallup Basin. Nevertheless, the Tribe has an interest in ensuring that water quality (including quantity) of streams discharging to the Puyallup River supports strong fish populations. Only a small portion of the Mid-Puyallup Basin lies within the Puyallup Tribe of Indians Survey Area (see *Figure 3-2*). However, all of the Mid-Puyallup Basin is situated in the Tribe's customary hunting and fishing area.

Representatives for the Puyallup Tribe cited the following issues or desires:

- Participation of Pierce County Water Programs in projects to restore oxbows along the lower reaches of the Puyallup River.

- Protection of stormwater water quality by using "Best Management Practices" for stormwater treatment, including retrofitting existing facilities.

- Removal of barriers to fish passage in creeks tributary to the middle section of the Puyallup River.

- Concern with the amount of growth & development in the Basin without use of best management practices for stormwater and encouraging low-impact development.

3.1.7 Muckleshoot Indian Tribe

The Mid-Puyallup Basin does not extend into Muckleshoot Indian Tribe reservation lands, although the Fennel Creek subbasin extends within a short distance of the Reservation. Of concern to the Muckleshoot Tribe is the water quality of the Puyallup River downstream of the confluence of the White River with the Puyallup River. White River Salmon use these reaches of the Puyallup River to come and go from spawning and rearing grounds.

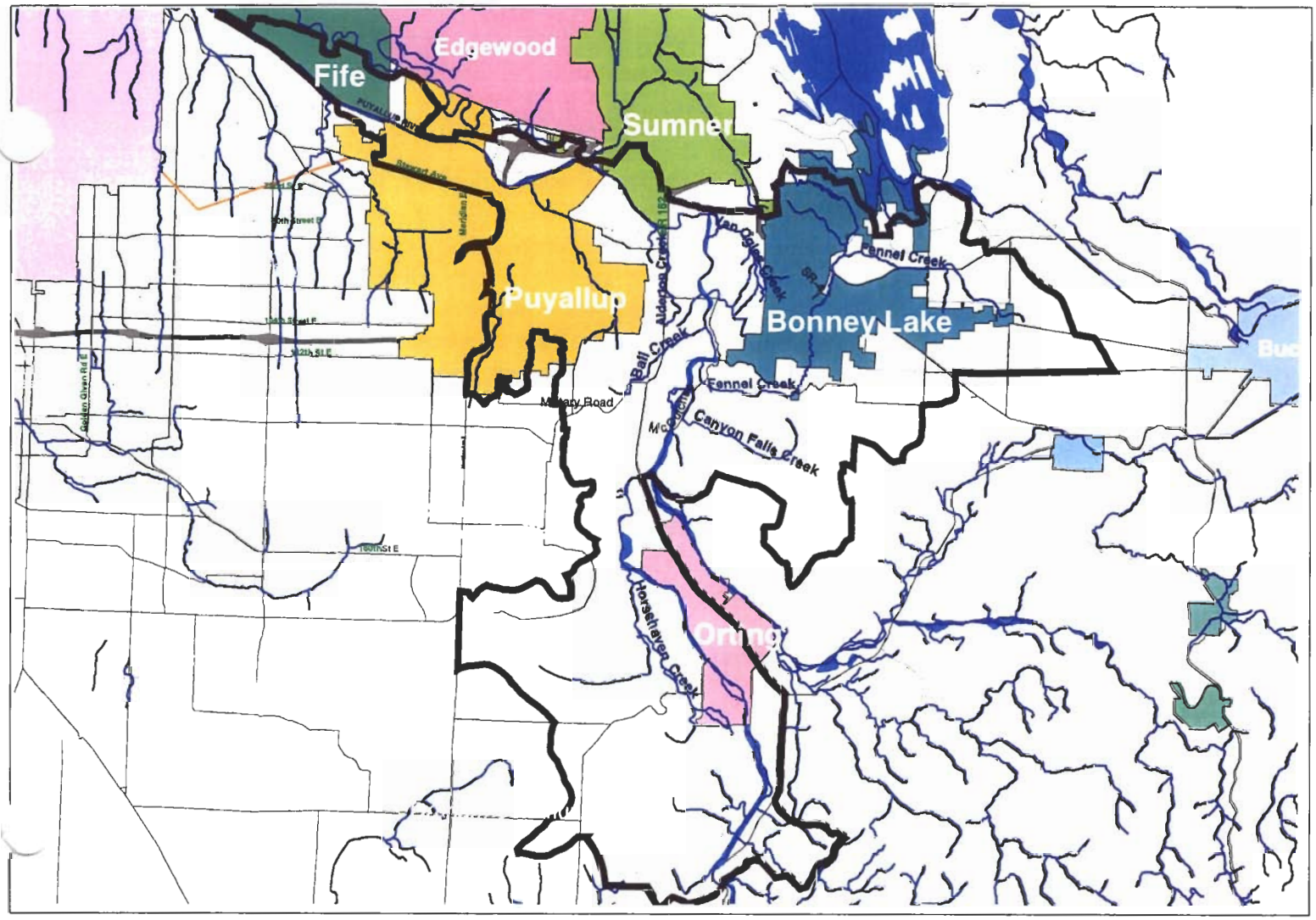
3.1.8 Puyallup River Watershed Council

The Puyallup River Watershed Council is composed of interested and affected people concerned about the health of the Puyallup River Watershed. Groups represented include the Indian tribes, fish hatcheries, environmental groups, sport fishermen, city governments, public utilities, Pierce County Water Programs, Pierce Conservation District, businesses, and farmers. The Council has been responsible for completing both the Lower Puyallup and the Upper Puyallup Watershed Action Plans, which seek to improve water quality in the Lower Puyallup Watershed, Upper Puyallup Watershed, and Puget Sound by reducing non-point source water pollution.

The Watershed Council requested that the Basin Planning Team work with them through their PRWC Water Committee. Issues and concerns expressed by the PRWC Water Committee include:

- Improving the water quality of stormwater entering the Puyallup River and its tributary streams.
- Continuing dialogue with the PRWC Water Committee as the Basin Plan progresses.
- Coordinating between the various programs of the County that either contribute stormwater to the Mid-Puyallup Basin, work on salmon recovery, or administer and prepare regulations concerning land clearing, grading and land development.

Seeking the advice and counsel of the Puyallup River Watershed Council and its members before key project decision-making.



Legend

- Mid-Puyallup Basin
- Streams

- Bonney Lake
- Buckley
- Carbonado
- Edgewood
- Fife
- Orting
- Puyallup
- South Prairie
- Sumner
- Tacoma
- Wilkeson

- 1873 Puyallup Tribal Survey Area

Arterials*
- Limited Access
- Principal Road
- Major Road
- Collector Road

0.8 0 0.8 Miles

N W E S

Figure 3.2 Local Governments in Mid-Puyallup Basin

Mid-Puyallup Basin Plan

Pierce County
Public Works & Utilities
Water Programs

3.1.9 Pierce Conservation District

The Pierce Conservation District is a special purpose district authorized by RCW 89.09 to help citizens manage natural resources wisely. This State statute authorizes conservation districts to conduct surveys and research, conduct educational and demonstration projects with the consent of landowners, design improvements, and recommend actions of individuals and governments to conserve natural resources. However, they cannot regulate or require adherence to their programs or recommendations. Pierce Conservation District administers a Dairy Waste Management Program, a Farm Assistance Program, salmon recovery programs, and a Stream Team Program. At the heart of these programs are water quality, soil conservation, habitat protection and habitat restoration.

Pierce Conservation District inventoried culverts within the Puyallup River Basin and created a database identifying culverts that limit fish passage. The Mid-Puyallup Basin Plan uses the fish passage inventory to point out problem culverts in the stormwater drainage system.

3.1.10 Citizens within the Mid-Puyallup Basin

Questionnaires

Pierce County Water Programs sent out approximately 350 mailings soliciting public involvement in the basin planning process. The mailings were sent to property owners adjacent to all streams, creeks, rivers, floodplains, and wetlands. A memorandum attached to the stakeholder questionnaire explained the intent of the Basin Plan and the importance of public participation in achieving a plan responsive to the public concerns and preferences. A number of questionnaire respondents expressed concern about water quality and habitat as opposed to flooding problems. Some respondents were contacted again to obtain more information for use in the problem identification task. All of the respondents were added to the mailing list for future meetings and mailings. An example of the questionnaires along with the attached memorandum that were sent out is presented in *Appendix B.*

Public Meetings

June 2001 at the Orting Senior Center. An introduction to the basin planning process, history of the Pierce County Surface Water Management Utility, and known flooding, water quality, and habitat problems were presented. People were asked to share information about flooding, water quality and fish habitat.

October 2002 at the Sumner City Council Chambers. Findings from “Phase 1” of the basin planning process were presented including Basin characteristics and preliminary flooding, water quality, and habitat problems. People shared additional information to supplement the problems list.

Details from each of the public meetings can be viewed in *Appendix B.*

3.2 Roles and Responsibilities

The importance of stakeholder participation is incorporated within the basin planning process because Pierce County Water Programs acknowledges that a consensus among stakeholders is crucial for basin plans to achieve their objectives. Keys to agreement are:

- Effective communication between staff, consultants and stakeholders; and
- Consideration of each person's or group's viewpoints at practical points in the planning process.

Responsibility for decision-making falls first with the Pierce County Water Programs Division of the Public Works & Utilities Department, who select the set of recommendations (projects, proposed policies, other suggestions) and transmits the plan to the Pierce County Executive. When satisfied with the draft plan, the County Executive refers the endorsed plan to the Pierce County Council. The County Council and County Executive approve basin plans by ordinance.

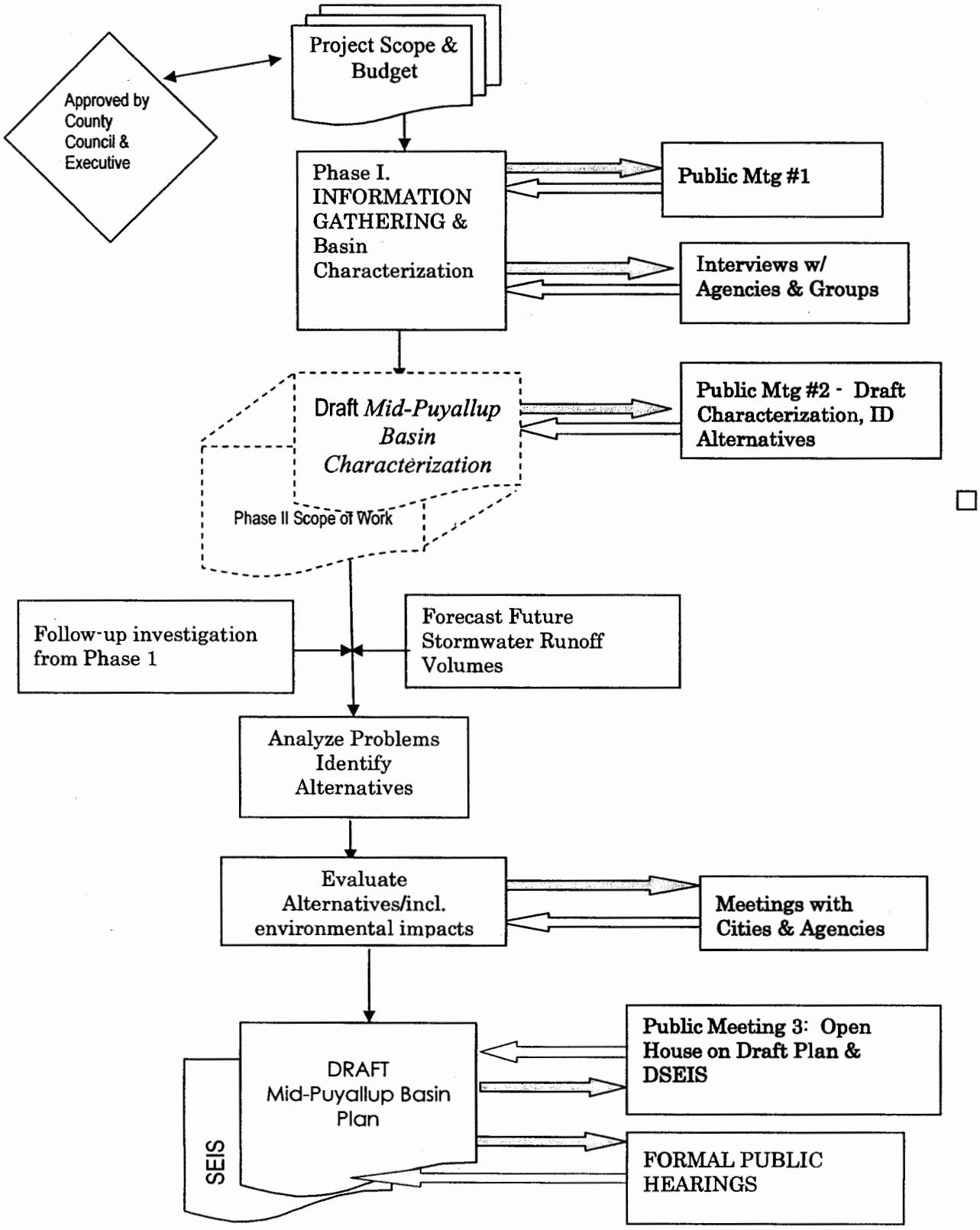
Effective communication entails continuous dialogue between the planning team (Pierce County Water Programs staff and consultants) and stakeholders. The goal is a shared understanding of project scope, project goals and objectives, problems, regulatory guidelines, alternatives, and the effects of alternatives on people and their interests.

Successful communication usually takes a mix of outreach efforts to reach enough people or accommodate their busy schedules. Accordingly, the public communication of this Basin Plan employed such media as individual and public meetings, open houses, study sessions, public access television, newsletters, newspaper articles, public notices, and formal requests for comment.

Public Involvement at Key Points

Figure 3-3 illustrates the stages in the planning process when public information and opportunities for involvement occurred.

Figure 3.3 Communications with Public & Other Agencies



4. CURRENT CONDITIONS

4.1 Mid-Puyallup Basin

The Mid-Puyallup Basin is a subsection of the Puyallup River Watershed that contributes to the Puyallup River between river miles (RM) 4 and 26.5 (See *Figure 1-1*). The Basin area covers 57.6 square miles just south of Lake Tapps in the central portion of Pierce County. From north to south, the Basin is roughly 13 miles long, with widths varying from up to 13 miles at the widest point, and to 4 miles at its narrowest.

Multiple jurisdictions exist within portions of the Mid-Puyallup Basin. Part of the City of Fife overlaps the northwestern corner of the Basin. Southeast of Fife, the City of Puyallup is the largest municipality within the Basin. The City of Bonney Lake is to the east with most of the city property within this Basin. The City of Sumner overlaps a small section of the Basin along its northern boundary while the City of Orting is the only city in the southern section of the Basin. The Mid-Puyallup Basin is mostly rural agricultural land, with suburban development dispersed primarily on upper terraces that surround the valley.

Multiple streams comprise the natural drainage system of this Basin and contribute flow to the Puyallup River main stem. Major tributaries include Alderton Creek, Van Ogles Creek, Ball Creek, Fennel Creek, Canyon Falls Creek, and Horsehaven Creek. Drainage in the Basin has been modified over the years with the progression of development, which has controlled much of the upland drainage with manmade systems of conveyance pipelines, ditches, and other stormwater facilities.

Climate in the Mid-Puyallup Basin is typical of the maritime Pacific Northwest region. Temperatures are moderated by proximity to the Pacific Ocean, resulting in mild winters and warm, but not hot, summers. Average annual precipitation (mostly as rain) is about 45 inches with 75 percent (75%) falling between October and March. Periods of maximum runoff correspond closely with periods of maximum rainfall.

4.2 Topography and Planning Units

4.2.1 Topography

Basin topography is characterized by a wide, flat valley bottom bisected by the meandering Puyallup River and abrupt valley walls on either side. (See *Figure 4-1, Topography*) The valley bottom has an elevation of 360-feet at the upstream end of the Basin and slopes gradually down to a 20-foot elevation at the downstream end. Valley walls climb an average of 500-feet before leveling to hilly terraces. The highest point in the Basin is 960-feet and is in the most southeastern corner of the Basin.

Both volcanic processes and glaciation formed the Puyallup River Valley. Scouring from the Vashon glaciation formed the deep, northerly trending Puyallup Valley. Approximately 4,800 years ago the Osceola Mudflow, originating on Mt. Rainier, poured down the White River Valley, across the Buckley Plain, down Fennel Creek and the Lower White River, and finally reached the White and Puyallup valleys between Auburn and Alderton. The much smaller Electron Mudflow, formed about 500 years ago, moved about 35 miles down the Puyallup River Valley as far as McMillin (Lower Puyallup Watershed Management Committee 1992).

4.2.2 Subbasins (the Planning Units)

The multiple tributaries that flow from the Mid-Puyallup Basin into the Puyallup River divide the Basin into smaller tributary basins. Some areas of the Basin drain directly into the Puyallup River and are therefore not associated with any of the tributary basins. These areas are direct drainage areas. The tributary basins and direct drainage areas were further divided into subbasins to allow more detailed analyses of hydrology. Subbasins represent smaller drainage areas, most with a principal drainage pathway that collects and conveys surface water from the subbasins. Two types of subbasins are represented: those with a distinct channel that serves as a principle drainage pathway, and those that drain as unconfined flow directly to the Puyallup River.

Subbasin divisions were determined first by identifying the multiple tributaries and direct drainages that contribute to the Puyallup River. Further division of the subbasins was based on a need for flow values at particular sites where flooding problems had been reported by citizens or identified by Pierce County Water Programs staff. These sites were selected following an assembly of problems identified within the Basin. Identification of problem areas or locations is discussed in Chapter 5. Flow data acquired at these problem sites were used to further assess the problems and develop solutions.

Delineations of subbasin boundaries were first conducted using two-foot contour data and stream locations obtained from the Pierce County Geographic Information System (GIS). Boundaries were then verified during field reconnaissance and were modified as needed.

Subsequent refinement of subbasin boundaries resulted from coordination with cities within or bordering the Mid-Puyallup Basin, some of which have conducted detailed analyses within their jurisdictions. Included was information obtained from the cities of Sumner, Puyallup, and Bonney Lake.

At the end of "Phase 1" (Basin Characterization), a total of 46 subbasins had been determined. These subbasins are shown in *Figure 4-2, Subbasins*, and the area of each subbasin is presented in *Table 4-1, Mid-Puyallup Subbasin Areas*. *Table 4-2* describes drainage pathways for the 28 subbasins that have a stream channel conveying runoff to the Puyallup River. *Figure 4-3* identifies the locations of these channels. The 18 remaining subbasins drain directly to the Puyallup River without having a significant drainage pathway.

Table 4-1
Mid-Puyallup Subbasin Areas

Subbasin Identification	Area (square miles)	Subbasin Identification	Area (square miles)
Fennel Creek		Puyallup Streams	
FC-1	2.69	P-1	2.18
FC-2	0.52	P-2	3.22
FC-3	1.91	Van Ogles Creek	
FC-4	3.66	VO-1	2.80
FC-5	0.97	Alderton Creek	
FC-6	0.42	A-1	1.37
FC-7	0.32	Direct Discharges	
FC-8	1.50	D-1	1.28
BL-1	0.06	D-2	0.04
BL-2	0.01	D-3	0.37
BL-3	0.50	D-4	0.96
BL-4	0.75	D-5	1.16
Horsehaven Creek		D-6	0.67
HH-1	0.79	D-7	1.15
HH-2	0.29	D-8	2.68
HH-3	1.10	D-9	0.89
HH-4	0.71	D-10	0.97
HH-5	2.41	D-11	0.70
HH-6	2.85	D-12	0.93
HH-7	1.89	D-13	0.83
Canyon Falls Creek		D-14	1.23
CFC-1	1.82	D-15	0.79
CFC-2	1.45	D-16	1.28
CFC-3	0.60	D-17	1.71
Ball Creek		D-18	0.39
BC-1	1.80		
BC-2	0.08		

Source: Entranco Geographic Information System

Table 4-2
Drainage Pathway Boundaries and DNR Classification

Subbasin Reach Identifier	Length (feet)	Upstream Boundary	Downstream Boundary	DNR Stream Type	Comments
Fennel Creek					
FC-1	21,980	Sumner Buckley Highway	Confluence with Puyallup River	3	Several species of anadromous fish spawn up to Victor Falls.
FC-2	1,830	Confluence with Bonney Lake Creek	Sumner Buckley Highway	3	No fish seen during the survey.
FC-3	8,060	Sumner Buckley Highway east of 214th Avenue E	Confluence with Bonney Lake Creek	3	Garbage is very noticeable in this reach including pesticide/ herbicide application sprayers.
FC-4	10,190	SR 410	Sumner Buckley Highway east of 214th Avenue E	3	Not included in the habitat evaluation
FC-5	0		Ponderosa Pond	n/a	n/a
FC-6	3,240	Ponderosa Pond	Springwood Drive	5	Not included in the habitat evaluation
FC-7	1,400	197th Avenue E	192nd Avenue E	5	Not included in the habitat evaluation
FC-8	500	Rhodes Lake	193rd Avenue E	5	
BL-1	820	Church Lake Road	Confluence with Bonney Lake Creek	5	BL-1 and BL-2 have the same principle drainage pathway.
BL-2	820	Church Lake Road	Confluence with Bonney Lake Creek	5	BL-1 and BL-2 have the same principle drainage pathway.
BL-3	4,840	Bonney Lake	Church Lake Road	5	Not included in the habitat evaluation
BL-4	4,280	Debra Jane Lake	Church Lake Road	5	Not included in the habitat evaluation
Horsehaven Creek					
HH-1	5,820	Confluence with east and west forks of Horsehaven Creek	Confluence with Puyallup River	3	HH-1 and HH-2 have the same principle drainage pathway.
HH-2	5,820	Confluence with east and west forks of Horsehaven Creek	Confluence with Puyallup River	3	HH-1 and HH-2 have the same principle drainage pathway.
HH-3	8,900	134th Avenue E	Confluence with east and west forks of Horsehaven Creek	3	Not included in the habitat evaluation
HH-4	5,250	188th Street E	Confluence with east and west forks of Horsehaven Creek	3	Coho salmon observed

Table 4-2 (Continued)
Drainage Pathway Boundaries and DNR Classification

Subbasin Reach Identifier	Length (feet)	Upstream Boundary	Downstream Boundary	DNR Stream Type	Comments
HH-5	8680	Jansky Road E	188th Street E	3	Coho salmon observed
HH-6	5490	Hidden Valley Landfill	134th Avenue E	5	Not included in the habitat evaluation
HH-7	8550	218th Street E	Orting-Kapowsin Highway	5	Drainage is mostly subsurface
Canyon Falls Creek					
CFC-1	16430	Pipeline Road E	Confluence with Puyallup River	3	Anadromous fish spawn up to McCutcheon Rd
CFC-2	6100	Orting Lake	Pipeline Road E	5	No surface flow
CFC-3	0		Orting lake	n/a	n/a
Ball Creek					
BC-1	8440	136th Avenue E	106th Street E	3	Coho salmon ascend this creek to at least the culvert under Military Rd
BC-2	2780	106th Street E	Confluence with Puyallup River	3	Access was denied on this reach
Puyallup Streams					
P-1	17610	43rd Avenue SE	Confluence with Puyallup River	5	Not included in the habitat evaluation
P-2	19220	106th Street E	Confluence with Puyallup River	5	Not included in the habitat evaluation
Van Ogles Creek					
VO-1	15860	3/4 mile north of Rhodes Lake Road	Confluence with Puyallup River	3	Coho and chum reported as using this stream
Alderton Creek					
A-1	9920	102nd Street E	Confluence with Puyallup River	5	Intermittent stream reach

Source: Entranco Geographic Information Systems 2002, and Washington Administrative Code Section 222-16-030

The Washington State Department of Natural Resources (DNR) classification system for water bodies in forested regions, WAC Section 222-16-030, was used to classify the stream reaches. The stream "type" for the channel in each subbasin is provided in *Table 4-2*. The DNR stream types are as follows:

- **Type 1** – Waters defined as "Shoreline of the State" within their ordinary high water mark.
- **Type 2** – Segments of perennially flowing natural waters that have a high fish, wildlife, or human use.
- **Type 3** – Segments of perennially flowing natural waters that have a moderate fish, wildlife, or human use.
- **Type 4** – Perennially or intermittently flowing natural waters more than two (2) feet wide between the ordinary high water marks and generally without significant fish, wildlife, or human uses.
- **Type 5** – All other natural waters, including streams with or without well-defined channels, areas of perennial or intermittent seepage, ponds, natural sinks, and drainage ways with short periods of spring or storm runoff.

4.3 Land Use

Land use affects a basin's hydrology and water quality in significant ways. Runoff responses are very different between forestland and urban land. Factors that create this difference are the amount of impervious surface area, and the extent to which soils and vegetation have been altered. The more impervious surface there is in a basin the more quickly stormwater will run out of the basin. This altered flow response changes the flow dynamic in local streams. Thus, the investigation of potential problems within a basin starts with identifying the impervious and pervious areas. In determining where problem areas may develop in the future, it is necessary to project as accurately as possible where growth will be focused and how much additional impervious area it will introduce.

4.3.1 Existing Land Use

Impervious areas in the Mid-Puyallup Basin are more highly concentrated near city centers and on suburban upland plateaus. (See *Figure 4-4, Existing Land Use*) Most incorporated areas lie in the north portion of the Basin; the only exception is the City of Orting in the south. Suburban developments are found throughout the Basin.

A combination of GIS and aerial photographs was used to determine existing land use conditions for each subbasin delineated for the Basin Plan. A GIS layer of existing land use (published in 1999) was provided by Pierce County, which became the basis for identifying land types in each subbasin. This layer was based on the County's Assessor-Treasurer's tax parcels, with 15 individual parcel categories. Under these classifications, agricultural land is listed as "Resource Land" and forested areas are listed as "Vacant." The "Other" category has been used for combinations of open water, forests, and agriculture.

Land use in each subbasin was first determined from the GIS information and then compared with aerial photographs. Changes were made in some of the subbasins based on the aerial photographs. These changes include listing the Cascadia development area as vacant land because construction has not begun at the present (2004), and making adjustments to density levels in some of the highly developed subbasins. *Table 4-3* presents the percentage of each land use type present in each subbasin.

Conversion factors for determining the percentages of impervious surface within the subbasins were provided by Pierce County in their Guidance for Basin Planning (2000) and are displayed in *Table 4-4, General Land Use Categories and Associated Total Percent Impervious Values*, and *Table 4-5, Low Density Residential Percent Impervious Values By Lot Size*. The land use categories used in the GIS layer were incongruent with the land use categories identified in this document. To establish a single land use designation scheme, land use designations from the GIS layer were converted to more closely match land use designations identified in Guidance for Basin Planning. Once done, the total and effective percent impervious values for each general land use type could be derived (See *Table 4-6, Existing Total Percent Impervious Values for Mid-Puyallup Subbasins*). Effective impervious surface represents that fraction of the impervious surfaces that are "effectively" hydraulically connected to the principal drainage pathways that are being studied. Spreadsheets used for calculating impervious surface for both existing and future conditions are included in *Appendix D*.

Critical Facilities

Critical facilities identified in the Basin are the McMillin Reservoir, the City of Sumner sewage treatment plant, and the City of Puyallup sewage treatment plant. The McMillin Reservoir is owned and operated by Tacoma Water and can store up to 210 million gallons of drinking water for residents within their service area. The reservoir is located at 12603 136th Street East just south of the City of Puyallup. The City of Sumner sewage treatment plant is located at 12801 Houston Road East in the City of Sumner. The City of Puyallup sewage treatment plant is located at 1602 18th Street NW in the City of Puyallup and began operation in 1999.

The Pierce County Sheriff's station in Bonney Lake provides emergency services and is located at 21201 Highway 410 East. No hospitals are located within the Basin. These critical facilities are documented in the Pierce County Hazard Mitigation Plan (2004).

Table 4-3
Existing Land Use Percent Identified by Type and Subbasin

Description	Subbasin Number							
	FC-1	FC-2	FC-3	FC-4	FC-5	FC-6	FC-7	FC-8
High Density Residential	4.9%	-	0.6%	1.0%	7.6%	22.1%	17.0%	73.2%
Single-Family Residential (0.75-1.0 acre lots)	25.5%	35.8%	31.5%	37.4%	59.7%	-	46.9%	-
Multi-Family Residential	0.6%	1.1%	0.5%	0.4%	-	0.3%	-	0.7%
Group Home/Other	-	-	-	-	-	-	-	-
Mobile Home	8.6%	2.7%	10.2%	12.0%	8.9%	3.3%	-	-
Commercial/Service	2.2%	1.4%	2.9%	2.8%	2.1%	7.3%	-	-
Industrial	0.1%	0.2%	0.3%	0.5%	-	-	-	-
Local Roads/Utilities	1.9%	0.5%	1.3%	0.5%	0.6%	1.8%	1.3%	1.4%
Education	1.2%	0.6%	-	0.9%	-	11.9%	22.4%	2.1%
Public Facilities	-	0.4%	-	-	-	-	-	0.0%
Quasi-Public Facilities	0.3%	0.1%	-	0.4%	1.4%	0.6%	-	0.0%
Open Space/Recreation	2.1%	-	0.5%	4.1%	0.3%	0.6%	-	0.2%
Agricultural Land	11.0%	20.2%	32.1%	21.1%	-	-	-	3.6%
Vacant	40.8%	35.9%	17.9%	17.5%	17.9%	35.5%	12.4%	18.4%
Other	0.8%	1.0%	2.3%	1.6%	1.4%	16.5%	-	0.4%

Table 4-3 (Continued)
Existing Land Use Type Identified by Subbasin

Description	Subbasin Number										
	BL-1	BL-2	BL-3	BL-4	HH-1	HH-2	HH-3	HH-4	HH-5	HH-6	HH-7
High Density Residential	0.6%	37.8%	0.1%	-	1.6%	0.2%	-	-	1.9%	2.2%	1.7%
Single-Family Residential (greater than 1.0 acre lots)	59.4%	33.1%	72.5%	61.2%	26.2%	32.0%	1.8%	9.2%	18.7%	3.9%	39.1%
Multi-Family Residential	4.0%	-	0.8%	1.0%	-	-	-	-	0.1%	-	-
Group Home/Other	-	-	-	-	-	-	-	-	-	-	-
Mobile Home	-	-	1.9%	11.0%	1.2%	3.2%	1.3%	2.8%	9.0%	2.1%	12.5%
Commercial/Service	-	-	0.1%	-	0.6%	1.3%	0.8%	1.2%	2.1%	1.5%	1.0%
Industrial	-	-	-	0.2%	-	-	-	0.7%	0.0%	2.2%	-
Local Roads/Utilities	1.2%	8.7%	0.4%	0.5%	0.3%	0.1%	7.0%	0.8%	1.2%	24.6%	0.8%
Education	3.8%	-	4.1%	-	-	-	-	-	-	-	-
Public Facilities	-	-	0.1%	2.3%	-	-	-	6.5%	3.1%	0.1%	-
Quasi-Public Facilities	8.1%	-	1.0%	-	-	-	-	-	-	-	0.4%
Open Space/Recreation	-	-	0.6%	12.0%	3.7%	0.9%	-	-	-	4.5%	-
Agricultural Land	-	-	0.1%	2.9%	3.0%	60.4%	21.6%	71.6%	45.4%	4.2%	23.9%
Vacant	13.7%	20.4%	8.6%	7.6%	62.5%	1.8%	67.4%	3.1%	14.5%	54.5%	15.6%
Other	9.1%	-	9.6%	1.1%	1.1%	-	-	4.0%	4.0%	0.1%	5.1%

Table 4-3 (Continued)
Existing Land Use Type Identified by Subbasin

Description	Subbasin Number							
	CFC-1	CFC-2	CFC-3	BC-1	BC-2	P-1	P-2	VO-1
High Density Residential	-	-	-	2.8%	-	27.8%	64.7%	11.9%
Single-Family Residential (greater than 1.0 acre lots)	7.7%	2.8%	-	37.0%	54.4%	-	-	14.4%
Multi-Family Residential	-	-	-	0.1%	-	2.8%	1.8%	0.2%
Group Home/Other	-	-	-	-	-	1.8%	-	-
Mobile Home	1.0%	0.7%	-	1.8%	2.9%	1.7%	1.8%	1.0%
Commercial/Service	-	-	-	2.5%	-	4.4%	0.9%	0.6%
Industrial	-	-	-	0.4%	-	9.3%	0.6%	0.2%
Local Roads/Utilities	-	-	-	11.8%	-	2.0%	0.7%	1.3%
Education	-	-	-	1.0%	-	3.8%	2.3%	0.1%
Public Facilities	-	-	-	0.0%	-	0.1%	0.0%	0.2%
Quasi-Public Facilities	-	-	-	0.1%	-	0.2%	0.4%	0.1%
Open Space/Recreation	-	-	-	1.4%	-	7.7%	4.5%	3.3%
Agricultural Land	-	0.1%	-	16.6%	40.3%	1.5%	3.8%	35.8%
Vacant	91.2%	96.4%	100.0%	20.2%	-	31.9%	17.3%	29.7%
Other	0.1%	-	-	4.4%	2.4%	5.0%	1.3%	1.3%

Table 4-3 (Continued)
Existing Land Use Type Identified by Subbasin

Description	Subbasin Number								
	A-1	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8
High Density Residential	0.0%	0.0%	8.5%	4.1%	2.5%	1.6%	9.1%	21.3%	1.9%
Single-Family Residential (greater than 1.0 acre lots)	29.9%	28.5%	-	18.9%	2.9%	48.2%	39.8%	17.1%	23.7%
Multi-Family Residential	0.3%	-	-	-	-	-	-	-	0.4%
Group Home/Other	-	-	-	-	-	-	-	-	-
Mobile Home	2.7%	31.1%	-	2.1%	-	3.7%	11.1%	2.3%	1.0%
Commercial/Service	1.9%	-	-	-	-	-	-	-	0.3%
Industrial	-	-	-	-	0.0%	-	-	-	0.6%
Local Roads/Utilities	3.6%	1.3%	-	-	-	2.2%	1.1%	0.2%	2.6%
Education	0.2%	-	-	-	-	-	-	-	0.0%
Public Facilities	-	-	-	-	-	-	-	0.1%	0.0%
Quasi-Public Facilities	-	-	-	-	-	-	-	-	0.3%
Open Space/Recreation	1.8%	1.6%	-	0.3%	3.2%	0.9%	-	0.4%	17.3%
Agricultural Land	31.2%	9.7%	42.8%	21.1%	79.1%	4.1%	6.2%	32.5%	36.5%
Vacant	23.6%	27.2%	48.8%	53.5%	12.1%	38.6%	30.8%	17.2%	14.7%
Other	4.8%	0.5%	-	-	-	0.7%	2.0%	9.0%	0.8%

Table 4-3 (Continued)
Existing Land Use Type Identified by Subbasin

Description	Subbasin Number									
	D-9	D-10	D-11	D-12	D-13	D-14	D-15	D-16	D-17	D-18
High Density Residential	1.0%	3.6%	8.8%	4.8%	4.7%	0.3%	3.8%	2.0%	-	2.4%
Single-Family Residential (greater than 1.0 acre lots)	43.2%	22.2%	9.4%	16.0%	44.0%	10.7%	39.0%	42.2%	16.9%	30.6%
Multi-Family Residential	0.6%	0.3%	-	-	5.4%	2.4%	4.3%	9.5%	0.7%	-
Group Home/Other	-	-	-	-	0.1%	0.4%	-	0.2%	-	-
Mobile Home	3.3%	9.1%	5.8%	1.6%	3.7%	1.4%	1.6%	1.1%	2.0%	7.1%
Commercial/Service	-	3.7%	-	5.2%	3.9%	2.9%	11.3%	22.0%	4.1%	-
Industrial	-	0.9%	-	-	0.3%	3.2%	3.0%	1.9%	5.4%	5.1%
Local Roads/Utilities	0.8%	7.1%	0.1%	0.7%	1.4%	0.5%	4.3%	2.6%	0.8%	-
Education	-	-	-	-	7.1%	-	1.0%	1.5%	0.3%	-
Public Facilities	-	-	-	-	0.2%	-	1.4%	0.5%	0.2%	-
Quasi-Public Facilities	-	0.0%	-	-	1.6%	-	-	1.3%	0.2%	-
Open Space/Recreation	7.7%	1.3%	0.1%	10.7%	1.3%	14.8%	-	0.9%	0.6%	0.5%
Agricultural Land	2.4%	20.5%	62.5%	52.7%	8.5%	45.2%	15.0%	0.2%	45.7%	20.5%
Vacant	39.3%	26.0%	13.2%	4.2%	15.8%	15.6%	12.7%	8.9%	20.5%	31.8%
Other	1.7%	5.3%	-	4.1%	1.9%	2.6%	2.6%	5.4%	2.7%	2.1%

Source: Entranco Geographic Information System and Pierce County Geographic Information System, 2002.

Table 4-4
General Land Use Categories and
Associated Total Percent Impervious Values

Land Use	Average Total Impervious (%)	Effective Percent Impervious (%)
Low-Density Residential	See Table 4-5	See Table 4-5
High-Density Residential	44.29	44
Multi-Family Residential	49.83	50
Mobile Home	23.20	18
RV Park	55.37	50
Group Home	26.12	21
College	37.22	30
Secondary School	27.75	30
Elementary School	24.37	30
Religious Center	49.91	50
Public Places	46.54	50
Quasi Public	79.06	79
Industrial	67.32	84
Commercial	83.32	85
Agricultural Land	3.98	0
Resource Land	4.00	0
Open Space	7.00	5
Roads	45.56	45
Major Highway	51.10	50
Forest/Open Water	0	0

Source: Pierce County Water Programs, 2000

Table 4-5
Low-Density Residential
Percent Impervious Values by Lot Size

Lot Size (acres)	Average Total Impervious (%)	Effective Impervious (%)
<0.25	35	30
0.25-0.35	30	25
0.35-0.50	25	20
0.50-0.75	18	13
0.75-1.00	16	11
1.00-2.00	12	7
2.00-5.00	8	3
5.00-10.00	5	2
10.00-20.00	3	1
>20.00	2	0

Source: Pierce County Water Programs, 2000

Table 4-6
Existing Total Percent Impervious Values for Mid-Puyallup Subbasins

Subbasin	Total Impervious Surface (%)	Effective Impervious Surface (%)
Fennel Creek		
FC-1	13	10
FC-2	10	7
FC-3	12	9
FC-4	14	11
FC-5	35	34
FC-6	22	22
FC-7	22	20
FC-8	34	34
BL-1	20	17
BL-2	26	24
BL-3	15	11
BL-4	15	11
Horsehaven Creek		
HH-1	6	5
HH-2	7	3
HH-3	5	4
HH-4	10	7
HH-5	12	8
HH-6	17	16
HH-7	13	9
Canyon Falls Creek		
CFC-1	1	1
CFC-2	1	0
CFC-3	0	0
Ball Creek		
BC-1	17	14
BC-2	11	7
Puyallup Streams		
P-1	28	29
P-2	33	32
Van Ogles Creek		
VO-1	11	9
Alderton Creek		
A-1	10	7
Direct Discharges		
D-1	13	9
D-2	5	4
D-3	6	4
D-4	5	2
D-5	11	8
D-6	14	11
D-7	15	12
D-8	10	7
D-9	9	7
D-10	15	13
D-11	9	6
D-12	13	9
D-13	21	18
D-14	11	9
D-15	25	23
D-16	35	34
D-17	13	11
D-18	12	10

Source: Entranco Geographic Information System and Pierce County Geographic Information System, 2002.

4.3.2 Future Land Use

The Pierce County Comprehensive Plan was developed and adopted in 1995 in response to the Washington State Growth Management Act (RCW 36.70A) requirements. The Comprehensive Plan, codified as Title 19A of the Pierce County Code, indicates a general intent to allow development within the Basin and with residential densities ranging from one unit per 20 acres to six units per acre.

The Pierce County zoning ordinance is codified in Title 18A of the Pierce County Code. *Figure 4-5* shows the zoning of the Mid-Puyallup Basin that resulted from the comprehensive planning process. The agricultural-based river valley is primarily zoned as rural, with lot sizes ranging from five (5) to 20 acres. Zoning for the upland plateau areas indicates a tolerance for higher density development with moderately dense single-family zoning predominating.

Future land use was determined for each basin using GIS layers that represent Pierce County zoning and land use designations taken from the County's comprehensive plan and GIS layers of each municipality that has land within the Basin. Calculation methods for existing and future land use are similar and assume that zoning areas will become fully built-out in the future.

The initial comparison of existing and future percent impervious area in each subbasin revealed that nine of the 46 subbasins showed lower values of impervious area under future conditions due to lower density land use being shown for some areas. For the purpose of developing the Basin Plan, it is assumed that higher density developments that exist today or already have final approval will be "grandfathered," i.e., built based on the previously higher density levels. As such, it is assumed that existing conditions in at these subbasins will remain the same. *Table 4-7* displays the percent impervious areas determined for future conditions in each subbasin.

4.4 Soils

Two soil types generally dominate the Mid-Puyallup Basin: Alderwood-Everett on the plateaus overlooking the Puyallup River Valley and Puyallup-Sultan on the valley floor along the river. (See *Figure 4-6, Soils*) Other soils found to a lesser extent include Kapowsin, Buckley, and Harstine. All soils are considered to be till-derived based upon published surficial geologic data.

The Alderwood-Everett Association forms in both glacial till and glacial outwash. Alderwood soils are moderately well-drained, whereas Everett soils are somewhat excessively drained. A till layer under Alderwood soils increases the potential for septic failures during periods of heavy rainfall. Septic systems in Everett soils can endanger groundwater supplies because this soil is highly permeable (Lower Puyallup Watershed Management Committee 1992).

The Puyallup-Sultan Association along the Puyallup River was formed in alluvium deposited by flood waters. Puyallup soils are well-drained, whereas Sultan soils are moderately well-drained. Septic systems in Puyallup soils are moderately prone to failures from wetness. In Sultan soils, septic systems also are prone to failure during the rainy season because of the high-water table (Lower Puyallup Watershed Management Committee 1992).

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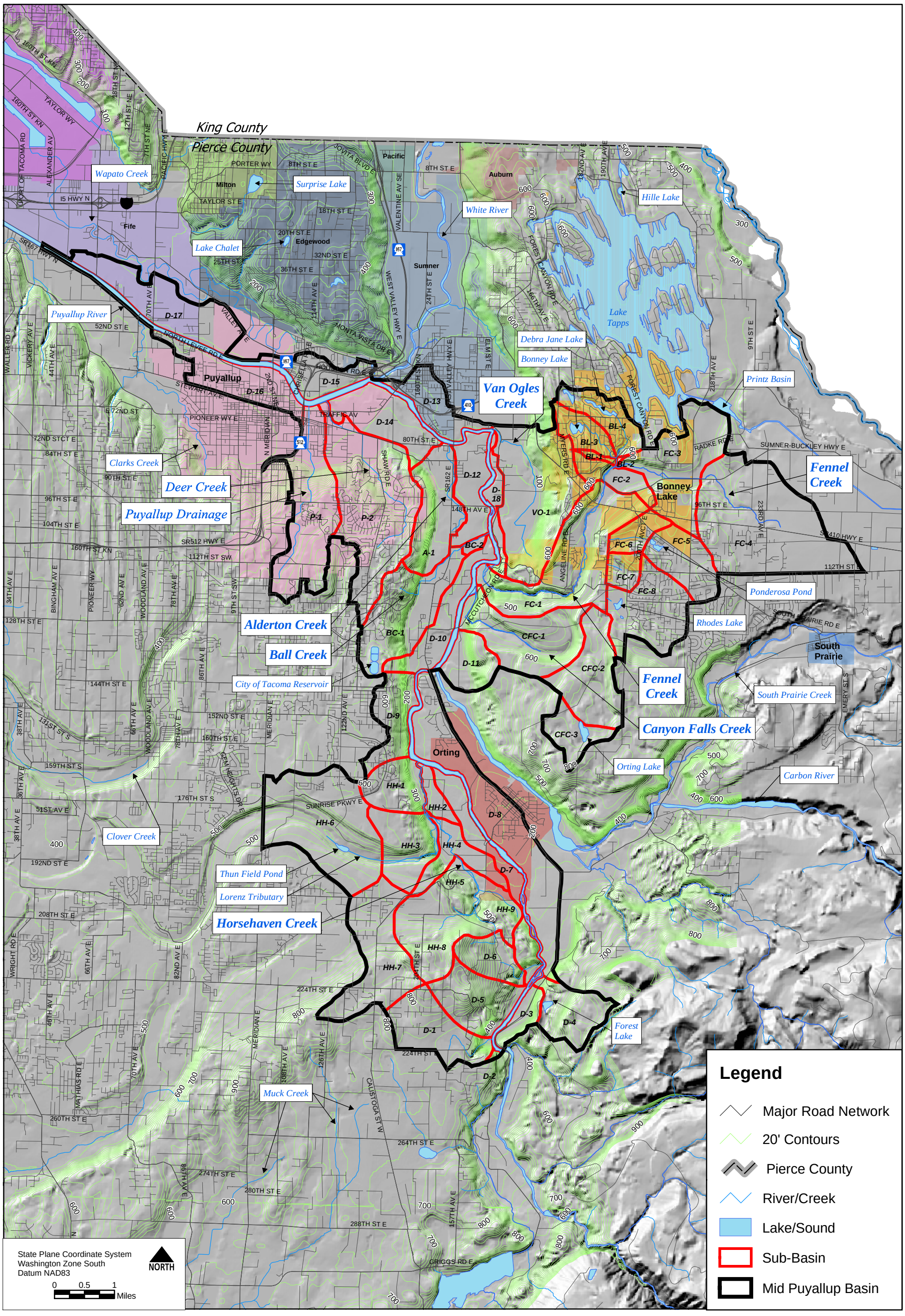

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Figure 4-1: Topography

Mid-Puyallup Basin Plan

PIERCE COUNTY

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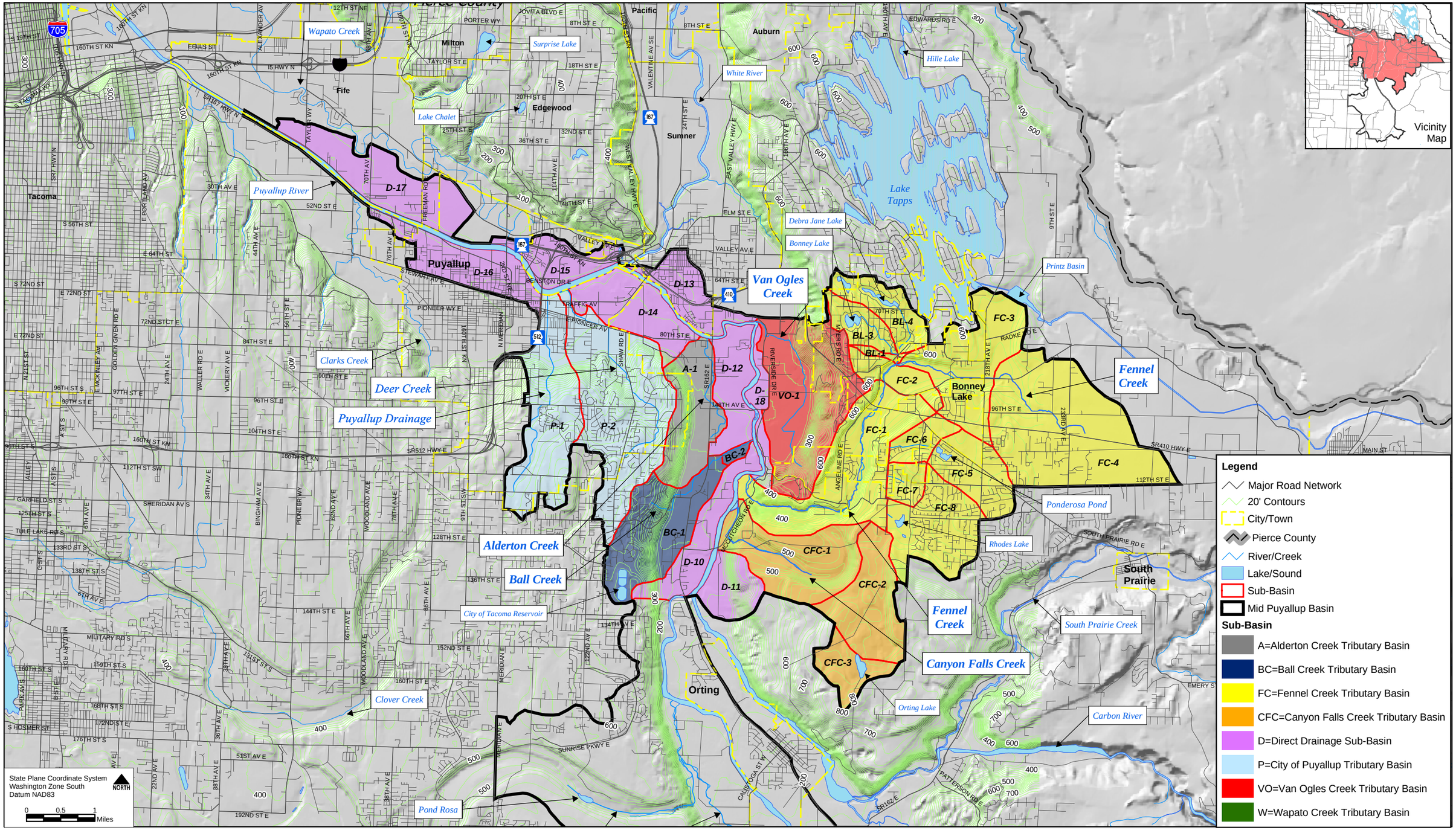

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Figure 4-2A: Sub-Basins

Mid-Puyallup Basin Plan

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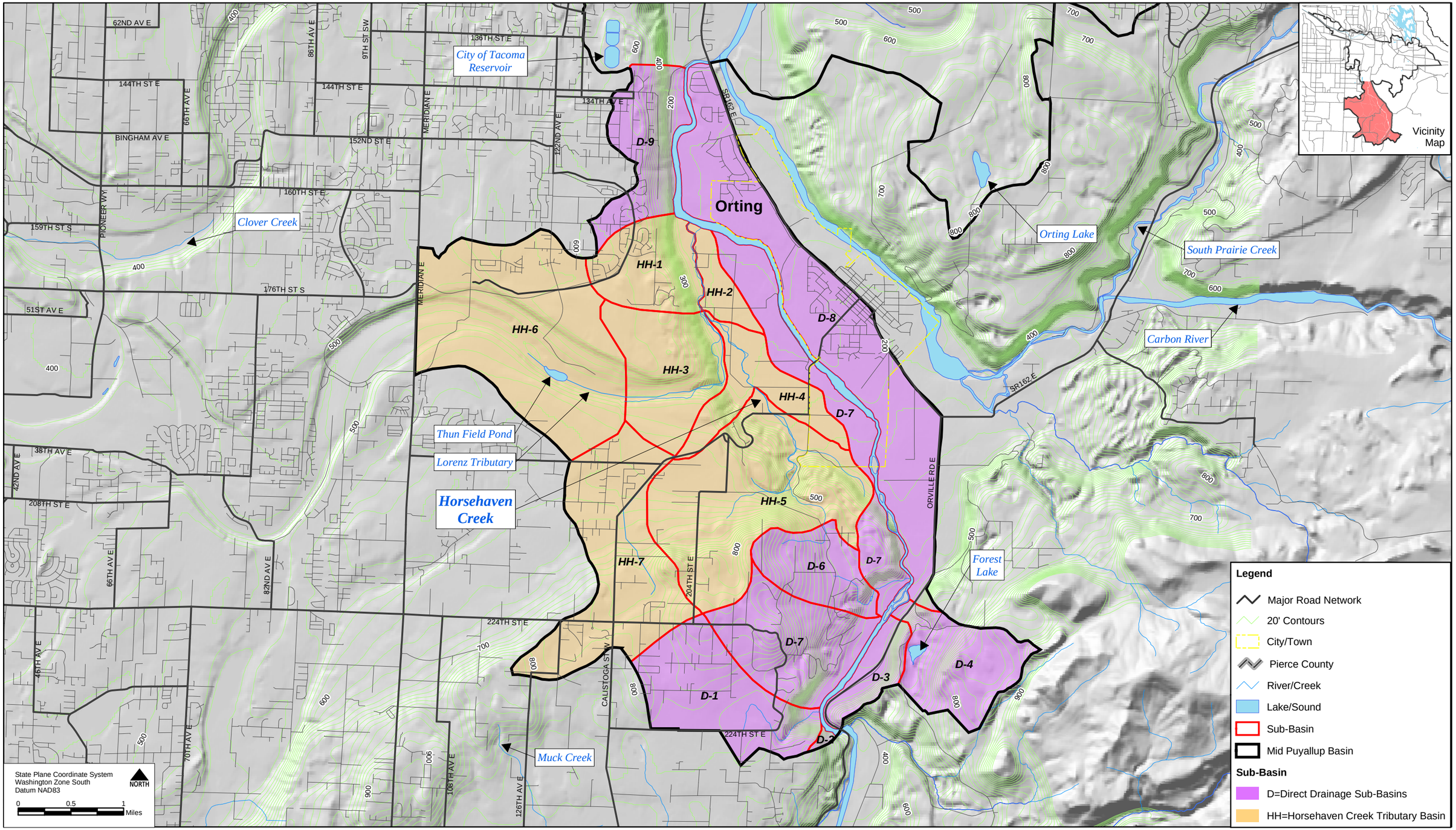

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Figure 4-2B: Sub-Basins

Mid-Puyallup Basin Plan

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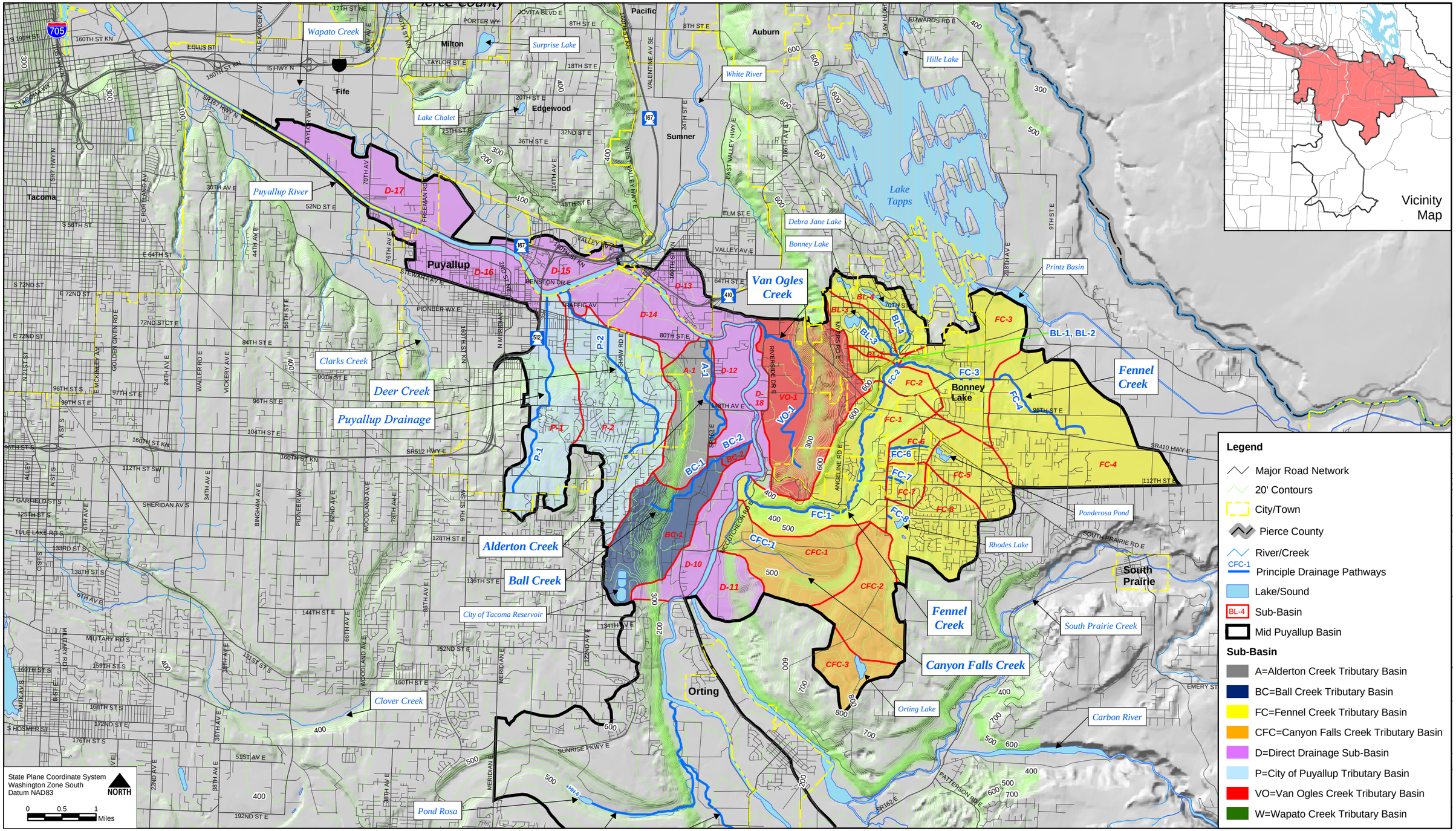

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Figure 4-3A: Principal Drainage Pathways

Mid-Puyallup Basin Plan

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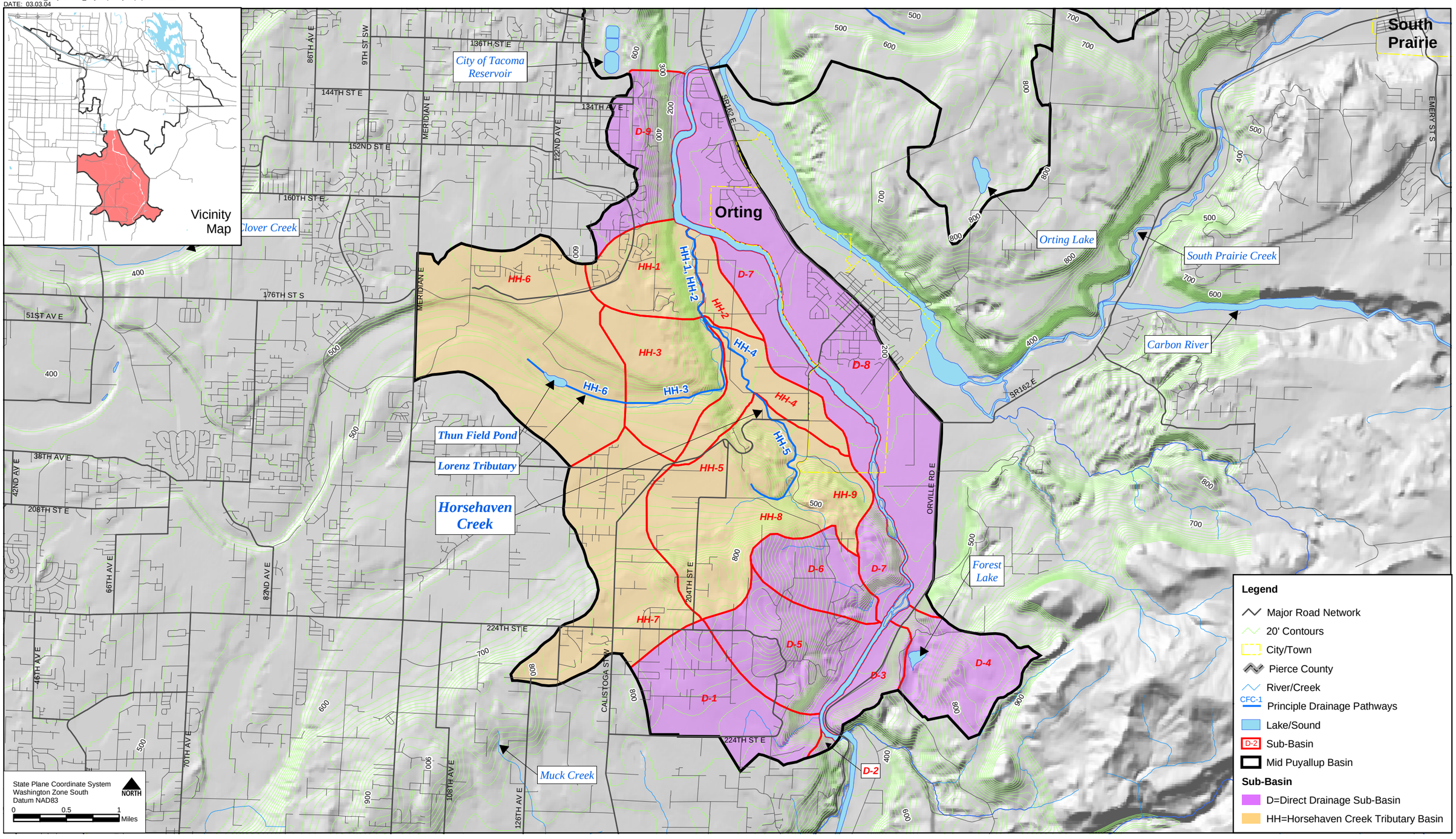

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Figure 4-3B: Principal Drainage Pathways

Mid-Puyallup Basin Plan

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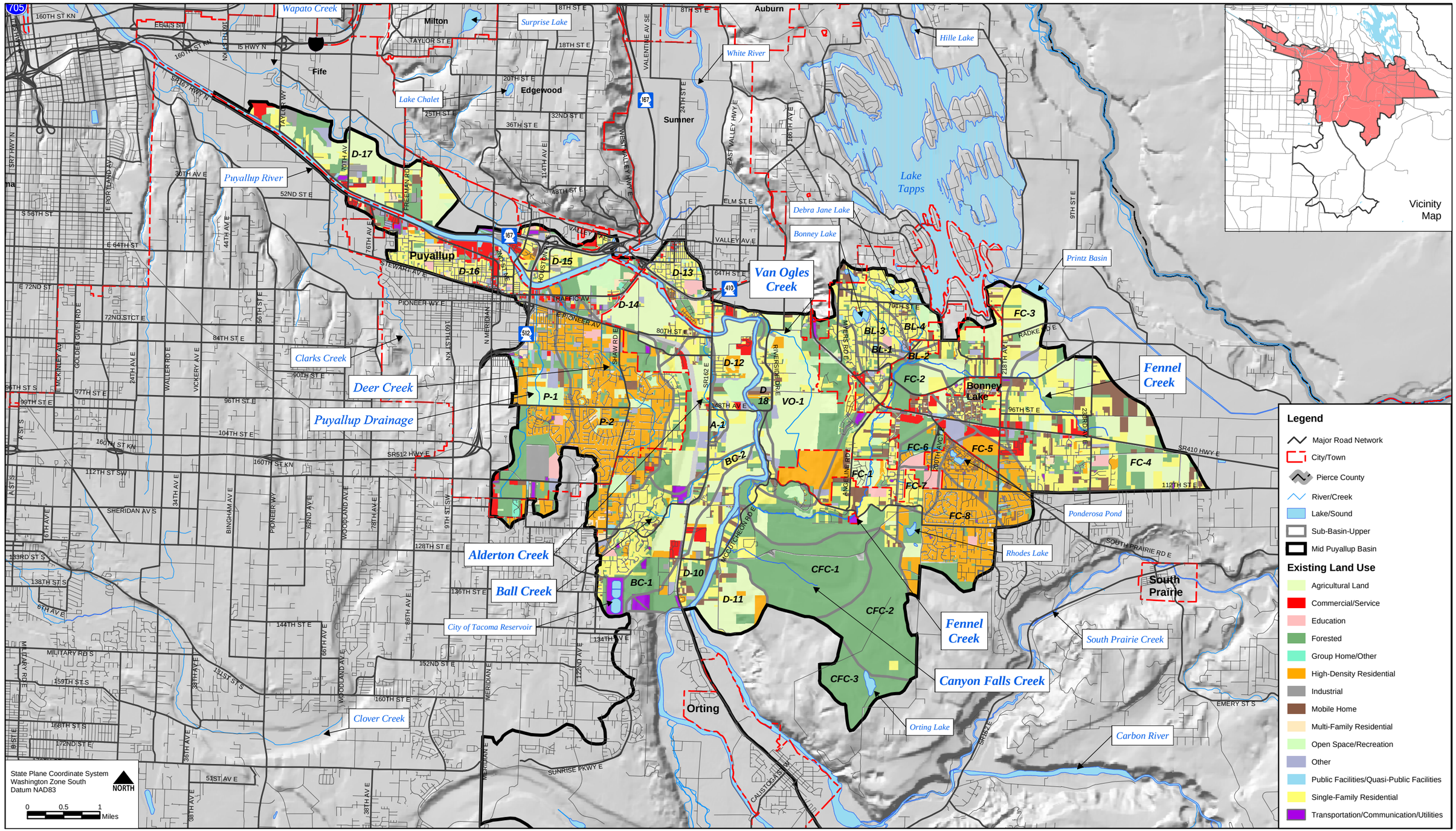

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Figure 4-4A: Existing Land Use
Mid-Puyallup Basin Plan

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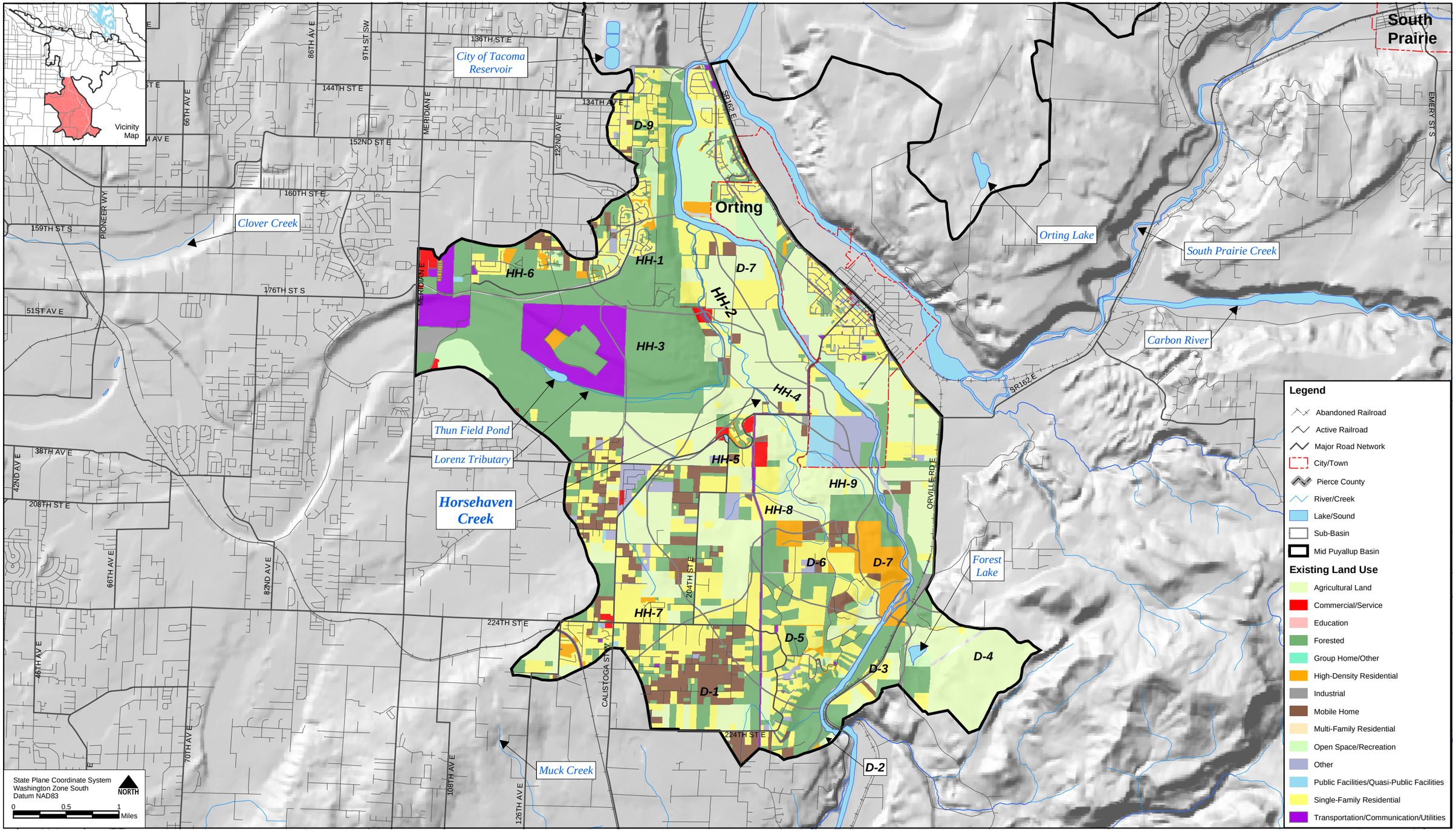

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Figure 4-4B: Existing Land Use

Mid-Puyallup Basin Plan

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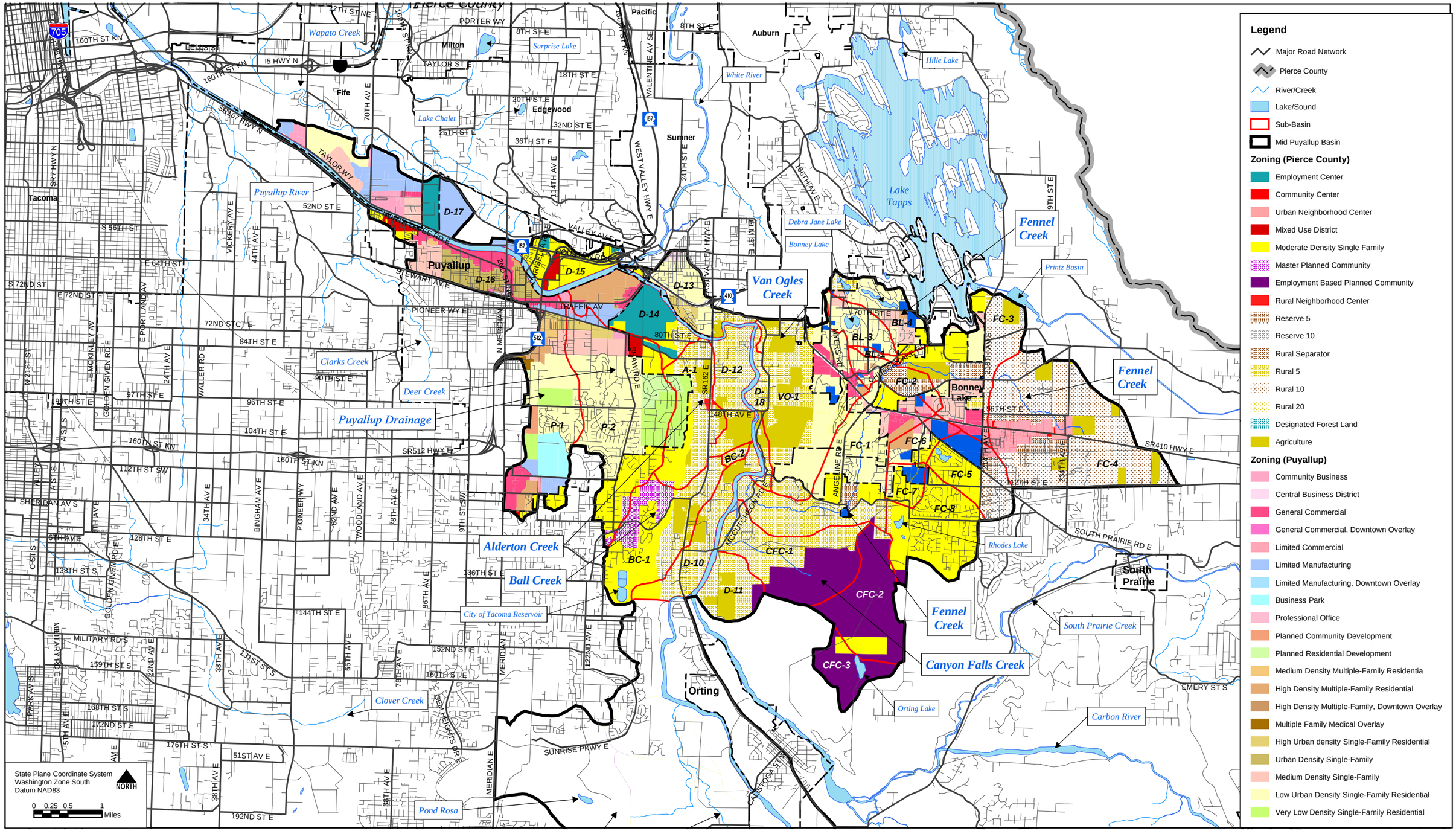

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Figure 4-5A: Zoning

Mid-Puyallup Basin Plan

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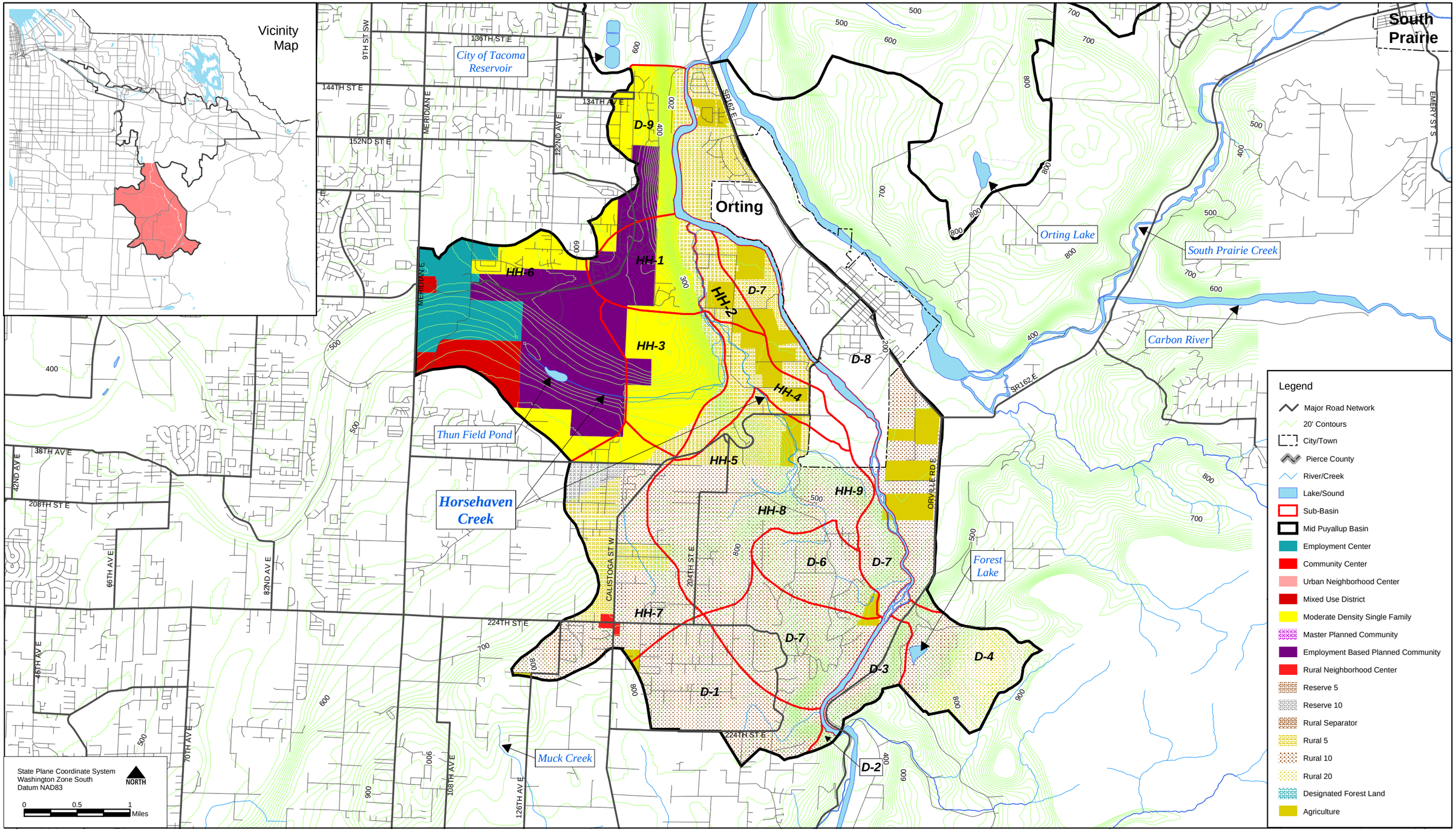

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Figure 4-5B: Zoning

Mid-Puyallup Basin Plan

PIERCE COUNTY entranco Momentum

Table 4-7
Future Total Percent Impervious Values for Mid-Puyallup Subbasins

Subbasin	Total Impervious Surface (%)	Effective Impervious Surface (%)	Subbasin	Total Impervious Surface (%)	Effective Impervious Surface (%)
Fennel Creek			Puyallup Streams		
FC-1	19	15	P-1	50	49
FC-2	17	14	P-2	36	32
FC-3	21	17	Van Ogles Creek		
FC-4	17	13	VO-1	17	14
FC-5 *	35	34	Alderton Creek		
FC-6	29	25	A-1	12	9
FC-7	26	21	Direct Discharges		
FC-8 *	34	34	D-1	16	11
BL-1	32	27	D-2	16	11
BL-2 *	26	24	D-3	16	11
BL-3	29	25	D-4	28	23
BL-4	26	22	D-5	16	11
Horsehaven Creek			D-6	16	11
HH-1	28	23	D-7	17	15
HH-2 *	7	3	D-8	27	27
HH-3	24	19	D-9	26	21
HH-4	11	9	D-10 *	15	13
HH-5	15	11	D-11 *	9	6
HH-6	50	48	D-12 *	13	9
HH-7	14	10	D-13	25	22
Canyon Falls Creek			D-14	62	62
CFC-1	19	15	D-15	38	34
CFC-2	33	28	D-16	58	58
CFC-3	34	29	D-17	64	68
Ball Creek			D-18 *	12	10
BC-1	20	15			
BC-2 *	11	7			

*Indicates Basin was adjusted to existing conditions and assumed zero growth

Source: Entranco Geographic Information System and Pierce County Geographic Information System, 2002.

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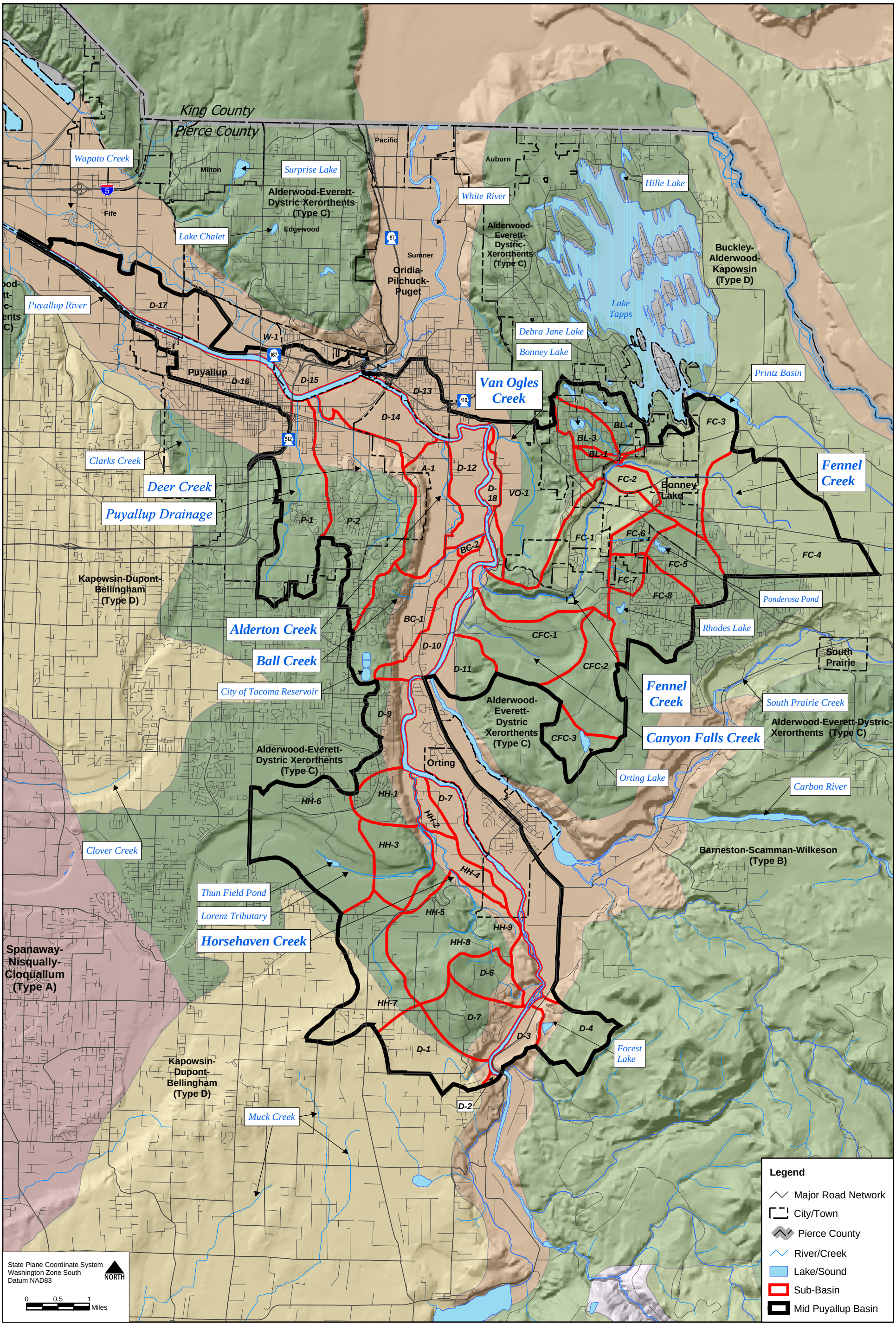

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Figure 4-6: Soils

Mid-Puyallup Basin Plan

PIERCE COUNTY entranco Momentum

4.4.1 Natural Drainage System

The Mid-Puyallup Basin includes a variety of natural drainage systems that are tributary to the Puyallup River. These systems include water bodies catalogued by Washington State under the Water Resource Inventory Area (WRIA) 10, as well as numerous smaller drainage ways that serve to collect and convey surface and groundwater runoff (See *Figure 4-3, Principal Drainage Pathways*).

Tributaries

The six Mid-Puyallup Basin tributaries catalogued under WRIA 10 that comprise the focus of this study are Alderton Creek, Van Ogles Creek, Ball Creek, Fennel Creek, Canyon Falls Creek, and Horsehaven Creek. There are numerous smaller streams throughout the Basin that drain local areas, either directly to the Puyallup River or into one of the streams described below.

Alderton Creek (Tributary 0399), confluence at Puyallup RM 12.2, Township 20 N, Range 4 E, Section 25

The Washington State Department of Fish and Wildlife (WDFW) (Williams et al. 1975) and the DNR hydrolayer maps the origin of Alderton Creek on the valley floor near the intersection of 102nd Street East and State Route 162 (SR 162) south of Alderton. From here the stream flows north to join the Puyallup River, just west of the corner of 80th Street East and SR 162 at about Puyallup RM 12.2, about 1.8 miles from its origin.

The stream is listed by these same sources as perennial, draining open fields and farmlands. The creek's drainage area is gradually being converted to residential housing. (The Pierce County Land Use GIS coverage indicates a mix of properties zoned "Agricultural" and "Rural Five".)

Discrepancies were found between how Alderton Creek is cataloged and mapped and its current condition. Alderton Creek is not shown on the 1993 USGS 1:24,000 Sumner quadrangle map. Field reconnaissance conducted as a part of the Basin characterization found that this stream alternates from surface to subsurface flow, piped in places, for virtually all of its length. Little natural surface channel remains. It is concluded that Alderton Creek no longer exists as a continuous open-water channel connecting to the Puyallup River.

Van Ogles Creek (Tributary 0400), confluence at Puyallup RM 13.1, Township 20 N, Range 5 E, Section 30

Van Ogles Creek originates on the valley floor south of 92nd Street East. It flows north along the base of the bluff west of Bonney Lake before looping west to Riverside Park where it passes under Riverside Drive and is joined by Tributary 0401 (unnamed). It turns north at this juncture, but swings west again within a moderately confined channel (steep bank on its east and north side) to its confluence with the Puyallup River. This stream and its tributary system upstream of

Riverside Drive drains a mixed-use agricultural, residential housing area. The Pierce County Land Use GIS coverage indicates a mix of properties zoned "Agricultural" and "Rural Five," although the housing density appeared to be considerably greater than this along Riverside Drive.

Stream length is given as 2.15 miles in a catalog of global streams and salmon utilization, but is 1.9 miles based on summation of DNR/WDFW hydrolayer segment lengths. Stream substrate is fine sediment and organic matter where observed in segment 16/8//1. The channel is slough-like at this point, and the water was quite murky on the day of reconnaissance (February 8, 2001).

Ball Creek (Tributary 0405), confluence at Puyallup RM 14.9, Township 19 N, Range 5 E, Section 6

Ball Creek is another valley floor tributary originating south of Old Military Road at the base of the bluff that forms the Puyallup Valley west wall. This stream flows diagonally northeast across the valley floor, crosses SR 162 and 106th Street East, and continues to its confluence with the Puyallup River. Ball Creek flows through land alternately used for agriculture and housing.

Stream length given in a catalog of global streams and salmon utilization is 1.35 miles, but summation of Washington State Department of Fish and Wildlife's "Salmon and Steelhead Habitat Inventory and Assessment Program" segment lengths gives 1.7 miles. The source of Ball Creek appears to be a system of springs and seeps coming down off the west valley wall at a point approximately 0.75 mile south of the mapped channel origin. This is close to the location where the City of Tacoma aqueduct crosses the valley floor and gives an actual stream length closer to 2.4 or 2.5 miles. The channel appears to be perennial and large enough to be fish-bearing from that point northward.

Fennel Creek (Tributary 0406), confluence at Puyallup RM 15.5, Township 19 N, Range 5 E, Section 7

Fennel Creek originates on the old Osceola mudflow near the north side of SR 410 east of its intersection with 233rd Street East. The stream generally flows west toward the City of Bonney Lake then turns south and flows through an old Vashon-age melt water drainage channel that also was filled by a lobe of the Osceola mud flow (Crandell 1963) to Victor Falls, RM 2, where the course alters to the west descending through a steep canyon to the Puyallup Valley floor at McCutcheon Road, RM 0.4. There the stream flattens and turns north to flow across the valley floor to its confluence with the Puyallup River.

Fennel Creek drains a mixed-use area of agriculture and rural, suburban and urban housing, as well as some light industry. Much new housing development is occurring in the valley and some within the canyon south of the City of Bonney Lake. A large gravel quarry (Maranatha Gravel) is located at the face of bluff that forms the south valley wall of Fennel Creek just upstream from McCutcheon Road, at approximately RM 0.5. The stream also has been known as Kelly Creek. Stream length is given as 7.95 miles and drainage area as 6.58 square miles in a catalog of global streams and salmon utilization. Wintertime base flow near the mouth of Fennel Creek range is on

the order of 15 to 20 cubic feet per second (cfs), whereas base flow in the upper reach near the Sumner-Buckley Highway is closer to 10 cfs.

Canyon Falls Creek (Tributary 0410), confluence at Puyallup RM 16.2, Township 19 N, Range 5 E, north half of Section 7

Canyon Falls Creek begins in wetlands in a geological depression on the border between sections 8 and 9 of Township 19N, Range 5E, approximately 0.5 miles south of Victor Falls on Fennel Creek. AES and Beck (1997) reported a series of wetlands extending downstream around a "fish hook bend" to the west as far as RM 1.8 where the first surface water "daylights," i.e., begins surface flow. From there, the stream flows just north of west to a commercial fish hatchery at about RM 1.0 where the hatchery water intake (water right for 15 cfs) dries the channel. Return water from the hatchery reenters the stream at RM 0.86. The stream then drops through a steep ravine (gradient 17–18 percent) to McCutcheon Road, RM 0.55, where the gradient flattens and the stream turns north to join the Puyallup River at Puyallup.

The headwaters of Canyon Falls Creek are undeveloped and forested down to the private hatchery. However, the Cascadia Planned Community development is planned for the uplands south of Canyon Falls Creek (Huckell-Weinman 1998) and a golf course development, named Falling Water, may be built on the uplands north of the creek, i.e., between Canyon Falls and Fennel creeks (Subdivision Development and Design et al. 1996). Land use downstream of McCutcheon Road appears to be agricultural and sparse residential.

Stream length is listed as 3.0 miles and the drainage area as 1.71 square miles in a catalog of global streams and salmon utilization; however, the Cascadia Employment Based Planned Community Environmental Impact Statement (Huckell-Weinman 1998) recorded the total drainage area as 3.8 square miles.

Horsehaven Creek (Tributary 0589), confluence at Puyallup RM 20.2 Township 19 N, Range 4 E, Section 25

Several different names are associated with this stream and its tributaries. The Mid-Puyallup Basin Plan follows the convention given in a catalog of global streams and salmon utilization, which also was used on the WDFW/DNR hydrolayer and by SSHIAP.

The Horsehaven main stem (called Soldiers Home Creek in Thorpe and Stepan 1985) begins at a small 1- to 1.4-acre pond, elevation 440-feet, in Township 18N, Range 5E, Section 6 southwest of the Orting Soldiers Home. It drains west and then north through a steep gully with an impassable cascade and emerges on the valley floor near the Soldiers Home where it is joined by tributaries 0592 and 0593. At this point, the stream becomes a valley tributary, flowing northwest along the base of the bluff for approximately two miles to its confluence with Tributary 0590 (called Lorenz Creek by the Pierce County Conservation District in Year 2000, but considered the main stem of Horsehaven Creek by Thorpe and Stepan 1985). Horsehaven Creek then continues north-northwest to join the Puyallup River at Puyallup RM 20.2

The gullies of both the main stem and Tributary 0590 appear inaccessible and forested (based on the revised 1994 USGS Orting quadrangle). However, the headwaters of Tributary 0590 are located in an area designated "Master Planned Community" on the Pierce County land use map and are within the boundary of the Rainier Terrace Planned Community Development (Thorpe and Stepan 1985). The valley floor is a mixed area of homes and agriculture. The Puyallup Tribe once considered building a fish hatchery along upper Horsehaven Creek but abandoned the plan because of the ephemeral nature of its stream flow in late summer months (R. Ladley, personal communication).

Horsehaven main stem stream length is given as 3.3 miles and the Tributary 0590 stream length is given as 1.4 miles in a catalog of global streams and salmon utilization. Tributaries 0591, 0592, and 0593 also are mapped in the catalog, but no stream lengths are given. Winter base flows along the main stem are typically on the order of 3 cfs.

Tributary 0590 itself originates at an approximately 10-acre pond, elevation approximately 450-feet, in Township 19N, Range 4E, southwest corner of Section 36, then flows west down a steep ravine with an impassable cascade to the valley floor where it turns north to join the main stem.

Overbank flooding of these natural channels occurs primarily along the Puyallup River with less extensive flooding along the tributaries. *Figure 4-7* shows the extent of the flood zones as mapped for the flood insurance rate maps published by the Federal Emergency Management Agency (FEMA).

Direct Drainages

The 18 subbasins adjacent to the main stem of the Puyallup River are considered to have direct drainage to the main stem through either multiple small channels or subsurface flow. The majority of these direct discharge subbasins drain the flat areas along the bottom of the river valley. Anecdotal accounts from local citizens indicate that drainage tiles were installed in many of these areas in the Basin around 1950 to improve drainage for farming. The land in these subbasins varies greatly from agricultural in the valley bottom to high-density residential sections in the north and south ends of the Basin. Some of the direct drainages in the southern end of the Basin drain elevated plateaus. These subbasins have been designated with D-(subbasin number) and are shown in *Figure 4-2*.

Streamflow Data

Existing streamflow data for the Mid-Puyallup Basin are limited to one relatively short gauge record from a USGS station maintained on Fennel Creek, USGS 12096000, Fennel Creek near McMillin) and three records collected as a part of this basin planning effort (*Table 4-8, Mid-Puyallup Flow Gauges*). Information from these sources is being obtained and was used for modeling (See Chapter 6) to the extent practical, considering when it was collected and the land use in place at the time. *Figure 4-8, Stream Gauges*, shows the locations of the stream gauges used for this Basin Plan.

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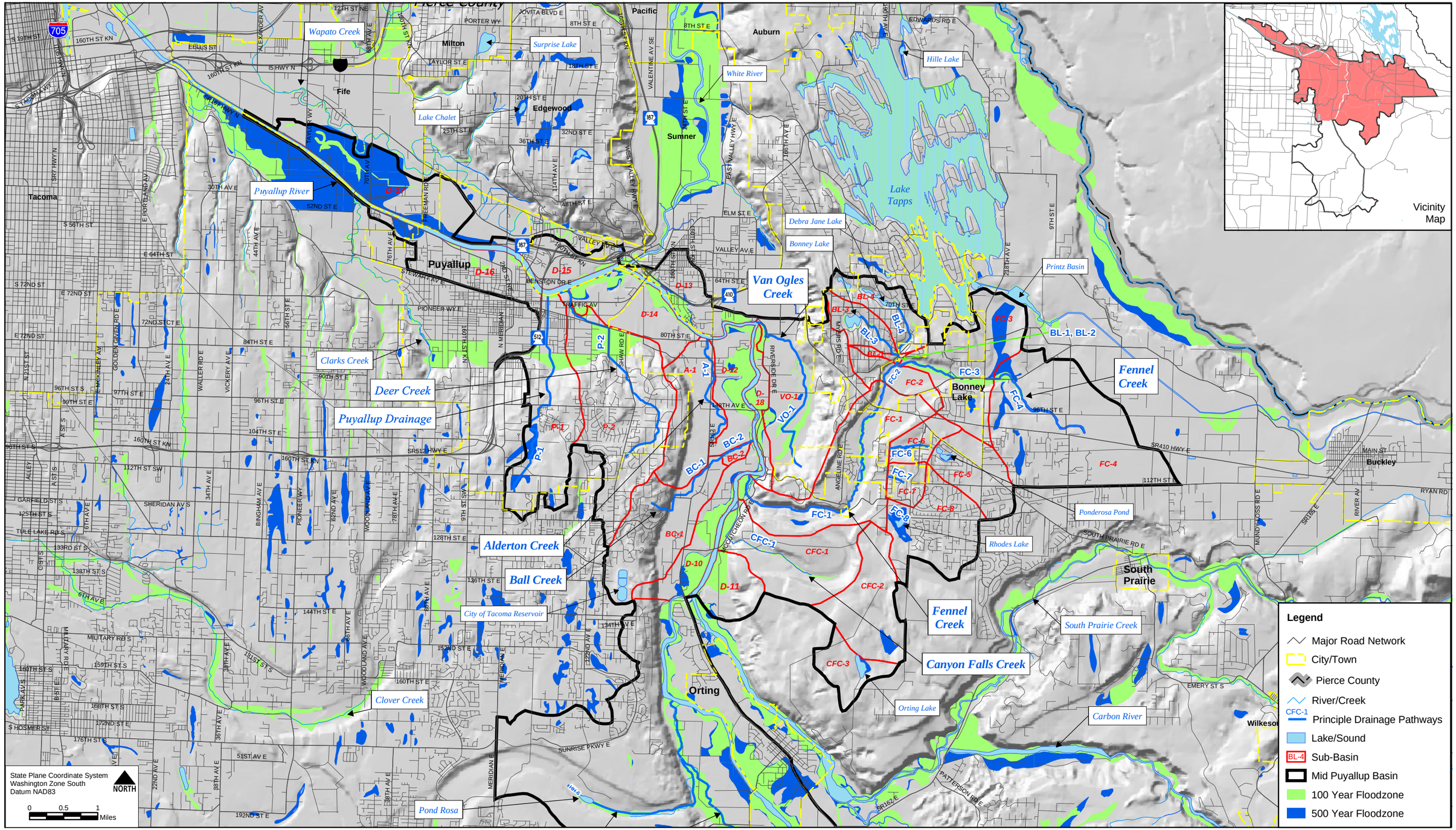

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Figure 4-7A: Flood Zones

Mid-Puyallup Basin Plan

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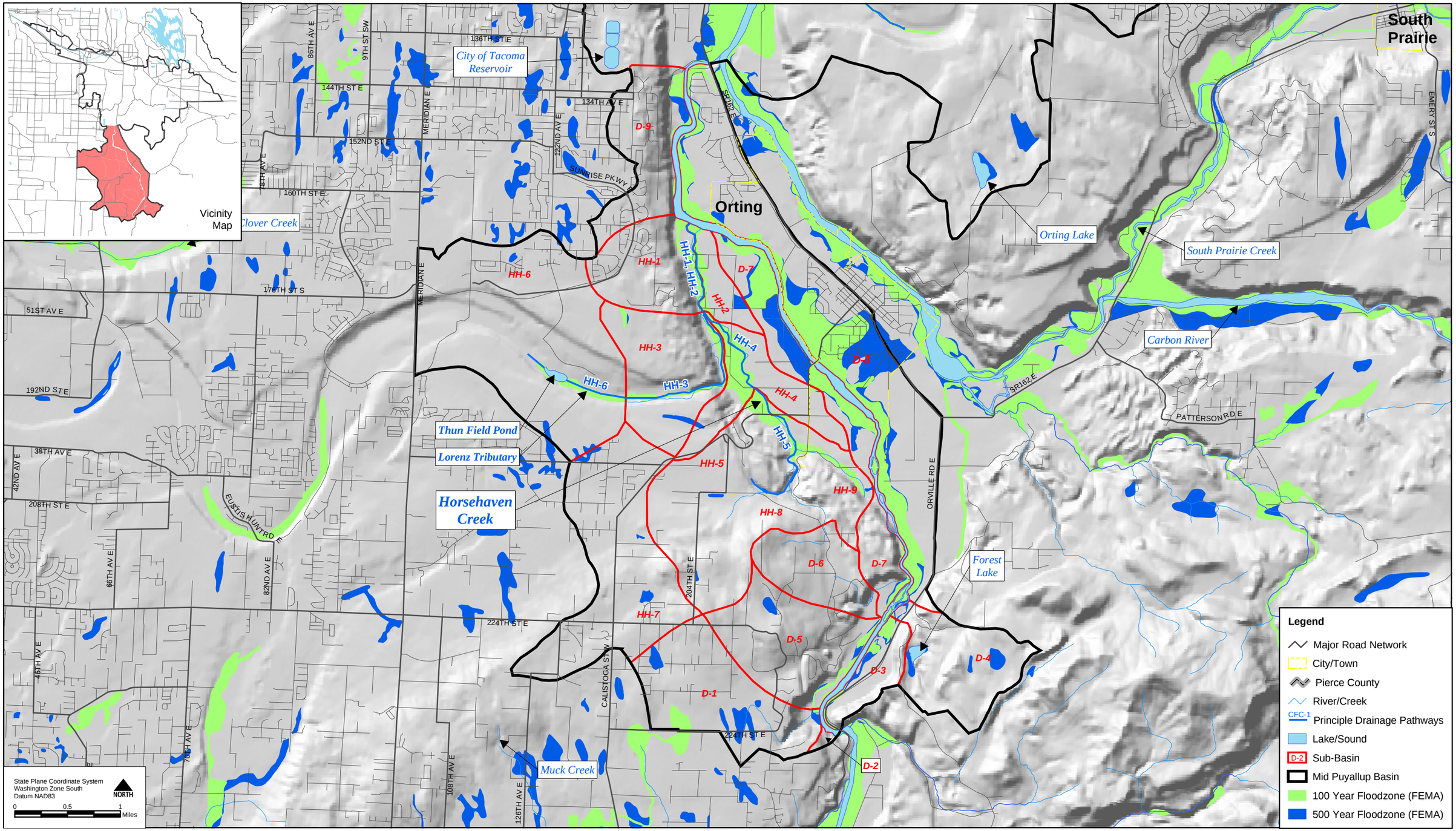

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Figure 4-7B: Flood Zones

Mid-p\Puyallup Basin Plan

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Table 4-8
Mid-Puyallup Flow Gauges

Gauge Designation	Maintained By	Location	Contributing Area (square miles)	Period of Record
Site 1	Pierce County	Fennel Creek near McCutcheon Road	12.5	October 2001 December 2003
Site 2	Pierce County	Fennel Creek near Sumner Buckley Highway	7.4	October 2001 December 2003
Site 3	Pierce County	Horsehaven Creek near 188th Street E	2.4	October 2001 December 2003
12096000	USGS (discontinued)	Fennel Creek near McMillan	12.5	1949

Source: Entranco 2002, and USGS website 2002.

Three temporary stream gauges were installed to support the Mid-Puyallup Basin Plan. Gauge sites were selected based upon the need for flow data on the tributary streams and the ability to access the streams. Initially, six streams were considered for gauging, including Alderton Creek, Van Ogles Creek, Ball Creek, Canyon Falls Creek, Horsehaven Creek, and Fennel Creek. After further review and field visits, Alderton and Van Ogles creeks were determined to be of marginal significance and, as a result, were eliminated from further consideration.

Ball Creek (Stream 0405) was ruled as a high value potential site, but property owner permission to install a gauge was never attained**.** Canyon Falls Creek (Stream 0410) also was identified as a stream of interest, but a suitable gauging site could not be located due to similar limitations. In the end, one gauge site was located on Horsehaven Creek and two on Fennel Creek as described below.

Initially, a gauge site was proposed near Horsehaven Creek's confluence with the Puyallup, but again property access was an issue so an alternative site on 188th Street East southwest of Orting was selected. During the installation of the gauge, the landowner adjacent to the road and upstream of the stream crossing gave permission to put the gauge on his land. The site on his land was preferable to the site next to the road for a number of reasons. First, the stream was flowing through a culvert, which simplifies the development of the rating curve. Second, the original stream crossing on 188th Street East was reported to flood, and that presented problems keeping the gauging equipment dry. Third, putting the gauge on private property and away from the roadway decreases the chances of equipment being vandalized.

Two gauges were installed along Fennel Creek because it is the largest tributary in the planning area. "Gauge 1" is at the bridge crossing on McCutcheon Road East in the road right-of-way. This site once was used as a gauge station by the USGS in 1949, so historical data are available for comparison. The site is far enough upstream from the confluence with the Puyallup River that

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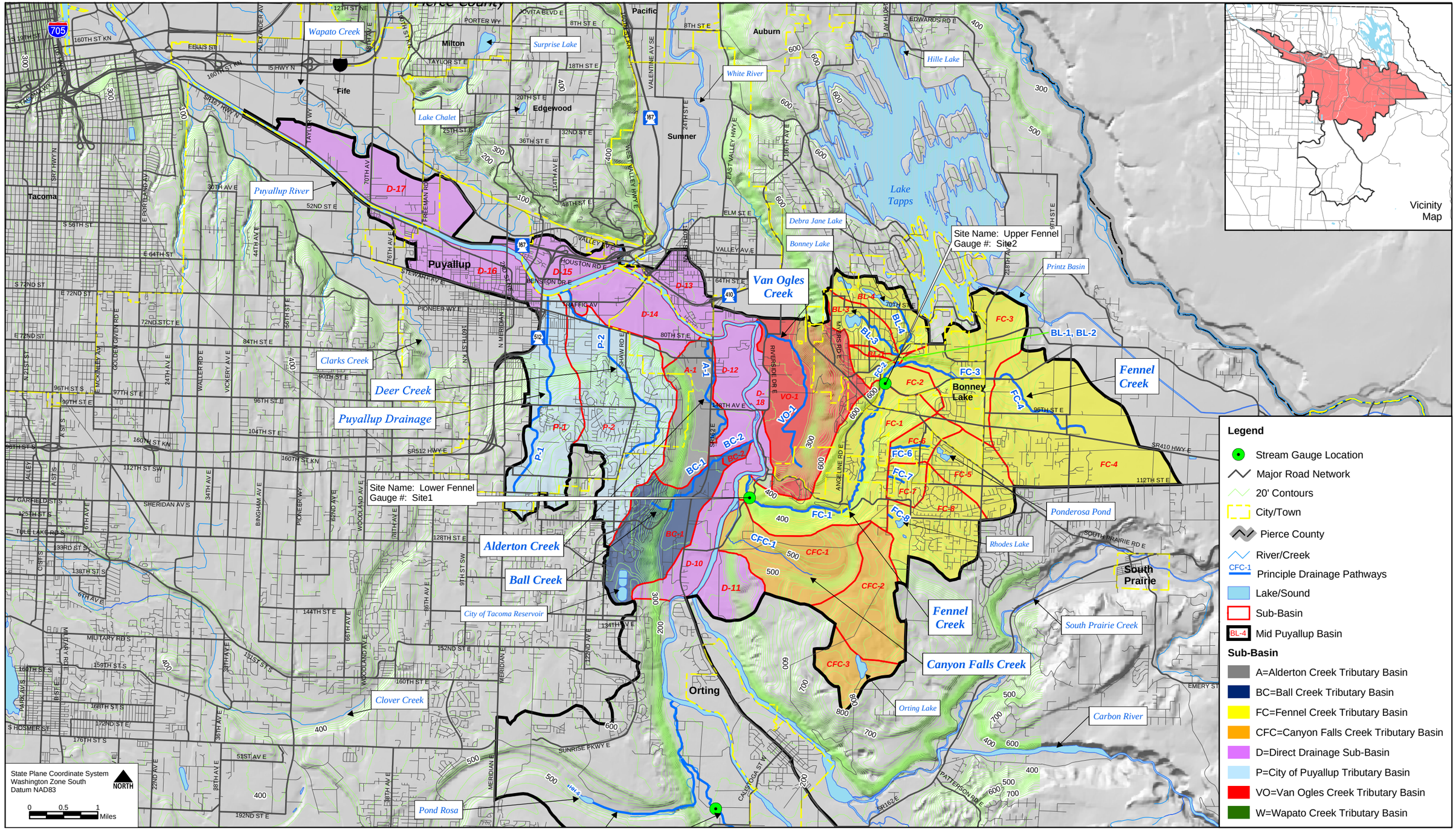

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Figure 4-8A: Stream Gauges

Mid-Puyallup Basin Plan

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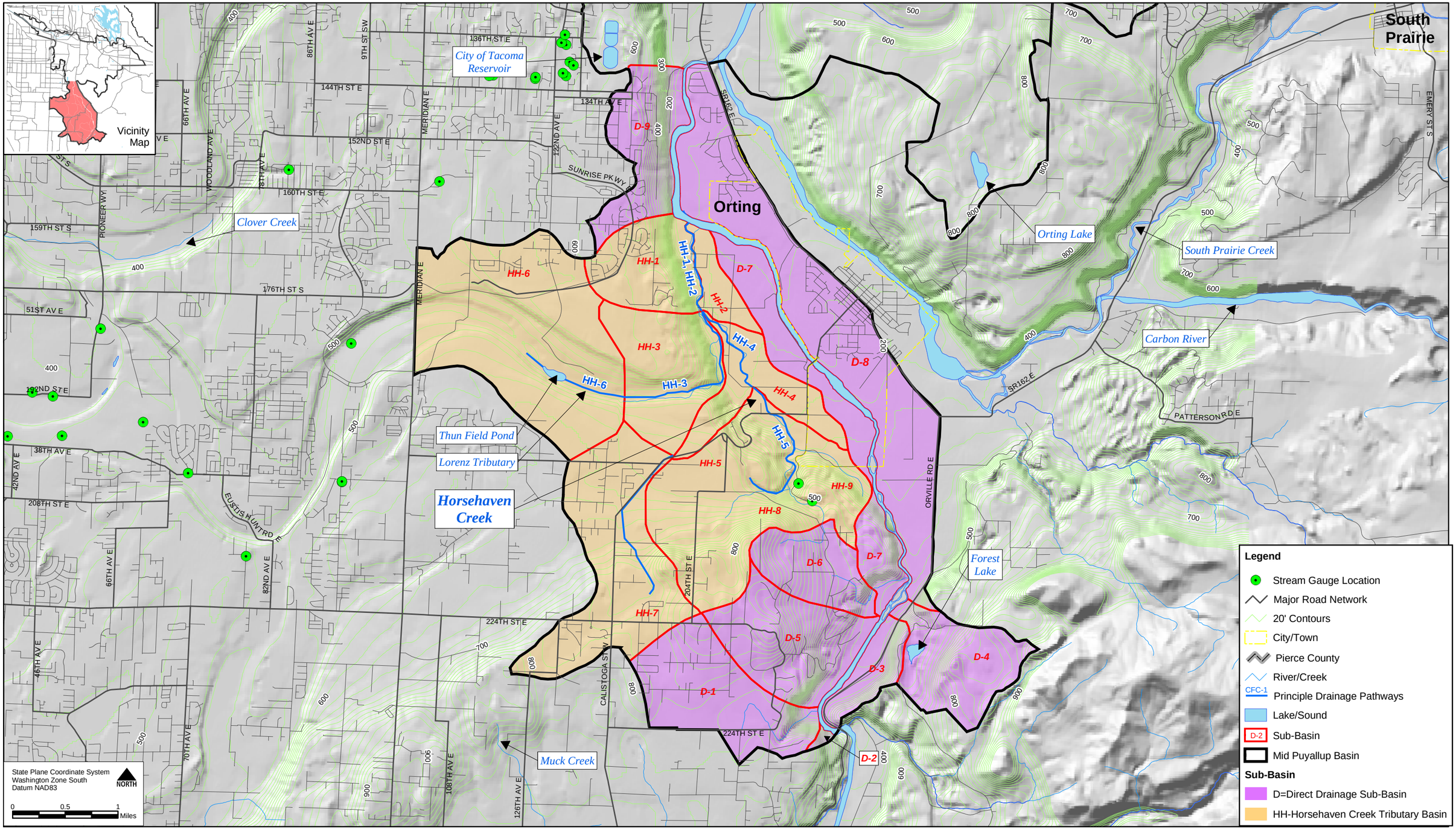

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Figure 4-8B: Stream Gauges

Mid-Puyallup Basin Plan

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backwater effects will not adversely affect the flow meter's accuracy. The site also has the added benefit of having some historical data available for comparison.

"Gauge 2" is located on the upper half of Fennel Creek where the creek crosses under the Sumner-Buckley Highway. The stream crosses under the road in a large arch culvert in the road right-of-way. The gauge was installed at the outlet of the culvert. The stream character at the upper gauge differs from that of the lower reach. The upper reach is slow moving with a silty streambed compared to the fast moving gravelly-bottomed lower reach.

Stream gauges were installed during September 2001 and are being maintained on an on-going basis. Along with flow measurements, temperature data also are being collected and recorded. Periodic visits are being conducted to download data. Graphs of data collected through "Phase 1" of the basin planning process (May 2002) are presented in *Appendix E*.

Groundwater

The occurrence and movement of groundwater in central Pierce County is largely controlled by the local and regional stratigraphy. Permeable glacial outwash (sand and gravel) generally forms excellent aquifers. Low permeability glacial till and interglacial silt generally restrict groundwater flow. The source of groundwater recharge is primarily from the infiltration of rain. Groundwater flow directions generally follow surface topography flowing from areas of recharge to areas of discharge such as to lakes and rivers. Discharge also occurs at artificial, constructed structures, such as sanitary and stormwater sewers and withdrawal from water supply wells. Normally, the predominant direction of groundwater movement in aquifers is lateral; however, there can be a vertical component to the direction of motion that is downward in recharge areas and upward in areas of discharge (Jones et al. 1999).

Groundwater levels fluctuate over time, both seasonally and long term, in response to changes in recharge to and discharge from aquifers. When recharge exceeds discharge, water levels rise, and where discharge exceeds recharge, water levels will decline. In general, water levels in shallow wells in western Washington rise from October through March, when precipitation is high, and decline from April through September, when precipitation is low. Water levels in deep wells generally respond more slowly, and usually with less change, than water levels in shallow wells.

The majority of the Mid-Puyallup Basin water supply comes from groundwater. There are 30 water purveyors that provide potable water in the Basin from a total of 50 "Group A" wells and 97 "Group B" wells (See *Figure 4-9, Well Locations*). "Group A" wells are public water system wells with 15 or more connections. The State Department of Health requires "Group A" water systems to collect water quality data on a regular schedule, to have a knowledgeable operator, and to have a water production gauge to keep track of water used. "Group B" wells have 2 to 14 connections and are required to sample and report annually.

An investigation of the Hidden Valley Landfill conducted in the early 1980s found that groundwater quality had been affected down gradient from the landfill. This site was placed on the "National Priority List," AKA, "Superfund List" in April 1989. Contaminants included dissolve iron and manganese, chloride, ammonia, nitrate, sulfate, and low intermittent levels of volatile organic compounds including benzene, chlorobenzene, 1,1-dichloroethane, and 1,4-dichlorobenzene (Kleinfelder 2001). These contaminants are not found in the surface water channels of Horsehaven Creek, which is downstream of the landfill. As part of the clean up for this site, a leachate collection system was installed and all leachate is now pumped and treated.

4.4.2 Constructed Drainage System

Drainage from the contributing areas in each subbasin has been modified with the progression of development into a network of pipes, ditches, culverts, and detention facilities. In the upland residential areas, drainage ditches direct surface water runoff along roadways to nearby streams. Newer developments pipe water from catch basins to detention facilities before discharging it to natural streams. Problem areas in the Mid-Puyallup Basin prone to frequent flooding are listed and discussed in Chapter 5.

Catch Basins

Catch basins are found primarily in the urban and suburban areas of the Mid-Puyallup Basin. These structures drain water from roadways and parking lots and direct it into pipes or ditches for conveyance to nearby streams. A characteristic grating covers catch basins that can become clogged with leaves and other debris. Maintenance of catch basins is essential to prevent water from backing up behind clogged gratings and causing flooding.

Culverts

Culverts are found throughout the Mid-Puyallup Basin. These conveyance structures range from small 6- to 8-inch driveway culverts to large 6- to 8-foot highway culverts. Most culverts in the Basin are upland from stream systems and convey runoff under driveways and roadways between ditches that direct water to streams. Some culverts pass stream flow along the natural channels. All culverts need to be sized for the flow they are expected to carry and to avoid fish passage barriers where applicable. Culverts too small or prone to blockage can become problem areas with frequent flooding or block the migratory passage of anadromous or resident fish. A description of fish blocking culverts in the Mid-Puyallup Basin is included in Section 5.3.

Drainage Ditches

Many suburban areas in the Mid-Puyallup Basin rely on roadside drainage ditches to convey water from the upland areas to the streams. These ditch systems are connected by pipes and culverts to complete the constructed drainages. Maintenance of ditches is important because over time they can fill with sediment and lose capacity. Drainage ditches also are used to convey excess water from agricultural areas along the flat valley bottom. These ditches typically are longer than those in the suburban areas and are dug along edges of fields, often modifying and straightening small natural channels.

Stormwater Ponds

Stormwater ponds are designed to detain runoff in an upland basin to prevent the extreme peak flows that are associated with urban storm flow. Stormwater ponds began to be included with new development in the early 1980s. Developments built before this time typically do not have stormwater ponds unless they have been retrofitted. Thus, stormwater ponds throughout the Mid-Puyallup Basin are found primarily in areas of newer development. Ponds usually are sized to hold the volume of water that would fall during a chosen return period storm. Storms exceeding this volume may over top the pond.

Outfalls to Puyallup River

Outfalls to the main stem of the Puyallup River consist of both natural drainage confluences and constructed drainages piped directly to the river.

See *Figure 4-10, Outfalls*, for the locations of the various drainage outlets to the middle section of the Puyallup River. Culvert outfall locations were obtained from the Pierce Conservation District's (Conservation District) "Puyallup River Fish Passage Inventory" database that was created in 1999. This inventory reports 13 piped outfalls along the Mid-Puyallup River. Details of these outfalls from the database are provided in *Table 4-9*. In addition to this, there are 17 natural drainage outfalls.

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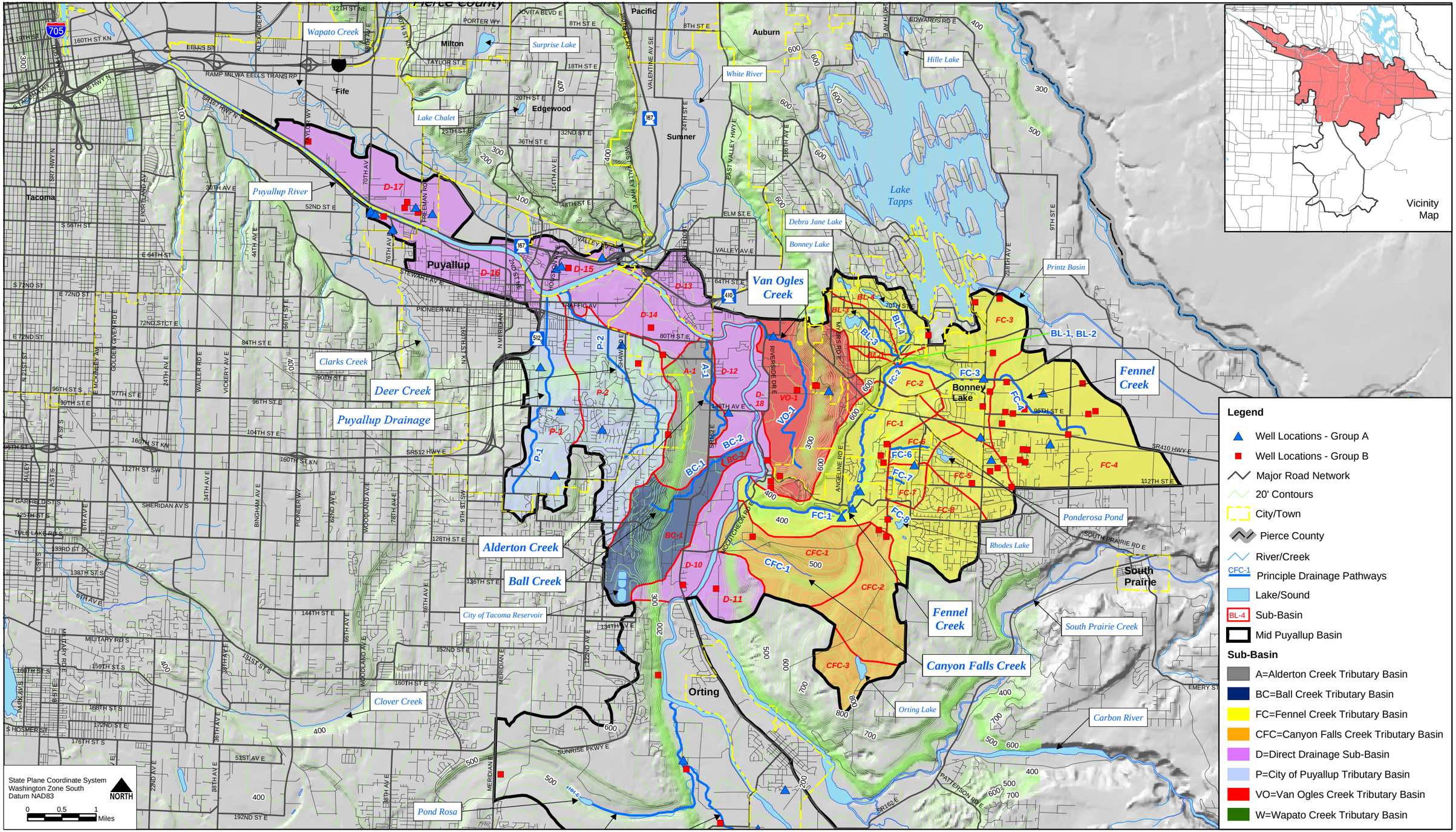

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Figure 4-9A: Well Locations

Mid-Puyallup Basin Plan

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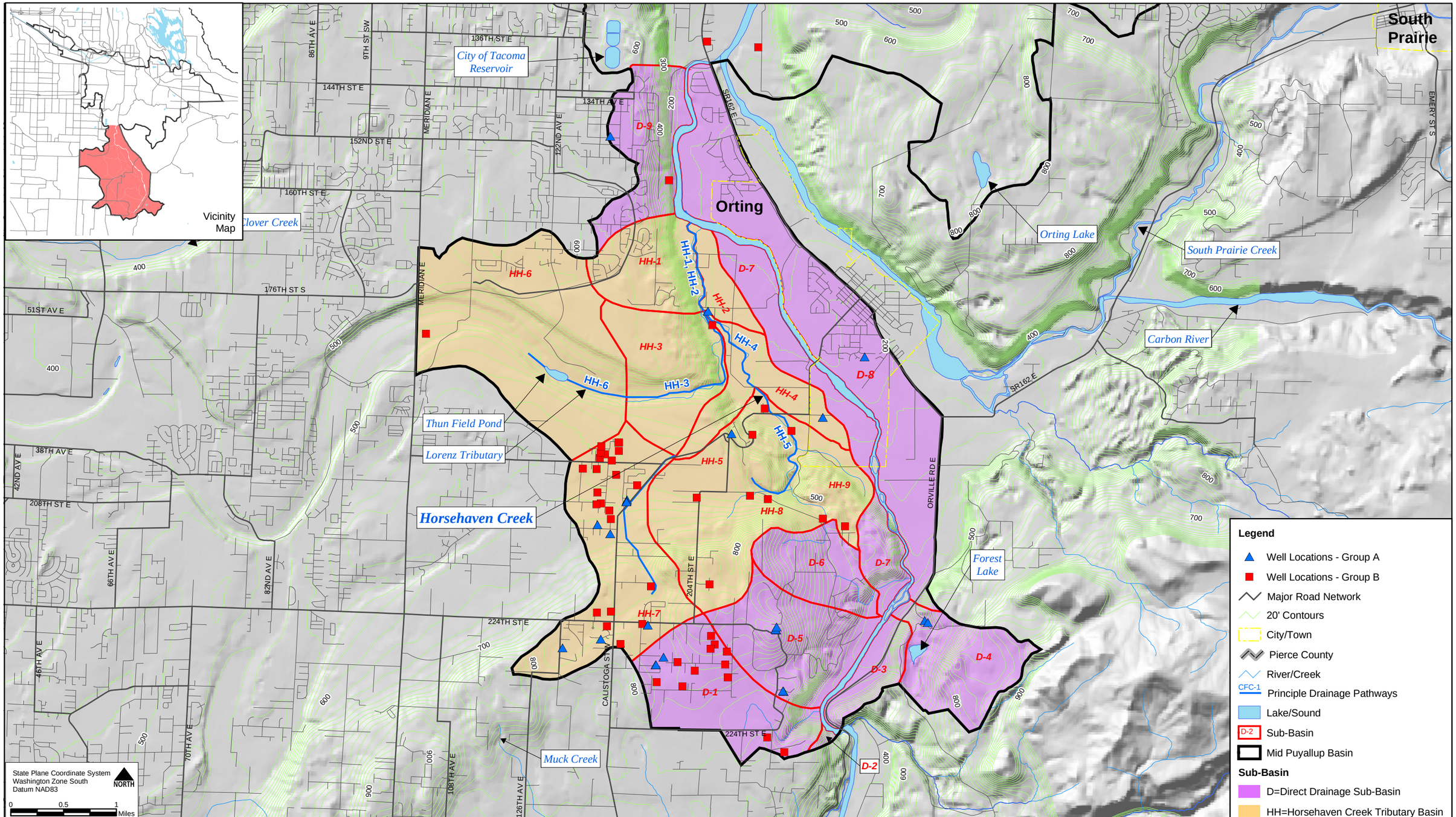

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Figure 4-9B: Well Locations

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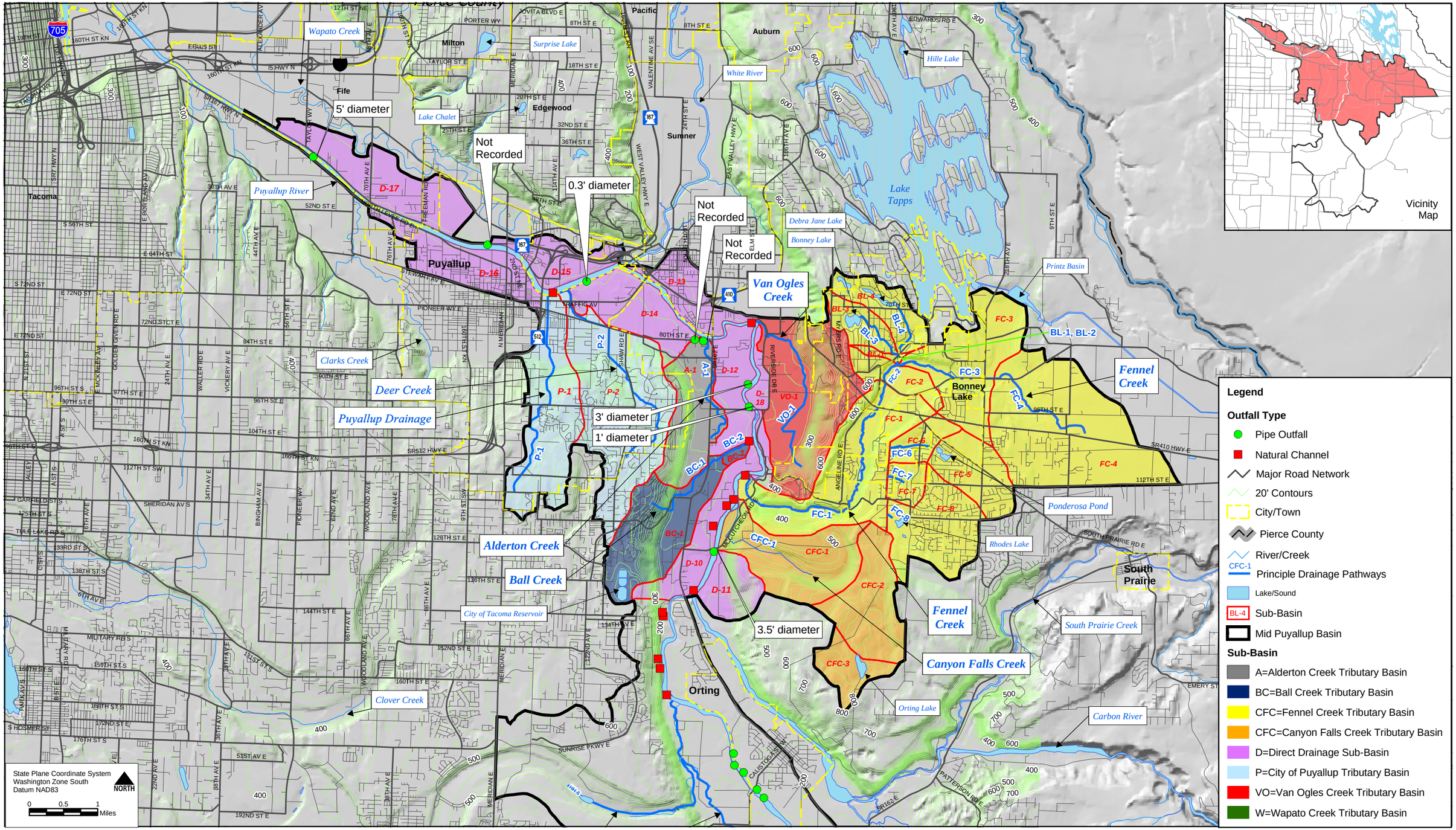

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Figure 4-10A: Outfalls

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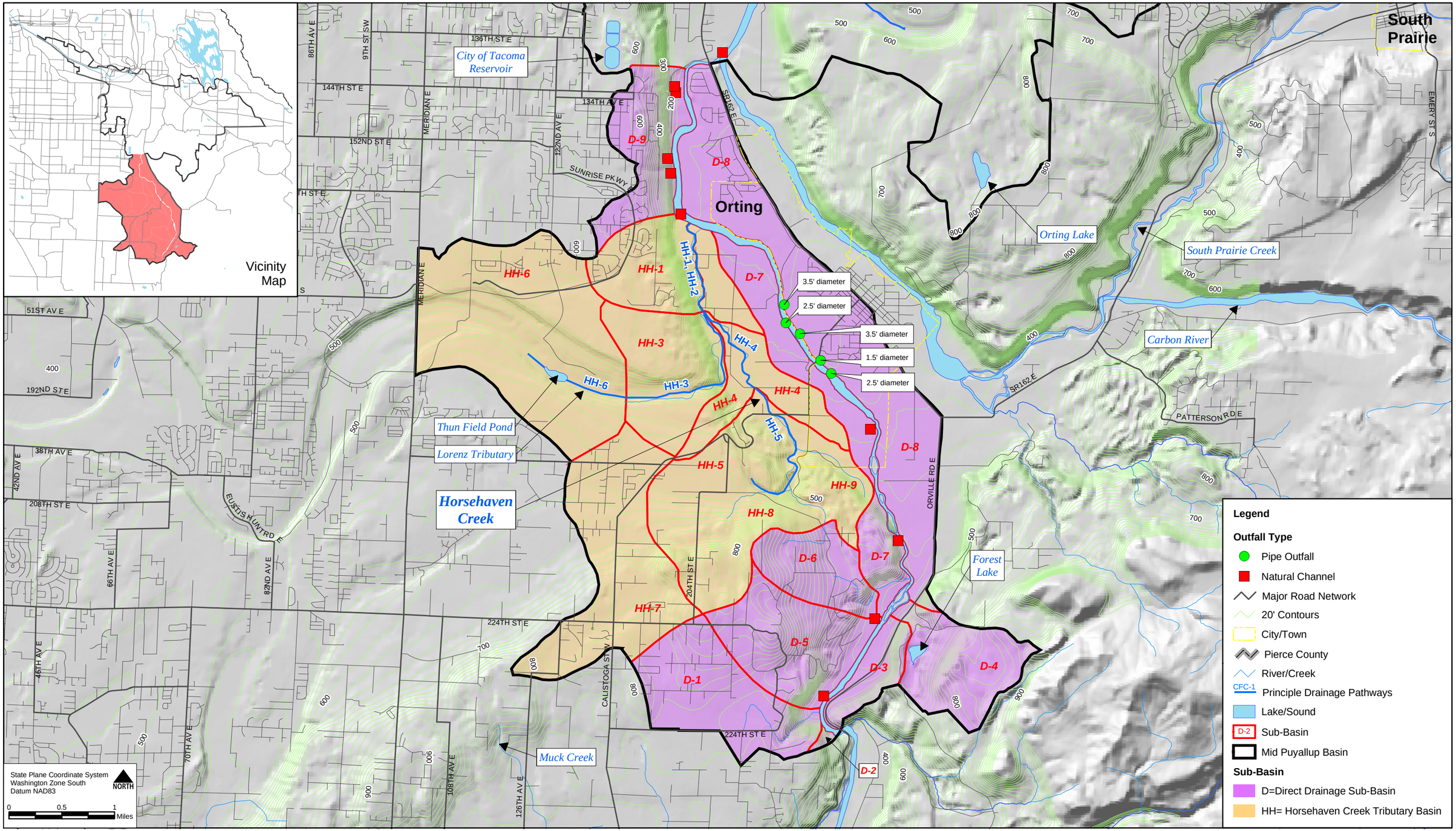

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Figure 4-10B: Outfalls

Mid-Puyallup Basin Plan

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Table 4-9
Puyallup River Outfalls

Site ID	Road Name	Shape	Size (feet)	Material
105 R012118a	Levee Road	Round	3-dia	Precast Concrete
105 R031619a	Levee Road	Round	5-dia	Not Recorded
105 R031721a	Levee Road	Round	1-dia	Corrugated Steel Tubing
105 R032918b	Levee Road	Round	3.5-dia	Precast Concrete
105 R033116a	Levee Road	Round	3.5-dia	Precast Concrete
105 R033117a	Levee Road	Round	3.5-dia	Corrugated Steel Tubing
105 R033118a	Levee Road	Round	2.5-dia	Precast Concrete
105 R033119a	Levee Road	Round	1.5-dia	Corrugated Steel Tubing
105 Ro33121a	Leach Road	Round	2.5-dia	Corrugated Steel Tubing
105 R111822a	Levee Road	Round	0.3-dia	Precast Concrete
105 S020323a	80th Street E	Round	Not Recorded	Precast Concrete
105 S020323b	80th Street E	Not Recorded	Not Recorded	Not Recorded
105 R121519b	Not Recorded	Not Recorded	Not Recorded	Not Recorded

Source: Pierce County Conservation District, Fish Passage Inventory 2000.

4.5 Aquatic and Riparian Habitats

Alderton Creek

A global catalog of streams and salmon utilization lists Alderton Creek as potentially used by coho salmon. Field reconnaissance of this stream, however, found that significant sections have been piped near its mouth and that upstream, open-channel areas are now little more than grass swales for road drainage. This stream is unlikely to support anadromous fish populations.

Van Ogles Creek

A global catalog of streams and salmon utilization lists Van Ogles Creek as supporting both coho and chum salmon. Field sampling conducted by the Puyallup Tribe confirms that these species, along with resident cutthroat, use this creek for both spawning and rearing.

Ball Creek

Ball Creek is used by both coho salmon and cutthroat trout for spawning and rearing. Hatchery-origin coho have not been released by State agencies or local tribes (C. Baranski, personal communication). However, a local resident reported that a single, "unofficial" release of between 500 and 1,000 coho fry was made by a property owner (who happened to be a hatchery worker) at the lower boundary of segment 16/10//2 in 1974 or 1975 (B. Gregory, personal communication).

During field surveys, a school of approximately 20 coho salmon parr was observed on the downstream side of the 106th Street East culvert, just inside the upper bound of segment 16/10//1. A property owner near the upper end of segment 16/10//3 observed adult coho in the act of spawning in the creek in November 2000. A local WDFW biologist disclosed that adult coho ascended the creek at least as far as the culvert under Military Road, a few hundred feet upstream of our segment 16/10//3 survey location (D. Nauer, personal communication). Stream resident cutthroat trout also were observed during our survey of segment 16/10//3.

Fennel Creek

On Fennel Creek, anadromous and migratory fish spawn up to Victor Falls at RM 2.0. This includes coho salmon, winter steelhead, pink salmon (in odd years), and one of the strongest runs of chum salmon in the Puyallup Basin.

Chinook salmon, listed as threatened under the federal Endangered Species Act, use segment 16/11//1 and part of segment 16/11//2, although in recent years, 5 to 9 chinook salmon redds have been observed in the lower reaches of Fennel Creek (Puyallup Tribe 2003). In the past, resident cutthroat trout were reported in stream segments upstream of Victor Falls, but none were observed during the present fieldwork. One possible reason for this was reported by the property owner at 9217 Angeline Road. He stated that cutthroat trout had been in the stream approximately eight to ten years ago, but many had washed up dead along his property, leaving "eels" (probably western brook lamprey) and crayfish as the only aquatic species remaining in that portion of the creek. This was a one-time-only event indicative of a fish kill. Evidently this kill was not reported to or investigated by responsible authorities, since no record of it could be found in WDFW or Ecology files. Sculpins (qualitatively the most abundant of the fishes), three-spine stickleback, and western brook lamprey were observed in the segments surveyed.

Canyon Falls Creek

Anadromous and migratory fish use Canyon Falls Creek up to McCutcheon Road. These include a substantial run of chum salmon and small runs of coho salmon, pink salmon (in odd years), and winter steelhead. A small number of chinook salmon also use the stream; six to ten fish per year have been observed by Puyallup Tribal Fisheries personnel in the last three to four years during spawner surveys. Larval Pacific lamprey and sculpins also have been reported. The principal spawning area for anadromous fish is in a 100-meter reach of segment 16/12//1 immediately downstream of McCutcheon Road though some fish have been seen upstream of the culvert. Other spawning occurs downstream to RM 0.3 where fine sediment deposition completely covers the streambed material.

Upstream of the private hatchery, there were reliable reports from nearby residents that non-migratory cutthroat trout and rainbow trout (the latter probably are escapees from the hatchery operation) are present in numbers and sizes that attract fishing by local residents.

Horsehaven Creek

Horsehaven Creek was stocked annually with hatchery reared coho salmon fry from 1981 through 1996 (C. Baranski, personal communication). The Puyallup Tribe once considered building its own fish hatchery on upper Horsehaven Creek but abandoned the plan because of the ephemeral nature of stream flow in the late summer (R. Ladley, personal communication). Coho and chum salmon use the creek along with resident, and possibly sea-run cutthroat trout.

During the field survey of the upper segments of the Horsehaven main stem, juvenile coho (estimated densities about 30 fish per 100 foot of stream) were observed rearing in pools in segment 16/20//7, as well as resident cutthroat trout (estimated densities of one to five fish per 100 feet of stream) in segment 16/20//8.

4.5.1 Habitat Assessment of Principal Fish-Bearing Streams

Pre-field assessments were made before fieldwork began to determine where field evaluations would be most beneficial. *Appendix F* provides a full report on the pre-field assessment process and findings. Each stream was segmented based on similar habitat and geomorphic characteristics and selected segments were evaluated in the field. See also *Figure 4-11, Habitat*.

Scoring for the BIBI is based on multiple metrics that have been established for the Puget Lowlands. The range of possible BIBI scores is from 10 to 50. Sites scoring 35 and above generally are considered “good” to “excellent,” those scoring below 25 are considered “poor.”

Field assessments were made of fisheries, fish habitat, water quality, and the Benthic Index of Biotic Integrity (BIBI) scores in accessible segments of Ball Creek, Fennel Creek, and Horsehaven Creek. Additional information also was obtained about the fisheries, habitat, and water quality values of upper segments of Canyon Falls Creek, which precluded the necessity of fieldwork in this system. Aerial photographs were also used to assess riparian conditions, surrounding land use, and general condition of the contributing watershed.

The Tri-County Urban Issues ESA Study Guidance Document (Feb 2000) describes the “Urban Stream Baseline Evaluation Method” (USBEM). The USBEM uses a standard suite of field methods to measure habitat quality and quantity in terms of 10 parameters:

1. riparian condition
2. substrate composition
3. embeddedness
4. bank condition
5. benthic invertebrate community (BIBI score)
6. passage barriers
7. pool frequency
8. channel pattern/bedform
9. large woody debris (LWD),
10. water temperature (seven-day average maxima)

In June 2001, parameters 1 through 4 and 6 through 9 were measured in segments where permission to access property was granted by willing property owners. Parameter 5, the condition of the benthic invertebrate community that uses the BIBI score, was measured later as the sampling protocol requires collections be made during September (May et al. 1997). For parameter 10, data for seven-day average maxima, determinations could not be made because temperature measurements were taken only on the day that crews performed the channel surveys. Instead, we reported here the water temperature found on the day of the survey. Continuous temperature data were collected later and are discussed in the water quality section of this report. We ascertained fish presence/absence in the segments surveyed using visual observation or seining as conditions required.

When suitable collection habitat could not be found anywhere at the site, it automatically was given the lowest possible score and the score was enclosed in parentheses, e.g., (10) to indicate that no samples were actually collected. This occurred at two of the stream segments evaluated. At another stream segment, access for BIBI collection was refused even though permission had been granted earlier in the year when we conducted the physical habitat survey. No BIBI score was entered for this segment.

Findings from the habitat assessments are summarized below for each creek. Information from the assessments was used to formulate a qualitative ranking for habitat quality and level of channel alteration. *Table 4-10* displays a summary of the assessed stream segments from the pre-field analysis, the field assessments, and the BIBI scores for sampled segments. More detailed information and copies of field sheets can be found in a complete report provided in *Appendix G*.

Ball Creek

Ball Creek flows across the flat valley bottom though mostly agricultural land and some rural neighborhoods. The creek begins along the edge of the valley wall where water from the hillside collects in an agricultural drainage ditch. The stream riparian corridor in this area is thin and patchy with distinct gaps in places where the channel flows past homes or underneath roads. This sparse coverage continues for most of the length of the channel particularly where there are neighborhoods. The downstream segment of the channel, 16/10//3, has thicker vegetation.

The field survey of Ball Creek stream segments was limited by the fact that site investigators were denied access to segment 16/10//1 and much of segments 16/10//2 and 16/10//3. For this reason the survey was restricted to only 220-feet of segment 16/10//2 from its lower bound at 106th Street East upstream to the end of a cooperative local resident's property, and a 394-foot reach of segment 16/10//3 near its upper bound at Old Military Road, where another cooperative property owner was found.

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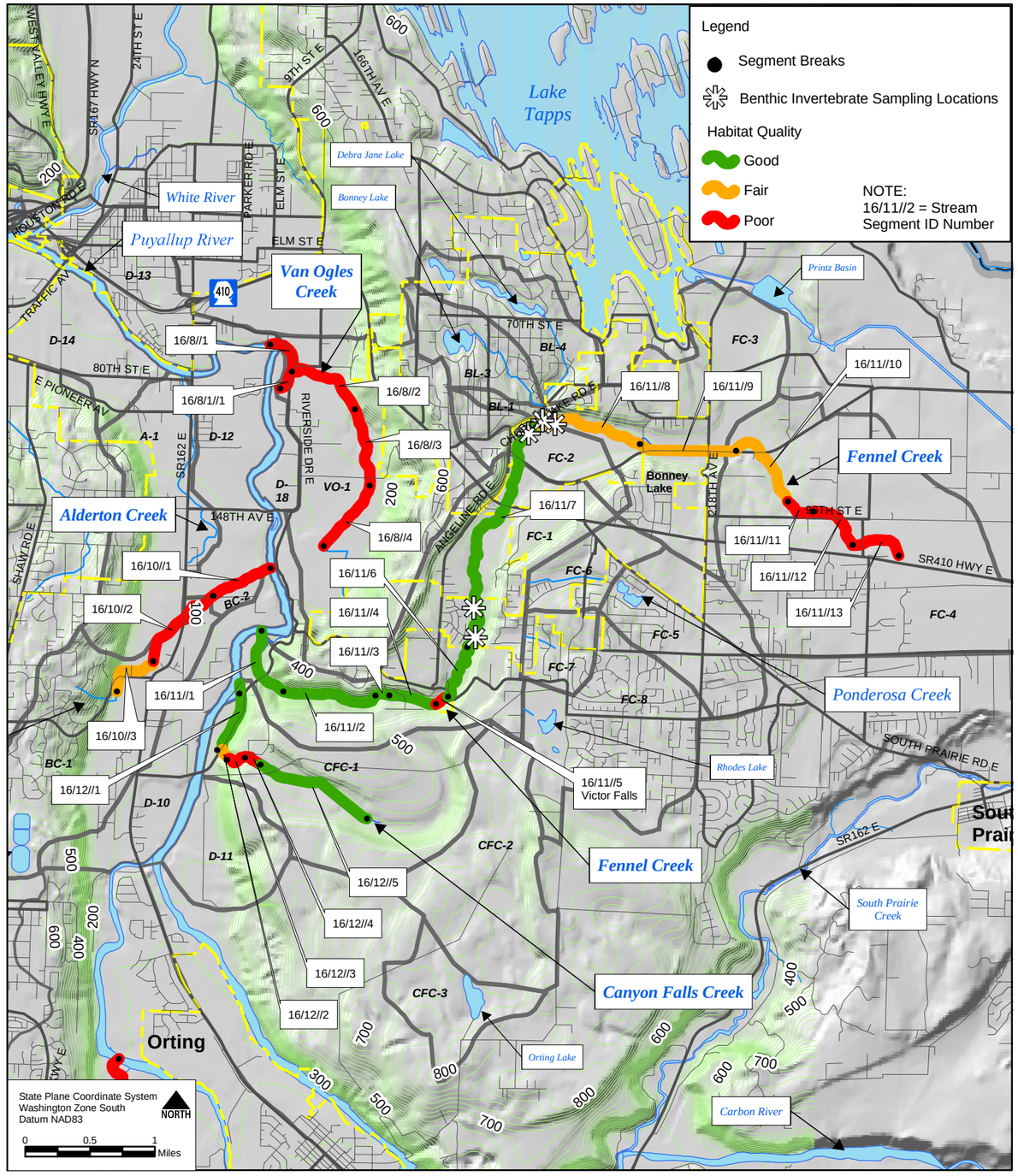

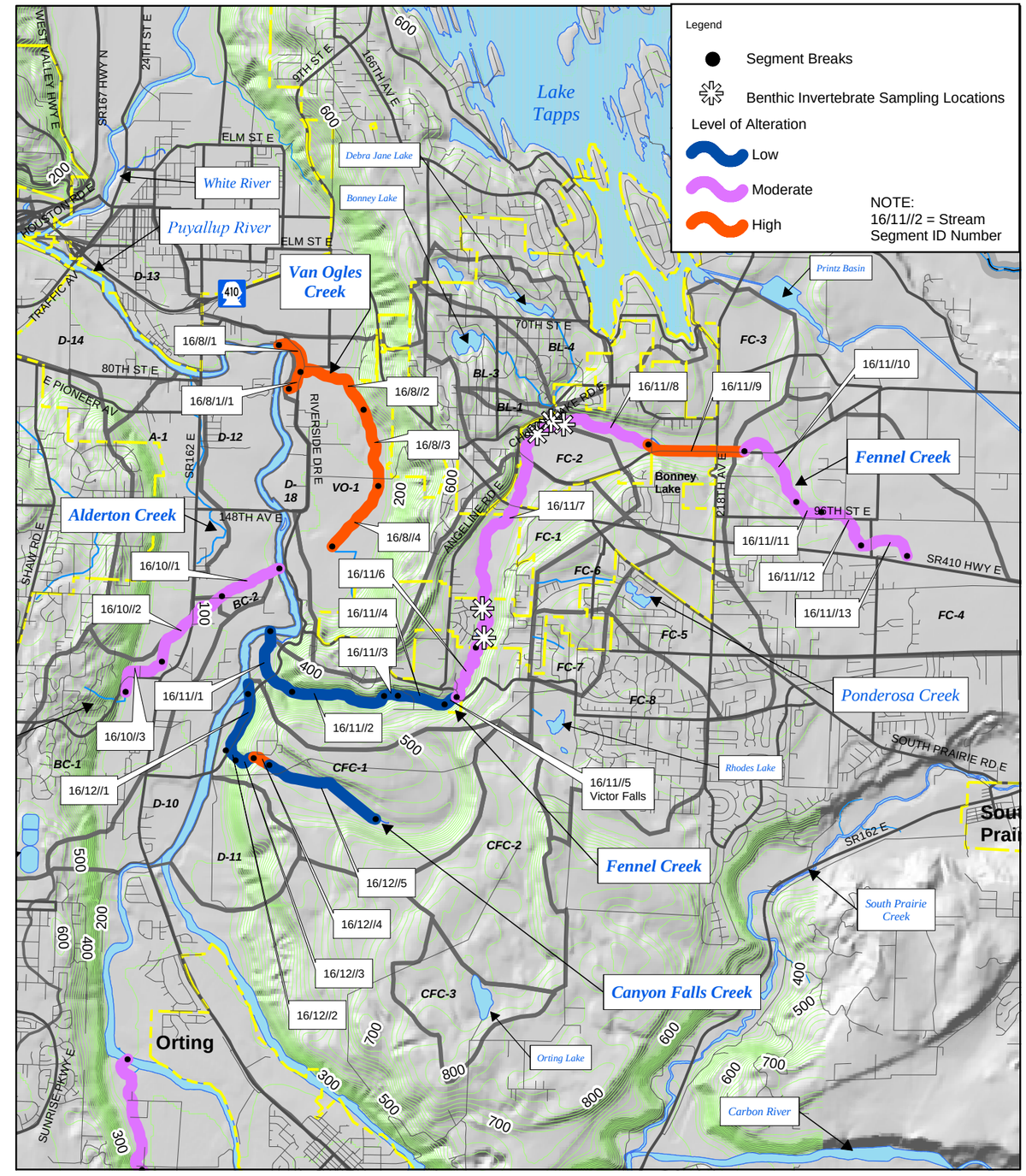

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Figure 4-11A: Fish Habitat

Mid-Puyallup Basin Plan

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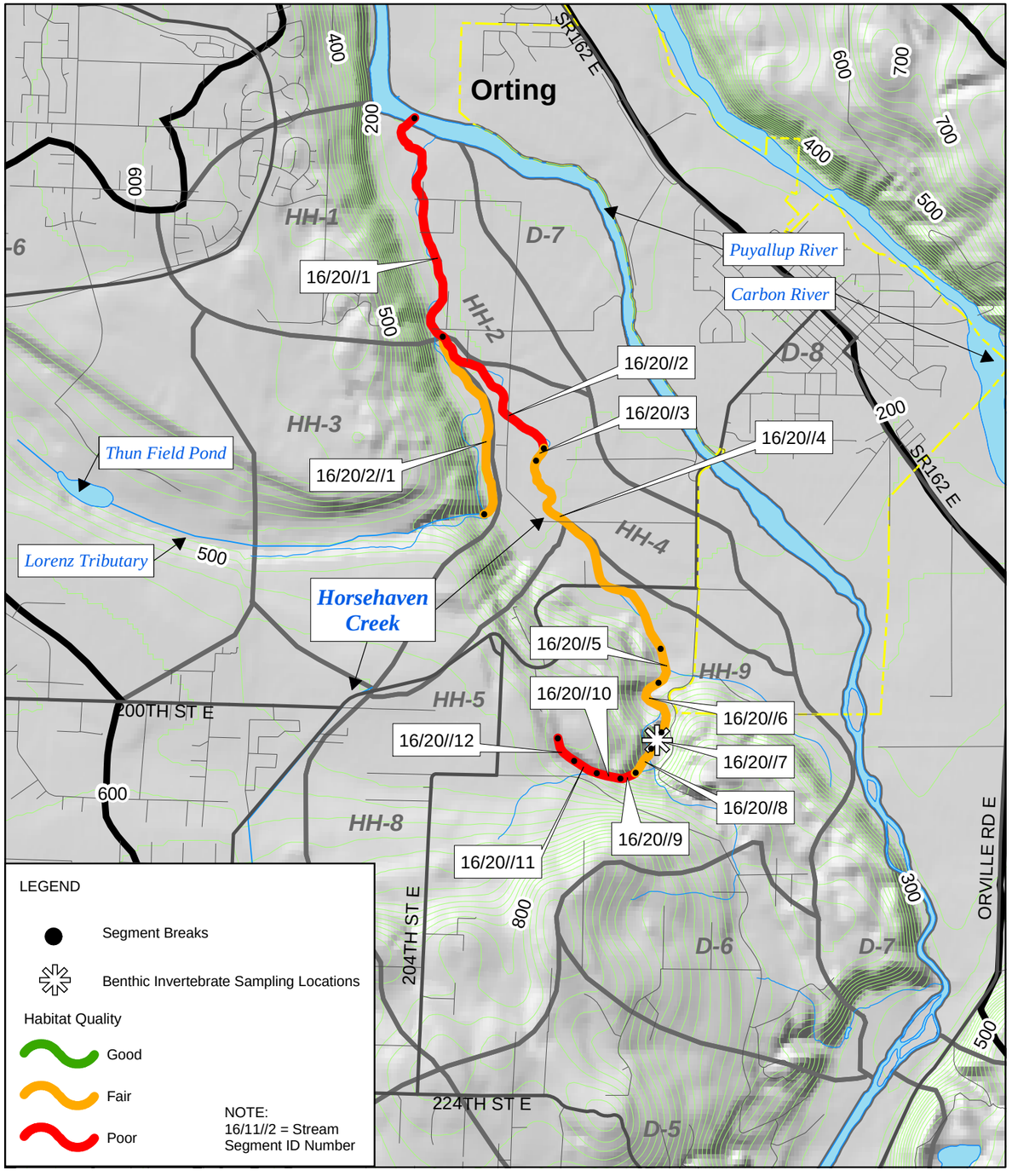

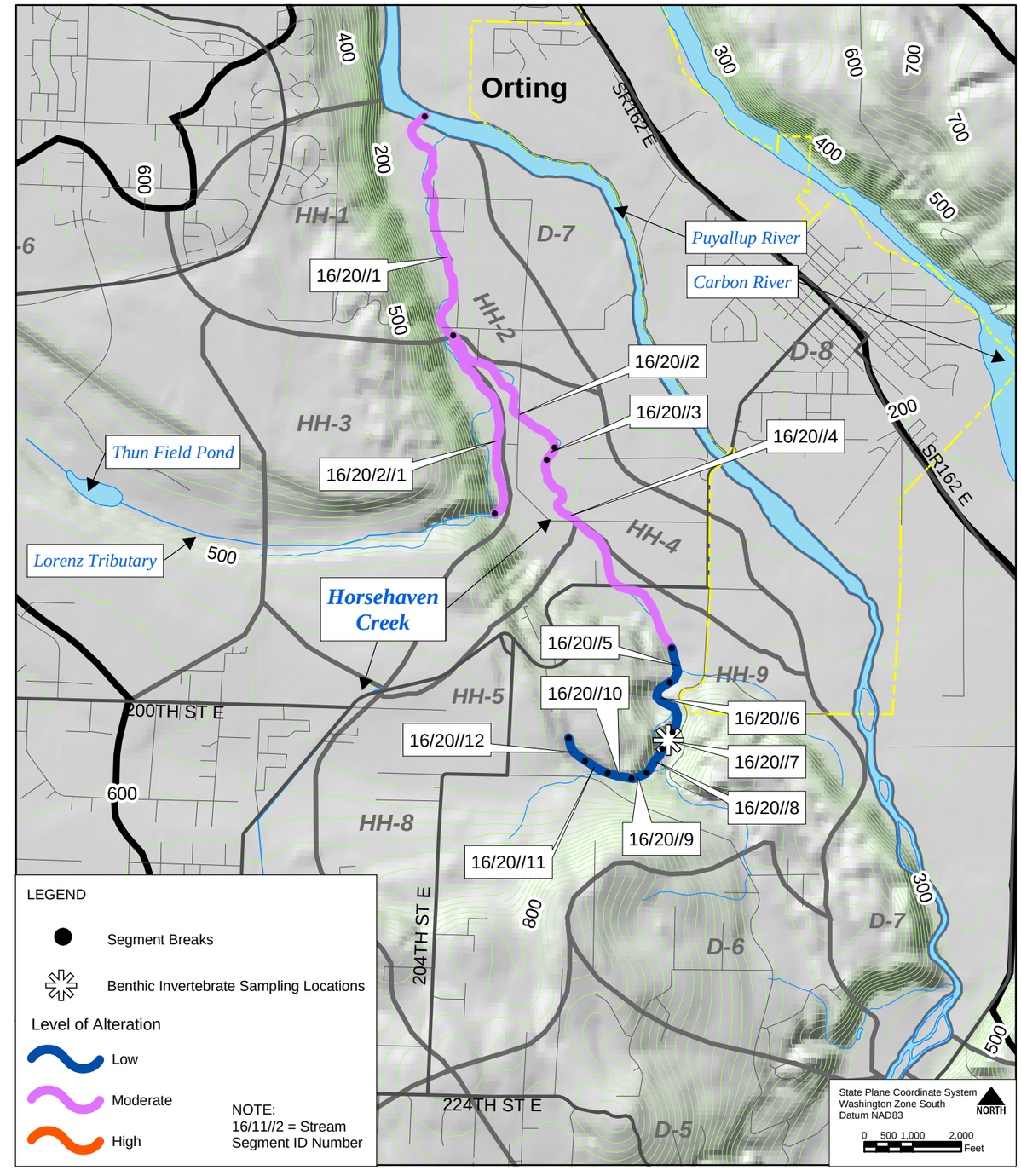

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Figure 4-11B: Fish Habitat

Mid-Puyallup Basin Plan

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Table 4-10
Summary of In-Stream Habitat Assessment

Segment Number	Fish Habitat Quality	Channel Alteration	BIBI Score
Van Ogles Creek			
16/8//1	Poor	High	
16/8//2	Poor	High	
16/8//3	Poor	High	
16/8//4	Poor	High	
16/8/1//1	Poor	High	
Ball Creek			
16/10//1	Poor	Moderate	
16/10//2	Poor	Moderate	(10)
16/10//3	Fair	Moderate	
Fennel Creek			
16/11//1	Good	Low	
16/11//2	Good	Low	
16/11//3	Good	Low	
16/11//4	Good	Low	
16/11//5	Poor	Low	
16/11//6	Good	Moderate	
16/11//7	Good	Moderate	26, 18, 16
16/11//8	Fair	Moderate	18
16/11//9	Fair	High	
16/11//10	Fair	Moderate	
16/11//11	Poor	Moderate	
16/11//12	Poor	Moderate	
16/11//13	Poor	Moderate	
Canyon Falls Creek			
16/12//1	Good	Low	
16/12//2	Fair	Low	
16/12//3	Poor	Low	
16/12//4	Poor	High	
16/12//5	Fair	Low	
16/12//6	Poor	Low	

Table 4-10 (Continued)
Summary of Habitat Assessment

Segment Number	Fish Habitat Quality	Channel Alteration	BIBI Score
Horsehaven Creek			
16/20//1	Poor	Moderate	(10)
16/20//2	Poor	Moderate	
16/20//3	Fair	Moderate	
16/20//4	Fair	Moderate	
16/20//5	Fair	Low	
16/20//6	Fair	Low	
16/20//7	Fair	Low	38
16/20//8	Fair	Low	
16/20//9	Poor	Low	
16/20//10	Poor	Low	
16/20//11	Poor	Low	
16/20//12	Poor	Low	

Note: Multiple entries for BIBI score indicates that multiple samples were taken in a given reach
Source: Trotter 2002

Although Ball Creek is used by coho salmon and cutthroat trout for spawning and rearing, pre-field and field observations show that stream habitat quality and quantity are poor in most segments and can be ranked no better than fair in the other segment examined. There is very little woody debris within the channel, limiting the number of pools and reducing the degree of channel complexity. Water temperature at the lower bound of segment 16/10//2 was 18.2°C on the day of measurement. The water temperature exceeds the Washington State Department of Ecology's (Ecology) standard of no greater than 16°C for tributaries of streams that are "Shorelines of the State" (the Puyallup River is such a stream), reinforcing the assessment of habitat quality of Ball Creek as poor to fair. Under Ecology proposed "Water Quality Standards" revisions, the temperature standard is 17.5°C. The channel contains a lot of fine silt with few if any riffles for macroinvertebrate sampling. No adequate sampling sites were found within the accessible length of segment 16/10//2 so a BIBI score of (10) was entered for this segment. No score was entered for segment 16/10//3 because access to it was denied and no collection could be made.

Fennel Creek

The headwater channel of fennel creek flows mostly in drainage ditches with little or no vegetated riparian area. The vegetation remains sparse until the creek enters the area adjacent to Sumner Buckley Highway where it becomes fully forested. As the creek turns to the south, it enters an open pasture with no vegetation. Beyond this pasture, the riparian corridor is sporadically forested until the creek comes to Victor Falls where it enters a fully forested area as it flows down off the

plateau. Vegetation is abundant from this point all the way to its confluence with the Puyallup River.

Based on the pre-field assessment, it was concluded that segments 16/11//1 through 16/11//4 provide good habitat quality and quantity for fish, and that these segments would not need to be examined in the field. Similarly, segments 16/11//11 through 16/11//13 were also not field assessed because the use of fish in these segments is low and there are no anadromous fish in these upper reaches. Access was granted only to segment 16/11//7 and 16/11//8 for field surveys.

The stream channel has been subjected to a moderate amount of alteration in segments 16/11//6 and 16/11//7. However, fish habitat quality and quantity in the lower two-thirds of segment 16/11//7 was found to be surprisingly good despite poor BIBI scores, ranging from 16 to 26. It is presumed that segment 16/11//6 is not much different. It also was concluded that the upper third of segment 16/11//7 and all of segment 16/11//8 are in only fair condition. This is because there are inconsistent amounts of LWD along the channel, areas that have been affected by cattle, accumulations of trash in some places, and a limited number of pools.

Canyon Falls Creek

Access to stream segments in Canyon Falls Creek could not be arranged with the property owners, so no field survey was carried out. Canyon Falls Creek flows entirely through private property except at the crossing of McCutcheon Road. The channel has been highly altered in stream segment 16/12//4 owing to operations of, a commercial hatchery and rearing operation. Elsewhere, channel alteration appears to be low and fish habitat quality and quantity appears to be good. The stream flows almost entirely though full forest with the riparian corridor intact.

Horsehaven Creek

Horsehaven Creek originates in a wooded area above the valley wall. From here it descends onto the valley bottom where it crosses through mostly agricultural land. In several places cattle have access to the stream. The lower sections of the stream flows along the base of the western valley wall where multiple springs in the valley wall contribute to its flow.

Access could not be obtained to much of this stream, including valley segments site investigators were most desirous of surveying based on the pre-field assessment. Only the stream at a single location in segment 16/20//1 near the upper bound of the segment could be reached. Water quality measurements were taken here, but a fish habitat survey could not be conducted because of the limited access. Suitable fish habitat for BIBI collection also could not be found. Instead, segments 16/20//7 and 16/20//8 in the upper reaches of the main stem were examined. These segments were accessed by entering from the road leading to the Pierce County Quarry in Township 18N, Range 5E, Section 6.

Although the Horsehaven Creek system is a much larger drainage than Ball Creek, pre-field and field assessments indicate that land uses and channel alterations have produced about the same effects on fish habitat quality and quantity in the valley floor stream segments as are found in Ball Creek; large quantities of silty sediment, little or no in-channel wood, sporadic riparian vegetation, and few pools. It was concluded that these valley floor segments, while indeed used by fish, provide poor to fair fish habitat quality and quantity. Conversely, segments near the

headwaters—where the stream descends from uplands—exhibit a low level of alteration and provide good habitat quality and quantity for fish. Because no suitable BIBI collection site could be found in the accessible length of segment 16/20//1, a score of (10) was entered for it. Segment 16/20//7, however, produced a value of 38, the highest score of the survey.

4.5.2 Wetland Habitat

In addition to providing flood attenuation and water quality benefit, wetlands are important habitats for plants and animals. Waterfowl, birds of prey, amphibians, fish, and wetland-adapted mammals (e.g., beaver, muskrat) depend on wetlands for foraging, nesting, cover, and resting.

The Basin contains over 2,800 acres of wetlands along the valley bottom and on upland plateaus (See *Figure 4-12, Wetlands*). Fennel Creek has the largest network of wetlands, including several large headwater wetlands on the upper plateau where the creek originates. The majority of the wetlands are along streams, with many small wetlands are scattered throughout the Basin.

4.6 Upland Habitats

The upland habitat types in the Mid-Puyallup Basin include coniferous and deciduous forest, pasture lands, and landscaped residential areas. Most of the Basin areas are either developed or used for agriculture. Remaining undisturbed native habitats consist of fragmented areas of forest. These habitats are mostly on steep slopes that are not easily developed. The largest areas of intact forest are in the southern end of the Basin to the south and west of the City of Orting.

4.7 Water Quality

Good water quality is important to the beneficial uses of water in the Mid-Puyallup Basin and is also a legal requirement of the County under its NPDES permit. Impaired water quality can affect fish habitat quality and the health of aquatic organisms, recreational activities such as fishing and swimming, drinking water quality from local wells and reservoirs, and irrigation of farmland. Three of the six streams (Fennel Creek, Canyon Falls Creek, and Horsehaven Creek) in this Basin Plan are classified by Ecology as "Class A" waters under its recent water quality standards (WAC 173-201A, 1997). [1]The remaining three streams have not been classified.

4.7.1 Water Quality Impairment

Impairment of water quality results from a variety of activities that contribute pollutants to aquatic areas. The Mid-Puyallup Basin has agricultural areas and a rising population that is incrementally altering the landscape from undeveloped and rural agricultural to urban areas. Both point and non-point sources of pollutants are concerns.

[1] NOTE: The Washington State Department of Ecology proposed major revisions to the State's "Water Quality Standards" that when effective, will change this classification system.

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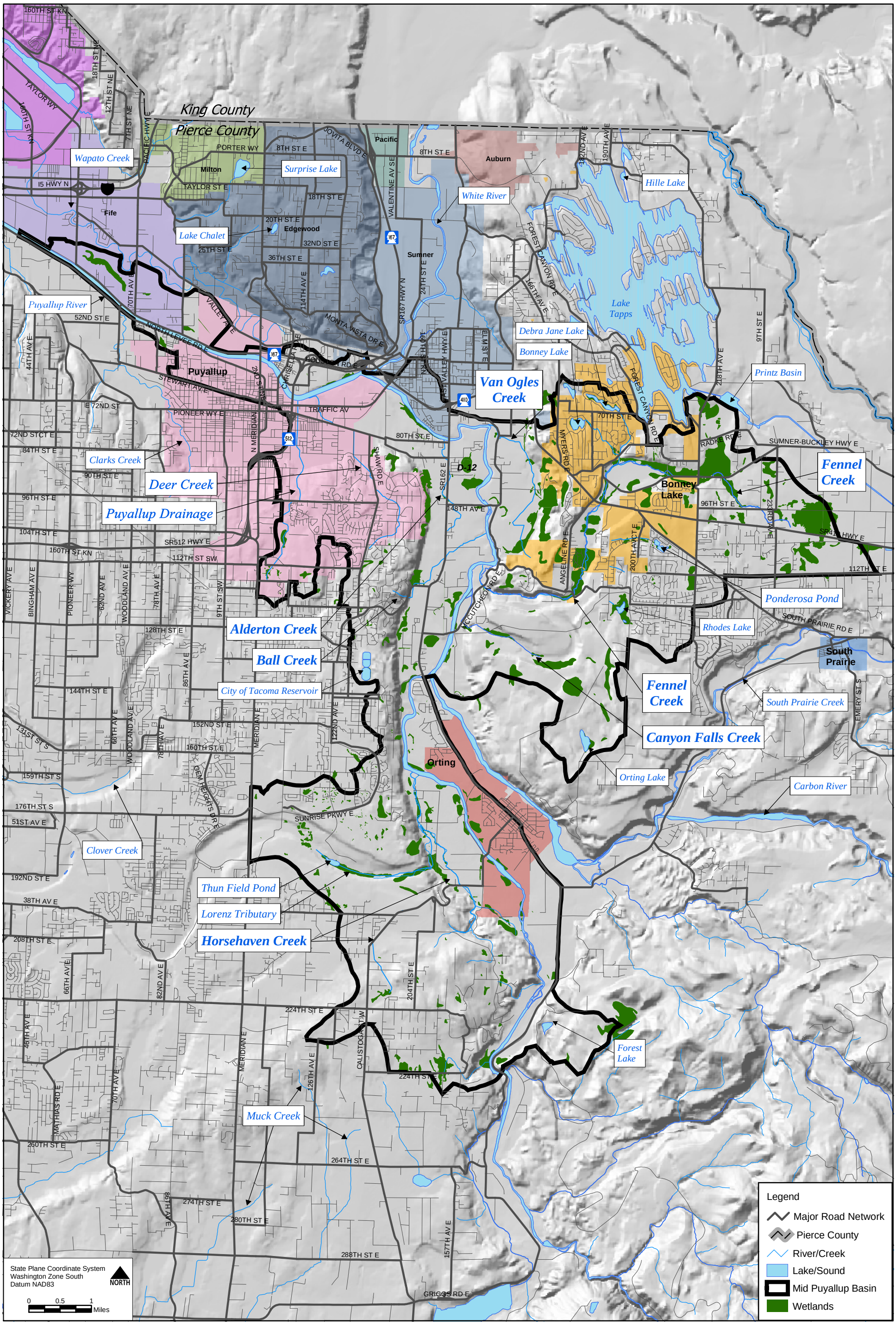

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Figure 4-12: Wetlands

Mid-Puyallup Basin Plan

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Non-point Sources

Non-point pollution primarily results from urban runoff and agricultural runoff. The primary pollutant of concern in urban runoff is fine particulates and pollutants which attach to them or are held in suspension. Dirt from bare soils, roadways, and areas under construction washes into waterways with rainfall runoff. Increased runoff from developments in upland areas promote accelerated erosion in the steeper gradient drainage courses leading from the plateaus to the valley floor. Sand and silt accumulate in streambeds and at accelerated rates in lakes and wetlands.

Under federal and State law, all discharges of pollutants may not violate water quality standards; however, non-point sources are not required to have a discharge permit from Ecology.

Residential runoff is also known to carry fecal coliform bacteria from pets, nutrients from lawn fertilizers, pesticides and herbicides from gardening, and oil and grease from automobiles and waste oil dumping. Commercial and industrial areas commonly have runoff containing oil and grease from parking lots, heavy metals, and hydrocarbons (Upper Puyallup Watershed Committee 2002).

Runoff from agricultural areas also carries nutrients and sediment from soil erosion. Fertilizers from fields contribute phosphorus and nitrogen to local waters, stimulating over abundant growth of algae and bacteria. Abundant algae can cause taste and odor problems, and sudden drops in available dissolved oxygen. In some cases, abundant algae can be toxic. Other pollutants associated with agricultural practices are herbicides, rodenticides, and pesticides. Waste from cattle and other farm animals can contribute fecal coliform bacteria and other pathogens to surface waters. In 1998, the Washington State Legislature passed the Dairy Nutrient Management Act (RCW 90.64). All dairies in the state must register with the Washington State Department of Agriculture under the federal Clean Water Act's NPDES program and prepare and implement a "Dairy Nutrient Management Plan." The Department of Agriculture is responsible for ensuring compliance.

Potential Point Sources

Point source discharges are discharges that are required to have a waste discharge permit from the Department of Ecology. Several potential point sources are unique to the Mid-Puyallup Basin. At the headwaters of Horsehaven Creek is the Hidden Valley landfill. This 328-acre site directs treated leachate into the Pierce County sanitary sewer system. Precipitation runoff from areas of the facility not in direct contact with any solid waste is pretreated in a holding pond and then infiltrated. At about RM 1.0 on Canyon Falls Creek is a private fish hatchery. This business is a fish rearing facility and does not intentionally release fish to the stream. Water quality is monitored downstream of each site. When water quality standards have been exceeded, none have been found to be directly associated with the facilities.

Other point source discharges in the Mid-Puyallup Basin include two wastewater treatment plants. The Puyallup treatment plant is in subbasin D-16 and discharges to the Puyallup River at RM 7.0. The Sumner treatment plant is in subbasin D-13 and discharges to the Puyallup River at RM 10.6. Neither treatment plant affects the tributary streams that are the focus of this Basin Plan. They

do, however, contribute to the total pollutant load of the Puyallup River thereby reducing the amount of pollution the main stem can receive from the tributaries set under Washington State mandated total maximum daily loads (TMDL's) for the Puyallup River. Pierce County, the Washington State Department of Transportation and the cities of Puyallup, Sumner, Bonney Lake, and Orting are also all point source dischargers for municipal stormwater and have or will have NPDES permits by 2005.

2004 Washington State Assessment of Water Quality

Washington State's 2004 assessment of water quality sorts water quality determinations into five categories as follows:

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

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

Category 3 - No data or no usable data is available

Category 4 - Polluted waters that do not require a TMDL
- Category 4a – Has a TMDL
- Category 4b - Has a pollution control plan
- Category 4c - Impaired by a non-pollutant, such as containing a barrier to fish passage

Category 5 - Polluted waters that require a TMDL [*The 303(d) list*]

2004 Assessment of Water Quality for the Mid-Puyallup Basin

Category 2 - none listed for the Mid-Puyallup Basin

Category 3 - none listed for the Mid-Puyallup Basin

Category 4 - waters impaired by a non-pollutant are as follows:

Ball Creek	4c	Fish Passage Barriers
Canyon Falls Creek	4c	Fish Habitat
Fennel Creek	4c	Fish Habitat, Instream Flows
Horsehaven Creek	4c	Fish Habitat, Fish Passage Barrier

Category 5 - none listed for the Mid-Puyallup Basin

Change between 1998 and 2004

The Category 4c list of waters impaired for fish use was not a part of the 1998 Water Quality Assessment. Fish habitat and fish passage barriers are further described in the fish habitat section of this chapter. Instream flows are described in the fish habitat section and as a component of the natural drainage system.

4.7.2 Water Quality Investigations

Water quality investigations from this and other studies in the Mid-Puyallup Basin are described below. Water quality data are collected by grab sampling in most of the studies discussed. This method often is selected because it is a quick and easy way to get a "snap-shot" of water constituents at a given location. However, it is not useful for determining compliance or trends.

Prior investigations of water quality in this area have focused primarily on the Puyallup River main stem, which is not a focus of this Basin Plan. Few comprehensive studies containing water quality data on the contributing streams were found. An exception to the predominance of grab sampling results is the temperature data collected at the flow monitoring stations. Continuous temperature recordings were gathered along with the flow data and were incorporated into the Basin Plan. *Figure 4-13* displays the locations of sampling sites from each study discussed below.

Sampling for Basin Plan

Water Quality Sampling During Fish Habitat Survey

Some water quality parameters were measured during field excursions for habitat assessments. Measurements were restricted to parameters measurable by portable field meters. *Table 4-11* shows data collected during summer base flow for this study. No samples were collected on Canyon Falls Creek because sampling is performed on this creek as part of the Cascadia Planned Community Development monitoring program; this information is shared with the County (See *Table 4-15, Water Quality Values from Fennel Creek Environmental Assessment*).

Pre-2004 State water quality standards for "Class A" waters, depicted in *Table 2-4*, were met for both turbidity and pH at all locations sampled. The dissolved oxygen standard was exceeded at the Bonney Lake Creek site on Fennel Creek by only 0.5 mg/l. Temperature standards were exceeded both on Ball Creek and Horsehaven Creek. Both sites are along flat agricultural land that has little riparian vegetation. The lowest temperature measured at any of the sites was upstream on Horsehaven Creek. Currently, there is no standard for conductivity. Conductivity values range from 107 to 226 μS and are typical values for streams with good water quality in this region.

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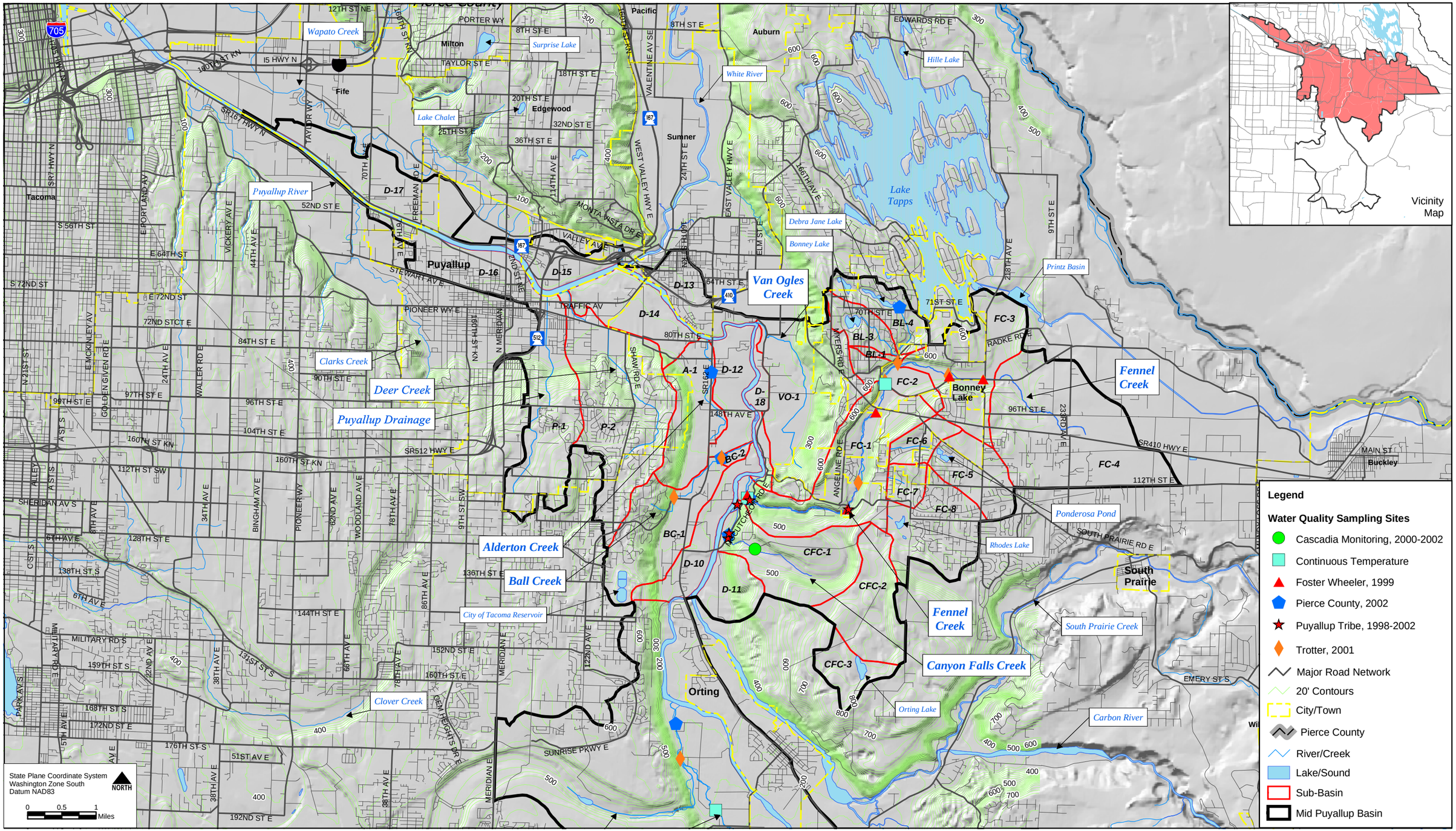

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Figure 4-13A: Water Quality Sampling Sites

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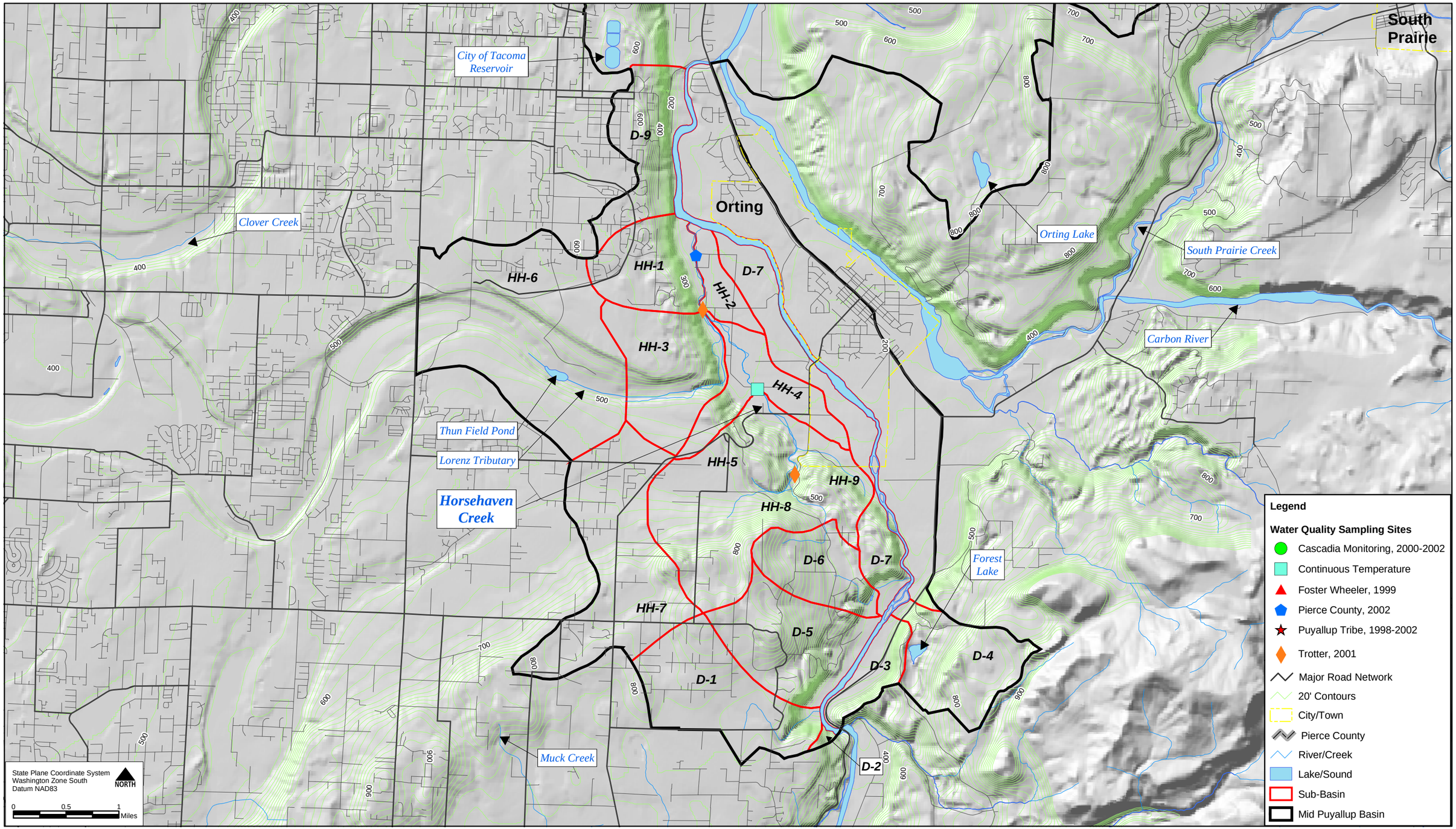

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Figure 4-13B: Water Quality Sampling Sites

Mid-Puyallup Basin Plan

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Table 4-11
Water Quality Measurements During Summer Low Flow

Stream Segment	Dissolved Oxygen (mg/l)	Turbidity (NTU)	Conductivity (µS)	pH	Water Temperature (°C)
Ball Creek					
16/10//2	8.8	1.3	226	7.8	18.2
16/10//3	9.6	1.0	194	7.9	not recorded
Fennel Creek					
16/11//7 Lower boundary	8.2	1.5	185	6.9	11.2
16/11//7 Sumner/Buckley	11.7	1.5	159	7.6	13.4
Bonney Lake Creek	7.5	1.4	186	6.8	14.1
16/11//8 Upper boundary	8.1	2.0	162	6.9	13.2
Horsehaven Creek					
16/20//1	8.6	2.6	169	7.2	19.3
16/20//7	9.7	0.1	107	6.8	9.5

Source: Trotter 2002

A series of four measurements also was taken over a three-week period during June 2001, following a rainfall of 0.98 inch in 24 hours (See *Table 4-12, Fennel Creek at Sumner-Buckley Highway*). Stormwater sampling of upper Fennel Creek occurred at the mouth of the culvert that conveys Fennel Creek under the Sumner-Buckley Highway. On the first day of sampling, the creek was judged to be flowing at bank full stage one day following the event. Conductivity was not measured during the first three visits due to a malfunctioning meter.

Table 4-12
Fennel Creek at Sumner-Buckley Highway

Sampling Date	6/12/01	6/14/02	6/21/01	7/3/01
Dissolved Oxygen (mg/l)	9.2	9.3	9.7	11.7
Turbidity (NTU)	7.6	7.6	1.9	1.5
pH	7.4	7.4	7.4	7.6
Water Temperature (°C)	11	11	12.4	13.4

Source: Trotter 2002

Water quality did not vary much during the three weeks following the June storm event. The only notable trend was decreased turbidity as storm flow subsided. A dissolved oxygen reading of 11.7 mg/l on July 3rd actually was greater than saturation for the water temperature measured that day and may be a spurious reading.

Water Quality Sampling by County Staff

Six additional water quality sampling sites were identified in the Mid-Puyallup Basin, selected along the major tributaries identified in this report. Three of the six sites (Fennel Creek at McCutcheon Road, Horsehaven Creek at Orting, and Ball Creek at 106th Street East) are just upstream from the mouth of the selected tributaries. These sites were selected to capture an integrated effect of water leaving the Basin. The other three sites (Alderton Creek at the highway SR 162 crossing, Fennel Creek at Debra Jane Lake, and Canyon Falls Creek at McCutcheon Road) were selected to target known or suspected problem areas. The Alderton Creek site is at a location found during a field visit. This site has prodigious growth of iron bacteria and is being tested for dissolved iron. The Fennel Creek site downstream from Debra Jane Lake was selected because of reports of high copper concentrations found there during an environmental analysis of Fennel Creek (Foster Wheeler 1999). Later, it was found that a copper-based algaecide was being applied to Debra Jane Lake. The site on Canyon Falls Creek at McCutcheon Road is just downstream of the fish farm. Grab samples were taken during the spring and summer of 2002; results are presented in *Table 4-13*.

The values reported in the first set of grab samples are typical for streams in the Puget Lowlands. Values for temperature and pH did not exceed pre-2004 State standards at any site. Dissolved oxygen was above standards at all sites except the Alderton Creek site, which has prodigious growth of iron bacteria. This site has an elevated dissolved iron value of 40.8 mg/l. The EPA drinking water standard for iron is below 0.3 mg/l, with taste thresholds around 0.1 to 0.2 mg/l. Alderton Creek lies along the flat valley bottom and receives iron laden groundwater in addition to surface water. The pre-2004 fecal coliform standard was exceeded for “Class A” waters in Horsehaven Creek near Orting. This same creek also has higher levels of phosphorous and nitrogen than the other sites, which is consistent with an agricultural-dominated basin. Ball Creek has a higher value for total suspended solids than the other sites because the bed material of this stream is a thick layer of fine sediment. No biochemical oxygen demand was detected in any stream measured.

Continuous Temperature Monitoring

On-going temperature monitoring is being conducted at the three gauge sites setup for this basin planning effort. Data collected at each site, at the time this report was written, are summarized in *Table 4-14*.

Table 4-13
Grab Samples Collected for Basin Characterization

Description	Fennel Creek @ McCutcheon Road	Horsehaven Creek @ Orting	Ball Creek @ 106th Street E	Alderton Creek @ Hwy Crossing	Fennel Creek @ Debra Jane Lake	Canyon Falls Creek @ McCutcheon Road
Date	5/3/02	5/3/02	5/3/02	5/3/02	5/3/02	5/3/02
Temp (^oC)	9.10	11.30	11.80	15.80	13.90	8.70
Dissolved Oxygen (mg/l)	11.72	12.45	13.71	0.19	8.40	12.36
pH	7.80	7.14	8.31	6.99	6.88	7.77
Conductivity (μS)	130.50	120.30	231.00	388.00	97.80	180.60
Coliform (CFU/100 ml)	12.00	120.00	92.00	n/a	n/a	n/a
BOD (mg/l)	ND	ND	ND	n/a	n/a	ND
TSS (mg/l)	ND	4.00	40.00	n/a	n/a	n/a
TP (mg/l)	0.13	0.22	0.17	n/a	n/a	n/a
TKN (mg/l)	ND	0.52	ND	n/a	n/a	n/a
Copper (mg/l)	n/a	n/a	n/a	n/a	0.01	n/a
Iron (mg/l)	n/a	n/a	n/a	40.8	n/a	n/a

ND = Non-Detected

n/a = Parameter not tested

Source: Pierce County Water Programs 2002

Table 4-14
Temperature Summary from Basin Planning Gauges

Site No.	Location	Period of Record	Minimum Value (°C)	Maximum Value (°C)
1	Fennel Creek at McCutcheon Road	4/ 2/02 - 4/ 24/02	6	11
2	Fennel Creek at Sumner Buckley Highway	4/ 2/02 - 4/ 24/02	6	12
3	Horsehaven Creek at 188th Street E	11/ 7/01 - 4/ 24/02	4	12

Source: Entranco 2002

Other Studies

Environmental Analysis of the Fennel Creek Corridor (1999)

In 1999, Foster Wheeler Environmental Corporation conducted an environmental analysis of the Fennel Creek corridor for the City of Bonney Lake. Water quality was included in the analysis and grab samples were taken at five points along the stream. *Table 4-15* lists constituent values from this study.

Elevated levels of copper were detected at almost every site. It later was determined that an algaecide containing copper was being used in Debra Jane Lake upstream of these sites. In 2002, copper was sampled for again under this Basin Plan and was not found in such high quantities. No other metals, with the exception of a slight elevation of mercury at Site 1, exceeded State standards. Sites 1 and 2 showed turbidity values slightly over State standards. This is the only other parameter exceeding standards at these sites.

Monitoring Downstream of Cascadia Development on Canyon Falls Creek

Water quality in Canyon Falls Creek is monitored regularly to establish predevelopment water quality levels for the yet to be constructed Cascadia Employment-Based Planned Community in the creek's headwaters. *Table 4-16* presents monitoring results. Data were collected 1.1 miles upstream of the creek's mouth at the Tacoma Water Supply Bridge. Results are similar to the Canyon Falls Creek water quality data collected by Pierce County for this study and indicate good water quality.

Table 4-15
Water Quality Values from Fennel Creek Environmental Assessment

Parameter	Units	Sample Site 1 50 feet west of 214th Avenue E	Sample Site 2 50 feet west of Kelly Lake Road E	Sample Site 3 300 feet downstream of SR 410	Sample Site 4 Between Victor Falls and Rhodes Lake Road	Sample Site 5 40 feet downstream of McCutcheon Road
Physical Parameters						
Total Coliforms	CFU/100 ml	1350	145	1340	2600	1900
Fecal Coliforms	CFU/100 ml	60	53	49	42	25
Dissolved Oxygen	mg/l	9.74	9.7	11.46	12.5	12.8
Temperature	Degrees C	6.5	6.4	9.9	4.9	5
PH	pH unit	6.8	6.9	7	7.4	7.6
Turbidity	NTU	7	6.5	4	3.5	3
Nutrients and Other Biological Parameters						
Acidity	mg/l	1	1	1	1	1
Biochemical Oxygen Demand	mg/l	10	10	10	10	10
Chemical Oxygen Demand	mg/l	29	22	19	10	11
Total Nitrogen (TKN)	mg/l	0.69	0.53	0.66	0.79	0.78
Fluoride	mg/l	0.2	0.2	0.2	0.2	0.2
Chloride	mg/l	3.4	3.2	3.2	3.7	3.5
Nitrite	mg/l	0.2	0.2	0.2	0.2	0.2
Nitrate	mg/l	0.71	0.74	0.95	1.4	1.3
Phosphate	mg/l	0.4	0.4	0.4	0.4	0.4
Total Phosphorus	mg/l	0.069	0.06	0.053	0.087	0.07
Sulfate	mg/l	13	8.1	10	10	9.6
Total Alkalinity	mg/l	19	16	20	30	31
Ammonia as Nitrogen	mg/l	0.05	0.05	0.05	0.05	0.05

Table 4-15 (continued)
Water Quality Values from Fennel Creek Environmental Assessment

Parameter	Units	Sample Site 1 50 feet west of 214th Avenue E	Sample Site 2 50 feet west of Kelly Lake Road E	Sample Site 3 300 feet downstream of SR 410	Sample Site 4 Between Victor Falls and Rhodes Lake Road	Sample Site 5 40 feet downstream of McCutcheon Road
Total Suspended Solids	mg/l	10	10	10	10	10
Total Dissolved Solids	mg/l	90	82	81	90	90
Metals						
Arsenic	µg/L	0.92	0.3	0.37	0.67	1.7
Cadmium	µg/L	0.14	0.03	0.01	0.008	0.007
Chromium	µg/L	3.3	0.9	0.52	0.49	0.47
Copper	µg/L	27.4	8.1	14	3.4	10.7
Hardness	mg/l	28	25	32	40	41
Lead	µg/L	0.24	0.2	0.1	0.1	0.09
Mercury	µg/L	0.016	0.008	0.008	0.006	0.007
Nickel	µg/L	1.17	0.8	1.1	0.68	0.55
Selenium	µg/L	2	2	2	2	2
Silver	µg/L	0.038	0.018	0.017	0.018	0.025
Zinc	µg/L	4.8	3.9	3.6	2.9	3

Source: Foster Wheeler 1999

Table 4-16
Canyon Falls Creek Water Quality Monitoring from Cascadia Development

Sample Date	Water Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (%)	Specific Conductivity (umhos/cm^2)	pH	Average Turbidity (NTU)	Discharge (cfs)	Nitrate Nitrogen (mg/l)	Total Cadmium (mg/l)	Dissolved Cadmium (mg/l)	Total Iron (mg/l)	Dissolved Iron (mg/l)	Total Suspended Solids (mg/l)	Hardness (mg/l)	Total Organic Carbon (mg/l)
8/24/00	10.33	7.32	65.0	186	6.78	nm	14.4	1.9	<0.0005	<0.0005	0.010	<0.005	5	80	nm
9/5/00	9.69	9.67	86.3	195	6.98	nm	13.0	1.8	<0.0005	<0.0005	0.011	<0.005	<1	75	nm
11/8/00	8.66	10.45	81.3	198	6.74	nm	12.4	1.6	<0.0005	<0.0005	0.380	<0.005	3	nm	nm
12/6/00	7.1	nm	nm	209	7.01	nm	11.3	2.23	<0.005	<0.005	<0.150	<0.150	<4	nm	nm
1/4/01	8.73	10.35	89.4	207	6.91	<1	10.3	2.17	<0.006	<0.0001	<0.150	<0.150	<4	95	nm
1/11/01	8.7	nm	nm	162	7.23	<1	10.2	1.42	<0.006	<0.0001	<0.150	<0.150	<4	55	<2.00
2/2/01	8.45	10.55	90.4	187	6.89	<1	10.1	2.14	<0.001	<0.0001	<0.150	<0.150	<4	88	<4.00
3/2/01	8.47	10.21	87.5	197	7.11	1	10.1	2.33	<0.001	<0.001	<0.150	<0.150	13	91	nm
4/10/01	8.66	11.41	97.9	179	7.22	nm	12.2	2.6	<0.0005	<0.0005	0.017	<0.005	<1	91	nm
5/2/01	9.22	12.29	107.2	180	6.94	nm	12.4	2.8	<0.0005	<0.0005	0.050	<0.005	<1	93	nm
8/17/01	---- equipment malfunction –no in situ data available -----						11.0	2.3	<0.0005	<0.002	<0.005	<0.01	<1	100	nm
10/16/01	9.4	nm	nm	192	6.63	nm	11.3	2.3	nm	nm	nm	nm	nm	nm	nm
12/4/01	nm	nm	nm	210	7.40	nm	10.8	1.7	nm	nm	nm	nm	nm	nm	nm
1/4/02	7.4	nm	nm	212	7.04	nm	12.2	2.4	nm	nm	nm	nm	nm	nm	nm
2/11/02	9.9	nm	nm	164	7.20	nm	13.5	2.8	nm	nm	nm	nm	nm	nm	nm
3/5/02	8.2	nm	nm	172	7.16	nm	14.5	2.7	nm	nm	nm	nm	nm	nm	nm
4/3/02	data not available							2.5	nm	nm	nm	nm	nm	nm	nm

nm = not measured
Source: Pierce County Water Programs 2002

Puyallup Tribe Water Quality Monitoring

The Puyallup Tribe has collected water quality samples on Fennel Creek and Canyon Falls Creek since 1998 and 1999, respectively. One site was monitored during 1998 on Fennel Creek at McCutcheon Road; samples were collected once monthly. During the subsequent three years, an additional sampling site was included at Victor Falls. In 2002, the Victor Falls site was dropped from the sampling program and samples were collected only at McCutcheon Road. Sampling on Canyon Falls Creek began in 1999 at three sites: the east side of McCutcheon Road, the west side of McCutcheon Road, and at the mouth of the creek. In 2000 and 2001, samples were collected only from the two sites near McCutcheon Road. In 2002, only the east side of the McCutcheon Road site was sampled.

Two general types of data—field and laboratory—were collected. Of the two types, field data were collected more frequently. Data collected on-site using hand-held meters, included dissolved oxygen, temperature, conductivity, pH, total dissolved solids, and salinity.

Laboratory data were collected less frequently. The laboratory parameters analyzed include total phosphorus, orthophosphorus, nitrate+nitrite, total suspended solids, fecal coliforms, and ammonia. These data are summarized in *Table 4-17* and *Table 4-18*. The range of values collected for each parameter in a given year is provided. The complete data tables are included in *Appendix H*.

For Canyon Falls Creek, the State water quality standards were exceeded only twice during the four years of sampling. The first occurrence was in March 2001 when the fecal coliform sample measured 2,800 col/100 ml. The second instance was in January 2002 when pH measured 9.43. Fennel Creek exceeded State water quality standards a greater number of times, particularly from fecal coliforms. Six fecal coliform samples exceeded State standards between October 1999 and May 2001. Dissolved oxygen dropped below standards once in December 2000 and pH was excessively alkaline in both December 2000 and January 2002. There has been no investigation to determine the reason the standards were exceeded.

Summary of Studies

In each of the studies described above, instances minorly exceeded State water quality standards. These studies included samples taken in Alderton Creek, Ball Creek, Fennel Creek, Canyon Falls Creek, and Horsehaven Creek. The only trend of impaired water quality is an apparent association of elevated summer water temperature in channels along the valley bottom that have no shade providing riparian vegetation. *Table 4-19* shows a summary of when standards were exceeded and noted in these studies. The only other water quality impairment to note was elevated levels of copper found in the upper reaches of Fennel Creek during 1998–99. Samples taken more recently (2002) show much lower levels of copper at this location.

Table 4-17
Puyallup Tribe Water Quality Data for Canyon Falls Creek

		1999	2000	2001	2002
Field Data	Units	8 samples	9 samples	11 samples	5 samples
Dissolved Oxygen	mg/l	10.28 - 12.99	10.34 - 14.73	10.33 -13.35	10.81 - 11.69
Dissolved Oxygen	%	-	88.1 - 116.1	97.1 - 109.5	88.3 - 99.9
Temperature	degrees C	8.51 - 13.30	6.70 - 11.81	7.4 - 12.57	7.15 - 9.48
Conductivity	µs/cm	99 - 231	192.4 - 270.0	210.0 - 220.0	83.4 - 213.0
pH		7.01 - 8.11	7.37 - 8.19	7.09 - 7.86	7.76 - 9.43
Total Dissolved Solids	mg/l	-	0.1234 - 0.1318	0.1344 - 0.1408	0.1083 - 0.1363
Salinity	ppt	0.00 - 0.10	0.09 - 0.11	0.0 - 0.1	0.08 - 0.10
Redox	millivolts	309 - 473	-	-	-
Laboratory Data		2 samples	3 samples	4 samples	0 samples
Total Phosphorus	mg/l	0.11 - 0.15	0.13 - 0.15	0.21 - 0.26	-
Ortho-Phosphorus	mg/l	-	0.10	-	-
Nitrate + Nitrite	mg/l	2.4 - 2.5	2.3 - 2.6	2.10 - 2.70	-
Total Suspended Solids	mg/l	ND - 2	ND - 2	ND	-
Fecal Coliforms	col/100 ml	2 - 60	5 - 60	1-2800	-
Ammonia	mg/l	0.11 - 0.11	0.09 – 0.18	ND - 0.21	-

Source: Pierce County Water Programs 2002

Table 4-18
Puyallup Tribe Water Quality Data for Fennel Creek

		1998	1999	2000	2001	2002
Field Data	Units	12 samples	10 samples	9 samples	10 samples	7 samples
Dissolved Oxygen	mg/l	11.39 - 13.54	10.10 - 15.19	6.92 - 14.40	10.10 - 14.35	10.50 - 14.12
Dissolved Oxygen	%	-	-	83.9 - 116.4	92.7 - 112.7	92.0 - 102.6
Temperature	degrees C	5.05 - 13.21	5.63 - 14.61	3.22 - 14.07	5.60 - 12.96	4.63 - 9.36
Conductivity	s/cm	141 - 211	63 - 201	119.1 - 191.0	137.2 - 215.0	128.0 - 160.2
pH		6.73 - 7.42	6.62 - 7.66	7.29 - 12.8	6.55 - 7.82	6.90 - 9.02
Total Dissolved Solids	mg/l	-	-	0.0764 - 0.1917	0.0877 - 0.9540	0.0820 - 0.1028
Salinity	ppt	0.00 - 0.10	0.0 - 0.1	0.01 - 0.10	0.0 - 0.1	0.00 - 0.07
Redox	millivolts	269 - 548	-	-	-	-
Laboratory Data		4 samples	3 samples	3 samples	2 samples	0 samples
Total Phosphorus	mg/l	0.03 - 0.22	0.08 - 0.12	0.05 - 0.19	0.16 - 0.26	-
Ortho-Phosphorus	mg/l	ND - 0.05	-	ND	-	-
Nitrate + Nitrite	mg/l	1.2 - 1.7	1.2 - 1.4	1.0 - 2.0	1.00	-
Total Suspended Solids	mg/l	2	ND - 2	ND - 4	4	-
Fecal Coliforms	col/100 ml	14	20 - 120	45 - 1100	38 - 2200	-
Ammonia	mg/l	ND	ND - 0.051	ND - 0.05	ND	-

Source: Pierce County Water Programs 2002

Table 4-19
Instances State Water Quality Standards Were Exceeded in Recent Studies of Mid-Puyallup Tributaries

Source	Time of Study	Number of Violations				
		Temperature	DO	pH	Fecal Coliform	Turbidity
Alderton Creek						
Pierce County	Spring 2002	0	1	0	0	0
Ball Creek						
Trotter 2002	Summer 2001	1	0	0	0	0
Fennel Creek						
Foster Wheeler 1999	1998-1999	0	0	0	0	2
Puyallup Tribe	1999-2002	0	1	2	6	0
Canyon Falls Creek						
Cascadia Corp.	2000-2002	0	1	0	0	0
Puyallup Tribe	1999-2002	0	0	1	1	0
Horsehaven Creek						
Trotter 2002	Summer 2001	1	0	0	0	0
Pierce County	Spring 2002	0	0	0	1	0

Source: Entranco 2002

5. IDENTIFICATION OF PROBLEMS

This chapter summarizes the surface water management issues and problems in the Mid-Puyallup Basin that were identified during the basin characterization process. The Mid-Puyallup Basin Plan (Basin Plan) focuses on areas of the Basin with poor drainage, with potential water quality impairment, and with degraded riparian corridors. Problems listed in this chapter are further examined in Chapters 6, 7, and 8 to determine which sites can be improved by capital improvement projects (CIPs), what type of CIPs would be most effective, and which problems can be solved without construction.

5.1 Problem Definitions

In general, the problems focused on in the Basin Plan are road and property flooding, surface water quality impairment, degraded fish habitat, and blocks to fish passage. Specific problems were identified from drainage complaints, questionnaires returned by residents, and problems already known to County staff. Most drainage issues within the Mid-Puyallup Basin are generally development-related and involve flooding. Development was the problem most frequently mentioned by citizens in the Mid-Puyallup Basin and included concerns that development was happening too fast and without consideration for the future, thereby causing deforestation, erosion, and the loss of aquifer recharge areas due to the increase in impervious surface area.

Water quality concerns were found to be associated with either site-specific activity in the Basin or non-point runoff sources. Citizen reports and concerns expressed by County staff regarding specific sites were used to identify areas of concern. Sites include areas of concern that may not currently exhibit water quality impairment, but pose a concern to citizens and therefore are discussed in this Basin Plan.

Degraded riparian habitat in the Mid-Puyallup Basin is primarily the result of poor agriculture and development practices that remove riparian vegetation, create blockages to migratory fish, and decrease channel complexity. Also, increasing urbanization can destabilize stream banks and increase sedimentation. Both of these effects are prevalent in many of the Mid-Puyallup silt-laden tributaries along the low gradient streams of the valley floor.

5.2 Flooding

Flooding issues ranged from streamside to residential flooding within the upland contributing basins. Flooding concerns also occur along the main stem of the Puyallup River, which are a result of Puyallup River flows rather than flows from Mid-Puyallup Basin tributaries. For that reason, Puyallup River mainstem flooding response is governed by the Puyallup River Comprehensive Flood Control Plan and not by this sub-basin.

Field investigations of problem areas were conducted following a review of service requests from Pierce County records and survey information collected from Basin residents. The initial list of complaints (included in *Appendix I*) was reduced by eliminating non-drainage related issues and some issues recorded as previously resolved by the County. Problems identified as sources of frequent flooding were typically related to inadequately sized conveyance in upland areas, including culverts, ditches, and stormwater ponds. The lack of a formal storm drain system was called out in several surveys. Aggradation in some tributaries also was blamed for recent flooding in some places. A review of the Federal Emergency Management Agency (FEMA) flood insurance claims found no repetitive loss properties in the Mid-Puyallup Basin.

Figure 5-1 shows the location of problem areas listed in *Table 5-1*. In some cases, several reported problems are clustered within a specific neighborhood. Such instances are listed as a single problem area in *Table 5-1* with all the associated addresses identified.

Some problems have greater justification for developing CIPs due to their relative significance in meeting the program objectives such as protection against flooding or prevention of resource degradation. Fixing a particular flooding problem could have the additional benefit of removing a fish passage barrier. Some problem solutions may need nothing more than increased maintenance to remove blockages from culverts and catch basin covers. A few problems occur on private property and thus may be beyond the scope of this Basin Plan.

The most significant problems were found within the tributary basin areas of Ball Creek, Fennel Creek, and Horsehaven Creek. Ball Creek has several minor flooding problems in the neighborhoods comprising its headwaters and one culvert on the downstream reach that will likely need to be replaced. Fennel Creek has a variety of flooding problems throughout the Basin. The most significant problem is a stormwater pond that is too small and needs an improved overflow path. Horsehaven Creek is similar to Ball Creek in that it has some minor flooding problems in the upper Basin area and on downstream culverts that will likely need to be replaced. Analysis of these problems is discussed in Chapter 6.

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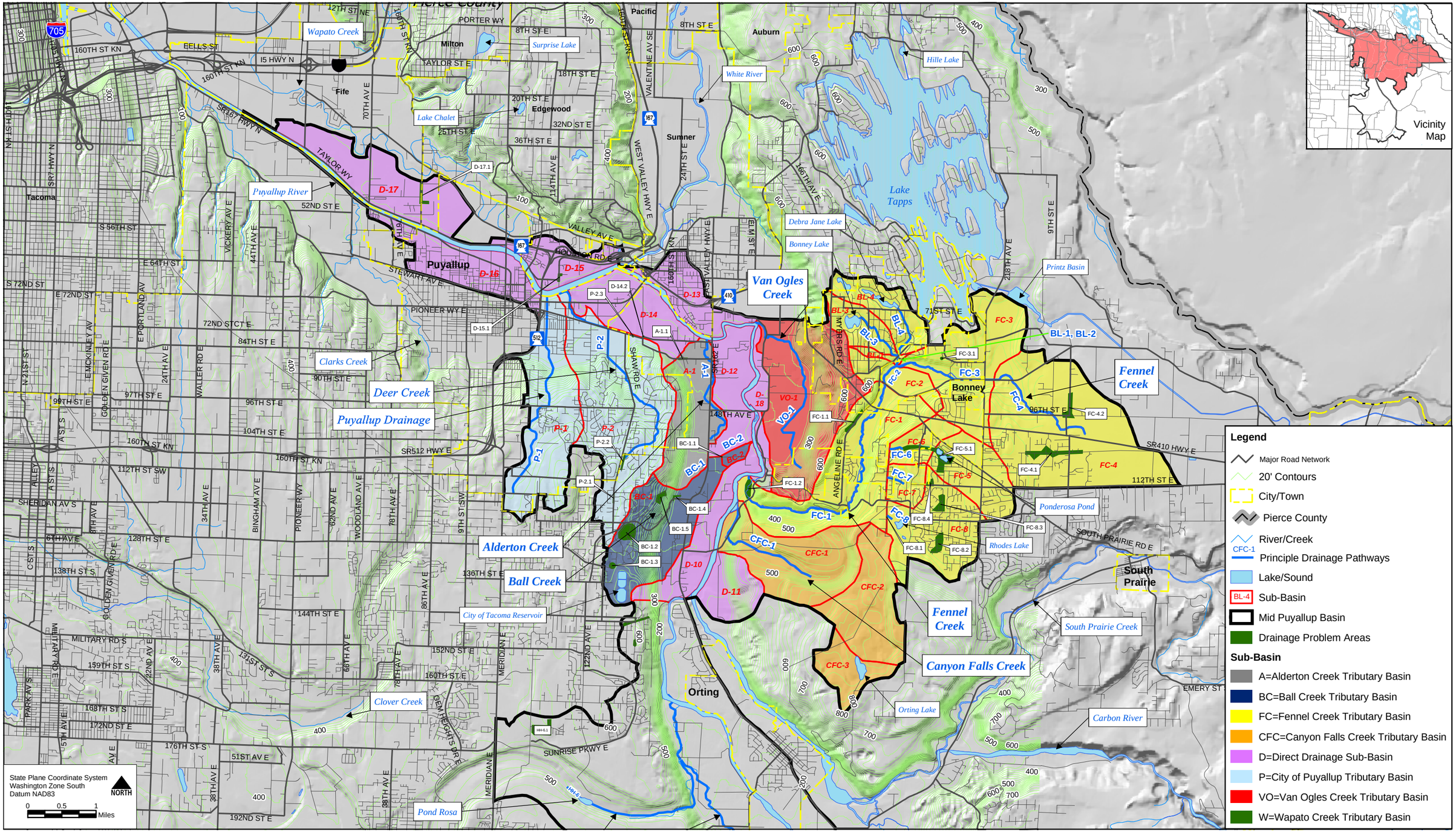

This MAP is for general planning purposes only, and is subject to updates and changes. Any user should check with Pierce County prior to use to be sure that the data is correct. Because of the scale of this map, any user should not rely on it for the exact definition of any boundary or division line shown on said map.

This MAP is based on information from numerous sources and the accuracy of which is not guaranteed by Pierce County and its consultants. Pierce County and its consultants are not responsible and shall not be liable to the user for damages of any kind arising from the data or information shown on this map.

Figure 5-1A: Drainage Problem Areas

Mid-Puyallup Basin Plan

PIERCE COUNTY

entranco Momentum

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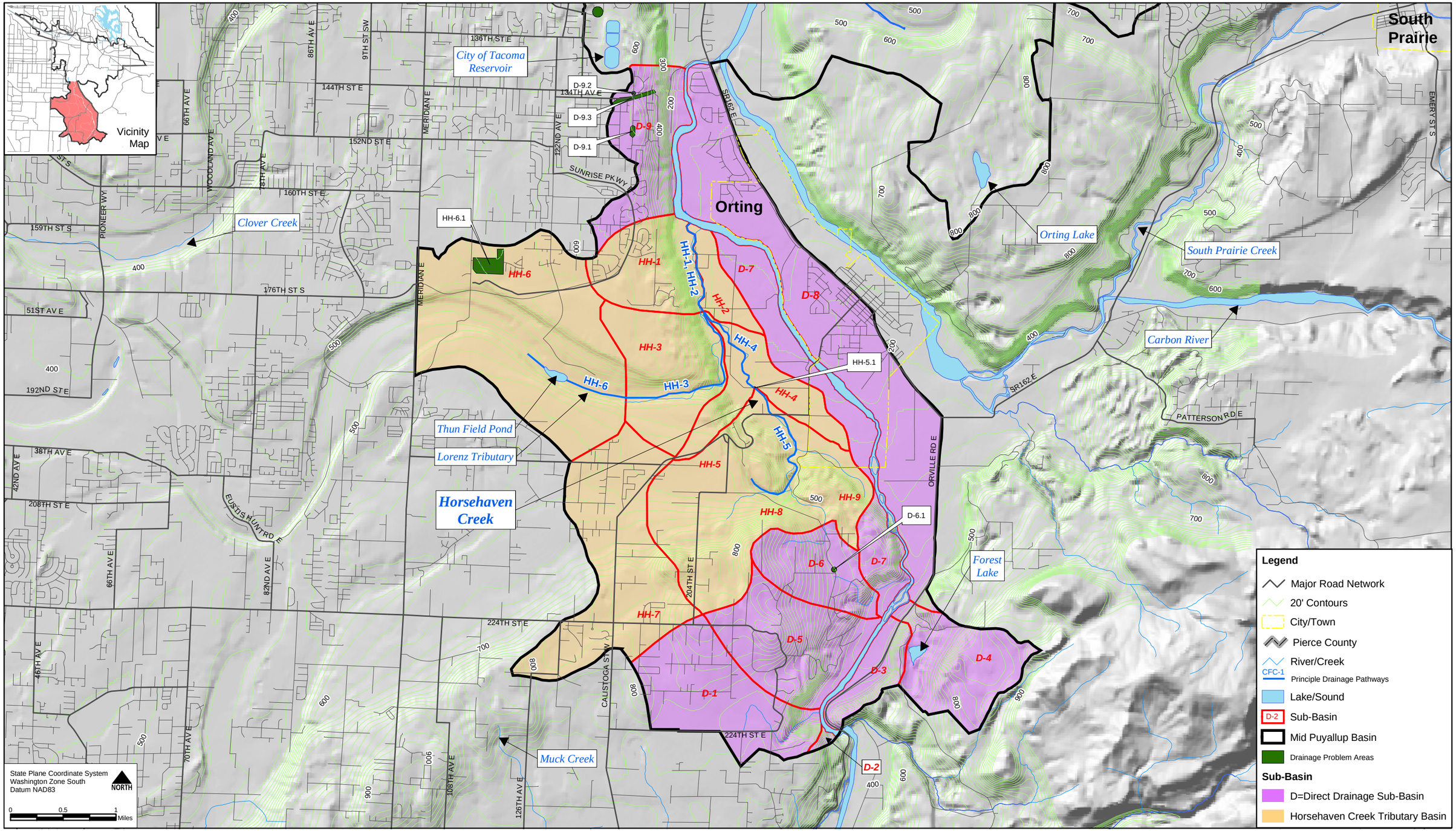

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Figure 5-1B: Drainage Problem Areas

Mid-Puyallup Basin Plan

PIERCE COUNTY

entranco Momentum

Table 5-1
Preliminary Flooding and Drainage Problems

ID No.	Source	Origin of Complaint	Description
Ball Creek Subbasin			
BC1-C07	Questionnaire GIS database (5319) Paper Files	15000 block of 106th Street E 15000 block of 106th Street E	Roadway Flooding and Private Property Flooding ■ The Ball Creek main stem floods at the culvert under 106th Street East. ■ The culvert is a 24-inch concrete pipe. ■ There is visible erosion of the right bank about 10 to 20 feet upstream from the culvert. ■ Reed canarygrass has colonized the bank opposite the eroded area. ■ A fish/duck pond is roughly 30 to 40 feet downstream from the culvert. ■ The area surrounding this small neighborhood is flat alluvial valley bottom. ■ Silt is building up in the creek.
BC1-RF01	GIS database (1246, 1259, 1261, 1310, 1925)	12300 block of 132nd Avenue E 12300 block of Tatoosh Road E 12400 block of Tatoosh Road E 13200 block of 124th Street Ct. E	Surface Flooding ■ Multiple reports of drainage problems within this development (Timber Ridge). ■ Minimal curbs with catch basins at low points along the roadway. Most reports were at addresses with a catch basin out front. ■ Either the drainage is inadequate to convey large flows or the catch basins become blocked reducing the conveyance capacity.
BC1-DET01	GIS database (424) Paper Reports	13100 block of 127th Avenue Ct E 13100 block of 129th Avenue E	Pond Overtopping ■ There is a large pond in the front yard at 13121 127th Ave Ct E. ■ This pond looks mostly decorative with little volume for detention. ■ The pond is on private property and floods private property
BC1-C11	Questionnaire GIS database (592, 4956)	14300 block of Old Military Road E 13800 block of Old Military Road E	Surface Flooding ■ This is where Ball Creek crosses under Old Military Road E and flows east toward the railroad. ■ A homeowner nearby suspects that the culvert under the driveway to the Puget Sound Energy substation is inadequately sized. ■ The culvert under the road alongside the railroad tracks is reported to have been installed without a County permit and may not be sized correctly.

Table 5-1 (Continued)
Preliminary Flooding and Drainage Problems

ID No.	Source	Origin of Complaint	Description
BC1-RF02	GIS database (33, 887, 1177, 1314)	11500 block of Jennifer Ct E 11700 block of 138th Avenue E 11700 block of 136th Avenue E	Surface Flooding ■ This neighborhood is near the edge of a plateau so the streets and properties are steep in some places. ■ The roads here have no curbs and only a few catch basins. Road runoff flows onto private properties causing flooding. ■ Several reports of flooding in this area and all are on the down slope side of roadways.
Fennel Creek Subbasin			
FC1-DET04	County Staff Paper reports	9800 block of Angeline Road	Stormwater Pond ■ This is a stormwater pond that is at the base of a hillslope underneath Sky Island development. Runoff is piped down the slope to this pond from the development. ■ The hillslope has been cleared of trees. ■ The pond is small, shallow and filled with abundant willow saplings. ■ Overflow from the pond is directed toward a low spot along the roadway, which could pool water over the roadway.
FC1-BRG01	Questionnaire	11100 block of McCutcheon Road	Private Property and Road Flooding ■ This property is adjacent to Fennel Creek near the confluence with the Puyallup River, downstream from the gravel pit. ■ McCutcheon Road to the south of this property overtopped in excess of six inches in the 1996 extreme storm event. ■ Homeowner claims that the gravel pit and upstream development have increased the incidence of flooding here. ■ Homeowner would like the stream dredged.
FC3-DET03	County Staff	204th Avenue Ct E	Stormwater Pond Overtopping ■ One lot in a development of roughly a dozen homes is dedicated to a stormwater pond. ■ The pond is small and designed to overtop toward the south, away from the development, and down a hillside. ■ About 25 feet down slope is a ditch that is supposed to collect and infiltrate the water though it looks in need of maintenance.

Table 5-1 (Continued)
Preliminary Flooding and Drainage Problems

ID No.	Source	Origin of Complaint	Description
FC4-RF02	Barricade request for water over road GIS database (600, 706, 756, 188) Paper Files	10300 block of 229th Avenue Ct E 22800 block of Entwhistle Road 22900 block of Entwhistle Road 10500 block of 230th Avenue E 24400 block of Entwhistle Road 10400 block of 226th Avenue E 10200 block of 229th Avenue E	Road Flooding ■ There are multiple drainage reports along Entwhistle from 222nd to 254th as well as along several roads nearby. ■ Entwhistle has been closed at times with water over the roadway both east and west of 234th Avenue E. ■ The roads in this area do not have curb and gutters. Several places along the road have shallow ditches or none at all. Some ditches have standing water indicating poor infiltration. ■ Near the west end of this problem area, there is a new infiltration pond that may be helping to alleviate these problems.
FC4-RF05	Questionnaire GIS database (311) Paper Files	23300 block of 96th Street E 23600 block of 96th Street E 9100 block of 234th Avenue E	Road Flooding ■ Fennel Creek flows through this neighborhood in roadside ditches ■ Several of the nearby driveway culverts are becoming plugged with sediment. ■ Road flooding has been reported at the corner of 96th Street E and 233rd. ■ Ditches in this area are shallow and some are filling with sediment.
FC4-C04	Foster Wheeler 1999	Old Sumner-Buckley Hwy	Road Flooding ■ Culvert under Old Sumner-Buckley Hwy is undersized and floods a portion of the highway during high flows.
FC5-DET01	County Staff Paper Files	10200 block of 205th Ave E 10600 block of 210th Ave E	Pond Overtopping, Surface Flooding (Ponderosa/Wembley) ■ Ponderosa Pond is a closed depression that overtops to the northwest. Homes near the “outlet” have had past flooding. ■ The Ponderosa homeowners association created a group called the Road Services District (RSD). This group hired Parametrix Inc. to improve the roadways in the neighborhood and construct several stormwater ponds. This work is now complete. This infrastructure will become Pierce County property upon acceptance by the County, which is in process. ■ One of the newly constructed ponds on the west side of Ponderosa Pond serves as the outlet and as a path for overflow; the other pond is at the southeast end of the lake. Water from the outlet pond passes through an 18-inch pipe and is released into a wetland at the end of 140th Street E. From here flow runs west through wetlands, crosses 200th Ave Ct E in an 18-inch culvert, enters a pond currently being used for construction runoff (at Brookwater development), and infiltrates into more wetlands.

Table 5-1 (Continued)
Preliminary Flooding and Drainage Problems

ID No.	Source	Origin of Complaint	Description
			■ An older stormwater pond to the south in the Fir Ridge neighborhood (formerly Wembley Park) has no overflow structure and no defined overflow path. Hence, some homes near this pond have had past flooding. One home, north of the pond and in its floodplain, was purchased by Pierce County and removed. ■ Overflow from the Fir Ridge pond could potentially be routed to Ponderosa Pond. If this option were implemented, the outlet of Ponderosa Pond would need drainage improvements such as increasing the outlet pond capacity if possible and upgrading the culvert crossing under 202nd Avenue E.
FC8-RF03	GIS database (1108)	1100 block of 193rd Avenue E	Surface Flooding ■ Where the outlet from Rhodes Lake crosses under 193rd Avenue E there is a low spot with wetlands on either side of the road. ■ The road is only slightly higher than the water level during base flow conditions. ■ This is purportedly a private road. There is no property damage from flooding in this area. ■ Flood water levels at this crossing could become higher in the future as Basin development increases.
FC8-RF04	GIS database (3726, 4353, 2918)	20300 block of 127th Street Ct E, 20500 block of 123rd Street Ct E, 20500 block of 123rd Street Ct E, 20500 block of 124th Street Ct E	Drainage System Failure ■ There are multiple reports within the Timber Ridge development. ■ A stormwater infiltration pond overtopped near 20502 123rd Street Ct E. This occurred during the 1996 100-yr event and there was no property damage. ■ Most reports are at addresses with catch basins in the road out front. It is likely that these catch basins simply need regular maintenance.
FC8-RF01	GIS database (6038, 3743) Paper Files	20400 block of 117th Street E 20300 block of 117th Street E 20400 block of 114th Street E	Surface Flooding ■ This is an older neighborhood with drainage that consists of ditches and 8-inch concrete culverts under each driveway. ■ There is no ditch at the northeast property on the corner of 117th Street E and 204th Avenue E. It is possible that this ditch was filled in by a property owner and now causes drainage problems in this area. ■ The water table is high in this area so it can take weeks for pooled water to go away.

Table 5-1 (Continued)
Preliminary Flooding and Drainage Problems

ID No.	Source	Origin of Complaint	Description
FC8-DET02	County Staff	Corner of 112th Street E and 203rd Avenue E	Pond Overtopping ■ The pond at this intersection has overtopped only once. This happened when a pond up hill overtopped during a large storm that occurred while this upper pond was under construction.
BL4-RF05	Paper Files	19400 block of Church Lake Road	Road Flooding ■ There is a low spot here along Church Road. The south side of the road has a shallow ditch that could overtop the road if the culvert becomes blocked.
Horsehaven Creek Subbasin			
HH5-C07	Anecdotal	188th Street E and Horsehaven Creek	Road Flooding ■ This is a 36-inch concrete culvert on Horsehaven Creek under 188th Street E ■ There is periodic road flooding at this location. ■ During base flow conditions, the water surface is about two feet from the crown of the road. ■ The road is mostly flat with mild undulations.
HH6-RF01	GIS database (3578, 5696, 3731, 3580, 3583, 510, 3590, 3587)	11100 block of 172nd Street E 11200 block of 172nd Street E 16800 block of 114th Avenue Ct E 17000 block of 110th Avenue E 17000 block of 113th Avenue Ct E 17000 block of 110th Avenue Ct E	Road Flooding ■ There are multiple reports of flooding in this development. ■ The development has curbs that form barriers along the streets such that if the catch basins become blocked, the water would pool on the roadway. ■ Either the drainage here is inadequate to carry large flows or the catch basins become blocked reducing the conveyance capacity.
Subbasins With Direct Runoff To Puyallup River			
D6-RF01	GIS database (268)	21400 block of Jansky Road E	Surface Flooding ■ This road is in a wooded area that deposits leaves and other debris into the roadside ditches. Driveway culverts then become blocked causing flooding.

Table 5-1 (Continued)
Preliminary Flooding and Drainage Problems

ID No.	Source	Origin of Complaint	Description
D9-RF04	Paper Reports	134th Avenue E between 144th Street E and 145th Street E	Road Flooding ■ There is a shallow ditch on the west side of the road that flows to a 12-inch concrete culvert under 134th Avenue E to a pond on the other side of the road. ■ It is possible that this site would overtop the road occasionally though water would not pool to any depth here as it would flow to the lower ground occupied by the pond.
D9-RF05	GIS database (1251) Paper Files	13300 block of 145th Street E 14400 block of 137th Avenue E 14600 block of 131st Avenue E 14400 block of 136th Avenue E	Surface Flooding ■ There are no ditches on the roads running east to west in this neighborhood. The majority of ditches are on roads running north to south. ■ There are multiple drainage reports in this neighborhood, but about half of the area lies outside the Mid-Puyallup Basin boundary. ■ There are two reports of erosion along 144th near 137th from road runoff.
D9-RF06	GIS database (877)	15000 block of 134th Avenue E	Surface Flooding ■ There are no ditches along this road. Runoff flows east from low spots along the road as sheet flow into wooded areas. Some houses along the east side of the road might flood periodically because of the topography. ■ Fill and grade violations and wetland violations have occurred at 14508 136th Avenue E and 14608 136th Avenue E downslope of this area. Any loss of wetlands in this area would reduce the drainage capacity.
D14-RF07	GIS (415)	Corner of 134th Avenue E and 80th Street E	Surface Flooding ■ This intersection has small ditches or none at all. ■ A bulb farm is on the northeast corner with parking across the street. The driveway to this parking area, south of 80th Street E, has a 4-inch plastic culvert, likely placed by the owner. ■ There are large ditches along 134th Avenue E but they end before reaching the intersection. ■ Trenches have been dug to divert water from the parking area. These trenches flow in haphazard directions ultimately directing the flow into the drainage system in place by the railroad tracks.
D15-RF08	GIS (829, 835) Paper Files	11500 block of 65th Street Ct E 6700 block of 114th Avenue Ct E 6600 block of 114th Avenue E	Surface Flooding ■ There are a few catch basins along the streets in this neighborhood. The catch basin in front of the house on 65th Street likely needs frequent maintenance to keep it clear of debris.

Table 5-1 (Continued)
Preliminary Flooding and Drainage Problems

ID Number	Source	Location	Description
D17-RF03	GIS (448, 466, 3834, 4825, 3356)	4500 block of Freeman Road E 4800 block of Freeman Road E 4900 block of Freeman Road E 5000 block of 85th Avenue E 8300 block of 49th Street E	Surface Flooding ■ Some of the ditches are overgrown by vegetation and in need of routine maintenance. ■ Most of the flooding occurs on private property.
P1-RF03	Paper Files	11600 – 11800 block of 114th Avenue E	Surface Flooding ■ Homeowners along this street claim that the drainage ditch in this area is too small. ■ Behind the homes on the west side of 114th Avenue E is a narrow wetland/ditch. The water flows north from here through a culvert under 43rd Avenue SE.
P2-RF01	GIS database (563, 610)	10600 block of 130th Avenue E 13000 block of 109th Street Ct E	Roadway and Surface Flooding ■ This neighborhood has curbs and catch basins on the street. The road is relatively flat with no obvious low spots. ■ Across from 10602 130th Avenue E is a stormwater pond. ■ Flooding here may have been caused by blocked catch basins.
P2-RF04	Barricade request for water over roadway GIS database (446, 604, 5133) Paper Files	11700 block of Shaw Road E 12700 block of 117th Street Ct E 12900 block of 116th Street Ct E	Road Flooding ■ A low point occurs in Shaw Road here. A 12-inch concrete culvert connects trenches on both sides of the road and routes runoff to a maintenance hole. ■ A newer gated community development is on the west side of Shaw Road. ■ Either the drainage is inadequate to convey large flows or the culvert periodically becomes blocked reducing the conveyance capacity.
P2-RF05	GIS database (891, 918)	13100 block Pioneer Way E	Surface Flooding ■ The culvert under the driveway at this address has multiple reports over three years. ■ Either this ditch is prone to blockage from debris, or it is inadequate to convey higher flows.
A1-RF01	GIS database (5123)	14300 block of Pioneer Way E	Surface Flooding ■ There is no ditch along the road at this location. ■ Runoff flows to low spots and infiltrates. High flows may be directed toward the railroad drainage system. ■ A fill and grade violation occurs in this area near the 14200 block of Pioneer Way E.

Source: Entranco and Pierce County Water Programs 2002

5.3 Water Quality Problems

The primary water quality issues in the Mid-Puyallup Basin are sediment from erosion, elevated temperatures from lack of riparian vegetation, pollutant discharges from dairy farms, and places where livestock have access to the creek. *Figure 5-2, Water Quality Problem Areas*, shows the specific problem areas listed in *Table 5-2, Basin-Wide Water Quality Problems*. This list represents sites reported as having problems in the past, having the potential to become problems in the future, or being of particular concern to nearby residents.

The water quality problems noted are found in five of the six tributary systems of the Mid-Puyallup Basin. Alderton Creek contains large quantities of iron bacteria likely as a result of groundwater contributions. Ball Creek receives erosional sediment from Old Military Road where the road climbs the valley wall above the creek. The creek also passes through farmland and could be affected by local agricultural practices. It is anticipated that this creek will soon appear on the State's 303d list of impaired waters for temperature and fecal coliform bacteria. Fennel Creek has had elevated levels of copper in its upper reaches in the past. Residents near the mouth of Fennel Creek report increased movement of sediment through the channel, though this perception may be an effect of the cessation of dredging within the creek. Currently, Canyon Falls Creek has no chronic water quality problems, though there is public concern for this creek's future because of upstream development in the headwaters and the presence of a commercial fish hatchery. The major impacts to Horsehaven Creek are from the agricultural areas surrounding much of the creek. Therefore Horsehaven Creek is dependent on the willingness of local residents to adhere to agricultural practices that protect waterways. Detailed discussions of water quality problems and conceptual solutions are presented in Chapter 7 of this Basin Plan.

During the time that this Basin Plan was being developed, the Washington State Department of Ecology revised their water quality standards and submitted them to the U.S. Environmental Protection Agency (EPA) for approval. The Mid-Puyallup Basin Plan was written prior to the approval of these new standards by EPA. If the new standards are officially adopted (anticipated in February 2004), it is advised that sections of this Basin Plan be reviewed and revised as needed.

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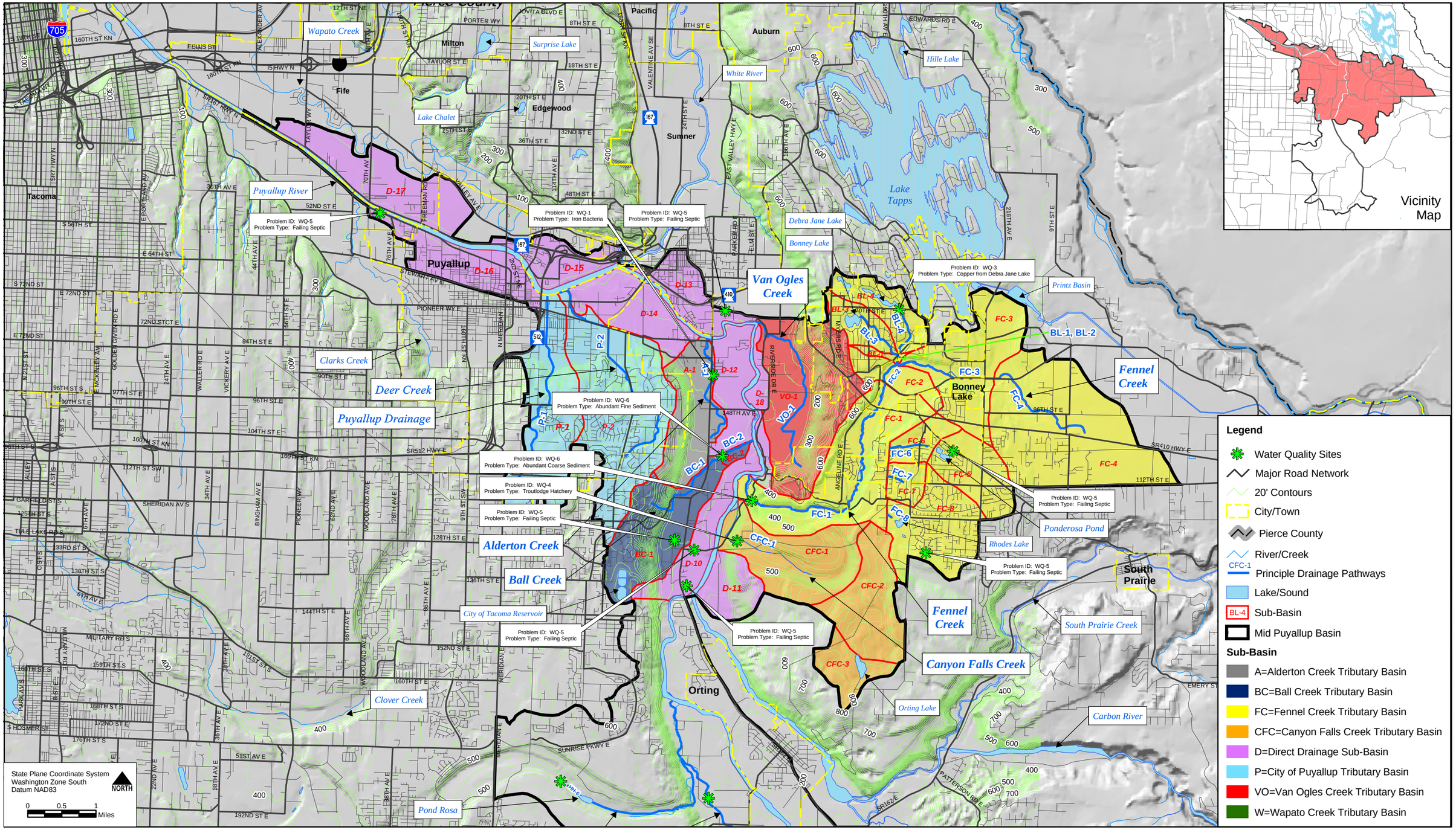

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Figure 5-2A: Water Quality Problem Areas

Mid-Puyallup Basin Plan

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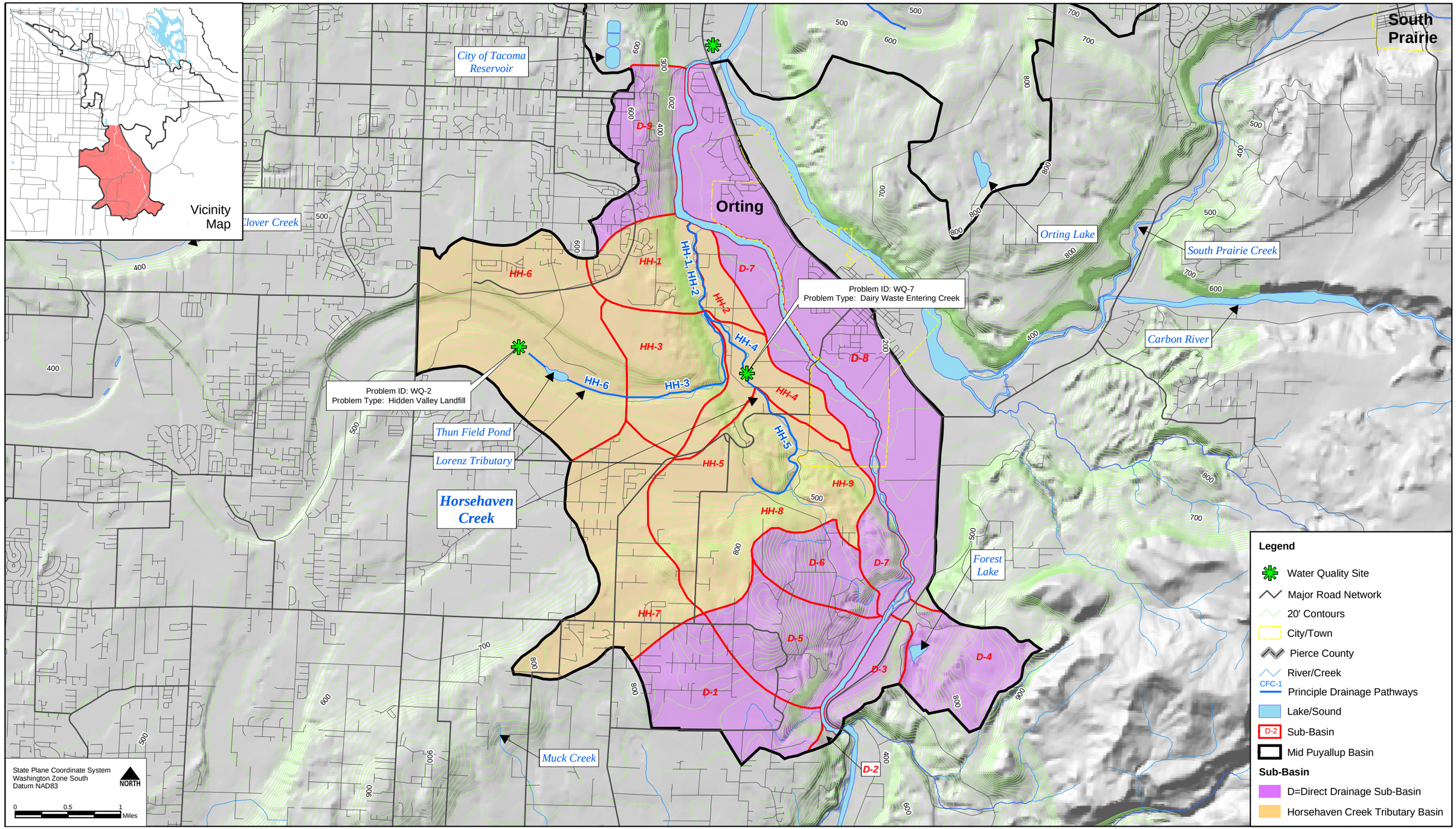

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Figure 5-2B: Water Quality Problem Areas

Mid-Puyallup Basin Plan

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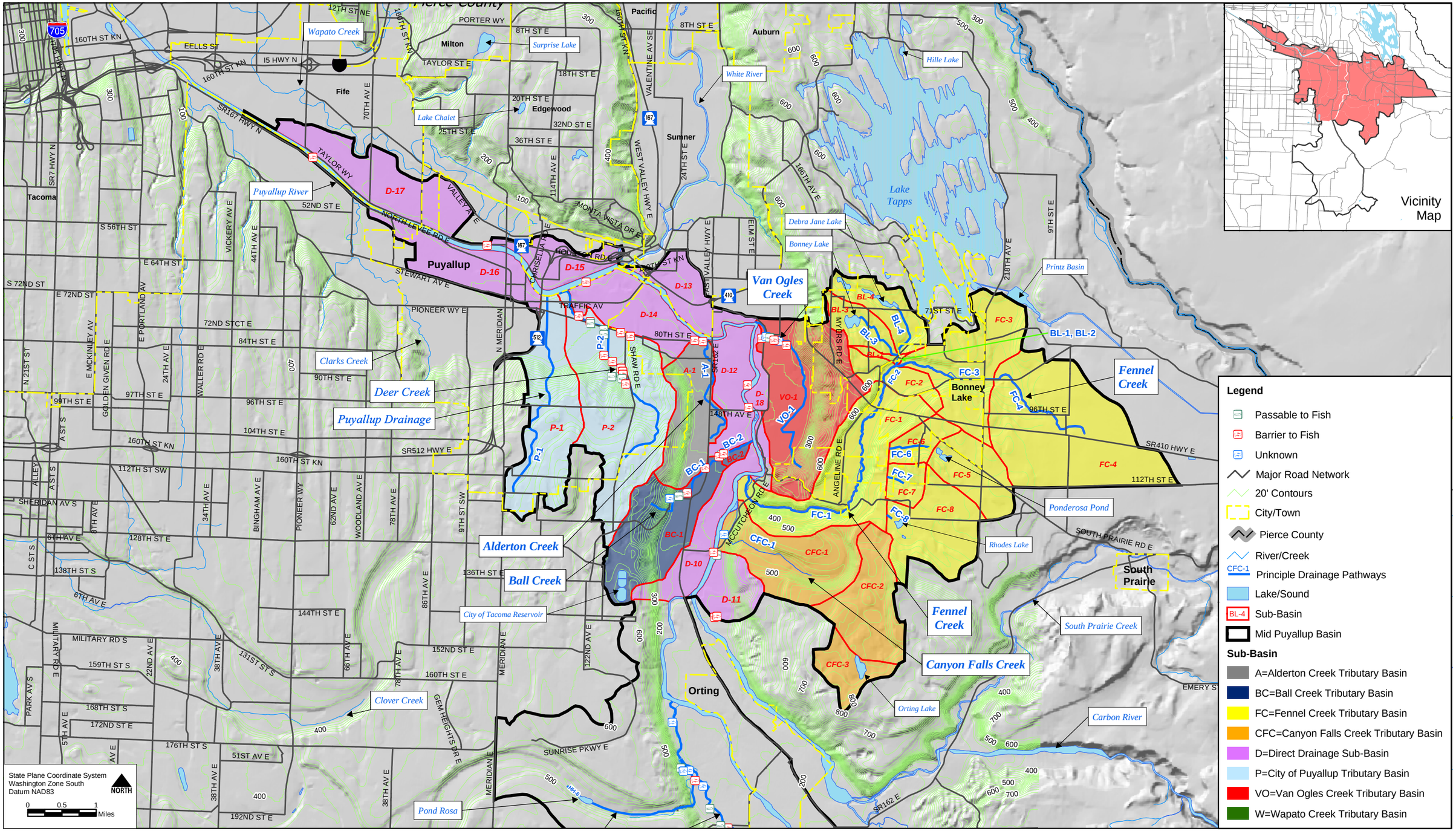

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Figure 5-3A: Fish Barriers

Mid-Puyallup Basin Plan

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Table 5-2
Basin-wide Potential Water Quality Problems

ID #	Problem	Source	Location	Description
WQ-1	Abundant iron bacteria in roadside ditch.	County Staff	Near Pioneer Way and 88th Street E	A roadside ditch at this location has abundant growth of iron bacteria. This is on the flat valley bottom near the Puyallup River where the groundwater table is close to the ground surface.
WQ-2	Industrial	Land Recovery Compost Factory, MK Work Order #4738, Site Development Plan	17925 Meridian Street East	This is a solid waste landfill with an adjoining compost factory and is regulated under State law by the Tacoma-Pierce County Health Department. This facility is in the headwater basin of Horsehaven Creek. Leachate from the landfill is treated and discharged to the Pierce County sanitary sewer system and so should not come in contact with local streams.
WQ-3	Copper contamination of Fennel Creek from Debra Jane Lake	Foster Wheeler Environmental Corporation, April 1999, Environmental Analysis of the Fennel Creek Corridor, prepared for the City of Bonney Lake	Fennel Creek	Upper reaches of Fennel Creek had copper levels that exceeded Washington State water quality standards. A suspected source of this copper is algaecide that has been applied to Debra Jane Lake.
WO-4	Upland Fin-Fish Hatching and Rearing	NPDES permit	Canyon Falls Creek	The facility is required to treat discharge in a settling pond prior to release. The permit allows for a maximum instantaneous discharge of 1.0 ml/L for settleable solids and 100 mg/l for total suspended solids. There are no restrictions listed in the permit for nutrients.

Table 5-2 (Continued)
Basin-wide Water Quality Problems

ID #	Problem	Source	Location	Description
WQ-5	Failing Septic Systems	GIS database (5232, 2791, 2899, 4736, 1586, 4452, 2705) Paper Files	13600 block of 146th Avenue E 14800 block of 128th Street E 20200 block of 128th Street Ct E 20700 block of Bonanza Drive 4500 block of 90th Avenue E 7200 block of River Road E 14200 block of 125th Street Ct E 7300 block of 153rd Avenue E	Out of eight reported septic problems, six are on the Puyallup Valley floor where groundwater is undoubtedly high. The remaining two locations are on a plateau with several nearby lakes, indicating that there is high groundwater in this area as well.
WQ-6	Erosion Areas	Questionnaire	Ball Creek Fennel Creek	Abundant fine sediment in Ball Creek is evident at the 106th Street E culvert. Abundant sediment in Fennel Creek. Land owner blames the gravel pit, but there are several new developments upstream and the soils here are loose outwash and are easily eroded.
WQ-7	Agricultural Impacts	Frey et al., 2000	Horsehaven Creek Fennel Creek	Incident of runoff overtopping a manure storage lagoon and running directly to Horsehaven Creek (March 22, 2000). Also, piped runoff from field drain tiles around the lagoon were discharged directly to the creek. Fecal coliform measurements exceeded State standards six times between 1999 and 2001 in testing done by the Puyallup Tribe.
WQ-8	Elevated Temperatures	Field measurement taken during habitat survey	Ball Creek Horsehaven Creek	Elevated temperatures have been measured where the creeks flow along the valley floor and have no riparian vegetation.
WQ-9	Trash Dumping	Habitat Survey	Fennel Creek	Trash was found in Fennel Creek near Kelly Road. The eclectic combination of litter included disturbing items such as pesticide/herbicide application sprayers.

Source: Entranco and Pierce County Water Programs 2002

5.4 Fish Habitat Limiting Factors

Fish habitat limitation results primarily from such factors as disconnected habitat, degraded habitat, and impassable culverts. An example of disconnected habitat is found in subbasin D-17. Currently, levees on the adjoining floodplain disconnect the oxbow habitat from the main stem of the Puyallup River. The largest oxbow represents almost 50 acres of rearing habitat. Pierce County and the Puyallup Indian Tribe, among others, are currently working toward reconnecting this, and possibly other off-channel habitat, with the Puyallup River. Concerns of maintaining levee integrity and function and protecting nearby private property will have to be addressed before such a project can proceed.

Habitat degradation typical of agricultural areas includes removal of riparian vegetation from the stream banks, removal of habitat-forming large woody debris from within the channel, and intrusion of fine sediment into the channel bed. Additional degradation comes from unmitigated urbanization that can alter stream flow and effect physical channel changes. With urbanization comes loss of forest cover, encroachment into riparian areas, and an overall increase in impervious surfaces. A current benchmark used to determine when urbanization levels affect streams is 10 percent effective impervious area (EIA) within a basin. Existing conditions in the tributary basins of Mid-Puyallup meet or exceed 10 percent EIA with future growth continuing to increase the EIA percentage (See *Table 5-3*)

Table 5-3
Effective Impervious Area in Tributary Basins of Mid-Puyallup

	Basin Area (acres)	Existing EIA (%)	Future EIA (%)
Alderton Creek	764.6	7.3	10.0
Van Ogles Creek	1699.9	8.7	14.3
Ball Creek	1095.4	13.6	16.1
Fennel Creek	7893.1	15.0	18.1
Canyon Falls Creek	2426.7	0.6	22.5
Horsehaven Creek	6256.5	9.7	23.2

Source: Entranco 2002

Fish habitat in the tributary creeks of the Mid-Puyallup Basin is currently in poor to fair condition especially in the valley bottom creeks. (See *Table 4-10, Summary of In-Stream Habitat Assessment*) The most affected channels are Alderton and Van Ogles creeks, which flow along the valley floor through agricultural areas. Both creeks have poor habitat quality, and a high degree of channel alteration. Ball Creek and Horsehaven Creek also flow through agricultural

areas along the valley floor for at least part of their length. These two streams have less channel alteration but still rank only poor to fair in fish habitat quality. The remaining two streams, Fennel Creek and Canyon Falls Creek, have good habitat in their headwaters with little channel alteration. Fish habitat quality is reduced in downstream areas of these creeks, however, and channel alteration becomes more frequent. Future conditions could further exacerbate these problems as urban growth continues.

The Pierce Conservation District conducted an inventory of impassable culverts for several County watersheds. In the Mid-Puyallup Basin, out of 81 culverts surveyed, 33 were determined to be barriers to the passage of migratory fish. (See *Figure 5-3, Fish Barriers*) Ball Creek had four blocking culverts, the greatest number affecting any of the major Mid-Puyallup Basin tributaries.

The first blocking culvert along Ball Creek is about 0.4 mile from the mouth. Horsehaven Creek has two blocking culverts, one is almost one mile from the mouth of the creek and the other is another mile beyond the first. The west fork of Horsehaven Creek is accessible to migrating fish. The first problem culvert occurs on the main fork upstream of its confluence with the west fork. Replacing the first culvert would open nearly one mile of the main fork to fish. Replacing the second culvert would open more than an additional mile beyond the first. The three blocking culverts on Van Ogles Creek are within roughly one mile from the mouth of the creek. Replacing these culverts would open almost 1.5 miles of stream habitat.

Table 5-4 presents all the culverts from the Conservation District's inventory that have been identified as fish passage barriers in the Mid-Puyallup Basin. Detailed analyses of those culverts that are on tributaries focused on in this Basin Plan are presented in Chapter 8.

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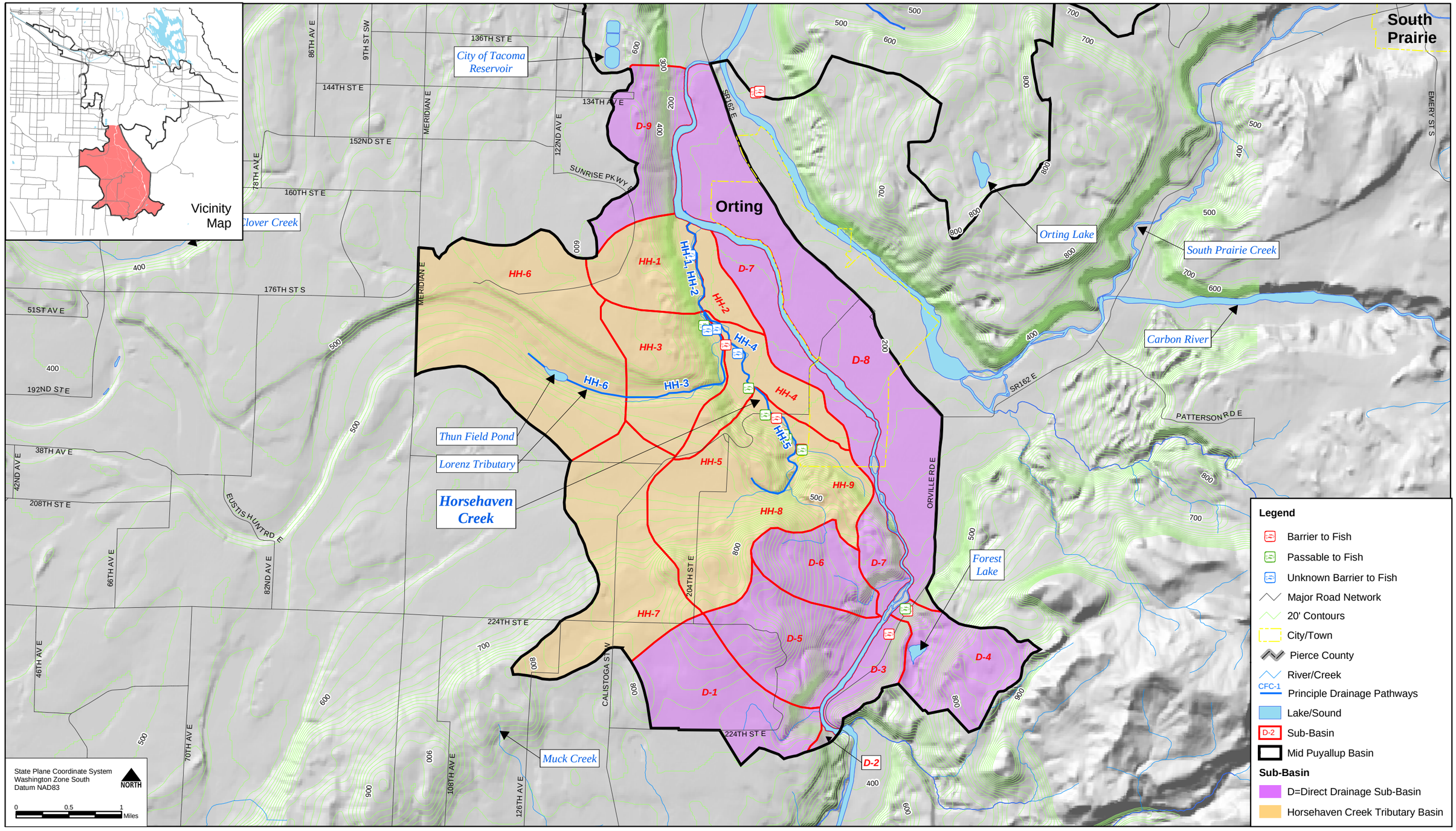

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Figure 5-3B: Fish Barriers

Mid-Puyallup Basin Plan

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Table 5-4
Fish Passage Barriers in the Mid-Puyallup Basin

ID # [a]	Location (ID)	Description
HAB-1	Levee Road 105 R012118a	■ This is an outfall pipe from an unnamed oxbow. ■ This is a 3-foot-diameter, round, precast concrete pipe.
HAB-2	Levee Road 105 R031619a	■ This is an outfall pipe from an unnamed tributary. ■ This is a 5-foot-diameter, round pipe that is covered with a tide gate, which prevents fish passage.
HAB-3	Levee Road 105 R031721a	■ This is an outfall pipe from an unnamed tributary. ■ This is a 12-inch-diameter, round, corrugated steel pipe that is probably too small for fish passage and outfalls onto rocks with no plunge pool.
HAB-4	Levee Road 105 R032918b	■ This is an outfall pipe from an unnamed tributary. ■ This is a 3.5-foot-diameter, round, precast concrete pipe that outfalls onto rocks 1.2 feet below, then cascades another 3 feet into the Puyallup River.
HAB-5	Driveway 105 R040715a	■ This is a culvert on Deer Creek. ■ This is a 3-foot-diameter, round, corrugated steel pipe that outfalls over rock with a 0.8 foot depth below the outfall.
HAB-6	Railroad Grade 105 R040715b	■ This is a culvert on Deer Creek. ■ This is a 4.5-foot-diameter, round, smooth steel pipe.
HAB-7	12th Avenue 105 R040820b	■ This is a culvert on Deer Creek. ■ This is an elliptical, corrugated steel tube with a 4.5-foot span and a 3-foot rise. There are rocks under the outfall with a poorly defined plunge pool.
HAB-8	27th Street E 105 R040822a	■ This is a culvert on Deer Creek. ■ This is a 2-foot-diameter, round, cast-in-place concrete pipe.
HAB-9	Shaw Road 105 R041218a	■ This is a culvert on Deer Creek. ■ This is a 2-foot-diameter, round, precast concrete pipe.
HAB-10	15th Avenue SE 105 R041219a	■ This is a culvert on Deer Creek. ■ This is a 5-foot-diameter, round, corrugated steel pipe.
none	Shaw Road, driveway 105 R041219b	■ This is a culvert on Deer Creek. ■ This is a 5-foot-diameter, round, corrugated steel pipe with no streambed material.
none	Shaw Road 105 R041219c	■ This is a culvert on Deer Creek. ■ This is a 2-foot, round, precast concrete pipe with an elevated outfall.
none	Shaw Road 105 R041222a	■ This is a culvert on Deer Creek. ■ This is a round, precast concrete pipe (diameter not recorded) with several sections at the lower end that are broken. ■ The creek here flows underground in a storm sewer for several hundred yards.

Table 5-4 (Continued)
Fish Passage Barriers in the Mid-Puyallup Basin

ID # [a]	Location (ID)	Description
none	Pioneer Way 105 R041316c	■ This is a culvert on an unnamed tributary. ■ This is a 1.5-foot, round, smooth steel pipe with a trash rack over the downstream end that outfalls onto rocks. The pipe has a metal shroud around it and is PVC at the upstream end.
none	Pioneer Way E, driveway 105 R041318b	■ This is a culvert on an unnamed tributary. ■ This is a 1.5-foot-diameter, round, corrugated ABS plastic pipe with rocks in the plunge pool and a 0.6-foot drop into the upstream end of the pipe.
none	Orville Road 105 R042021b	■ This is a culvert on an unnamed tributary. ■ This is a 1.5-foot, round, precast concrete pipe.
HH4-C05	150th Avenue E 105 R050517b	■ This is a culvert on Horsehaven Creek. ■ This is a 3-foot-diameter, round, precast concrete pipe with a board across the upstream end creating a pond above and causing a drop into the pipe.
HH5-C13	Orting Quarry Road 105 R050520a	■ This is a culvert on an unnamed tributary to Horsehaven Creek. ■ This is a 2-foot-diameter, round, precast concrete pipe with riprap blocking the downstream end and lots of sediment partially blocking the pipe.
HH5-C10	Driveway 105 R051118a	■ This is a culvert on Horsehaven Creek. ■ This is a 3-foot, round, precast concrete pipe.
BC1-C08	SR 162 105 R051215a	■ This is a culvert on Ball Creek. ■ This is a pair of 1.5-foot, round, corrugated steel pipes with precast concrete on the downstream end.
BC1-C07	106th Street E 105 R051216c	■ This is a culvert on Ball Creek. ■ This is a 3-foot, round, precast concrete pipe that fills with fine sediment reducing the passage of fish. ■ This culvert also appears in this report as flooding problem BC-1.1.
BC1-C09	Driveway 105 R051217a	■ This is a culvert on Ball Creek. ■ This is a pair of 1.5-foot, round, smooth steel pipes that are corrugated steel tubes upstream.
none	Levee Road 105 R051220a	■ This is a culvert on an unnamed tributary. ■ Upper end of culvert is totally covered with sediment.
none	Levee Road 105 R051220b	■ This is a culvert on an unnamed tributary. ■ This culvert is buried in sediment.
BC2-C05	Driveway 105 R051721a	■ This is a culvert on Ball Creek. ■ This is a pair of 2-foot, round, corrugated steel pipes with sediment accumulating in both.

Table 5-4 (Continued)
Fish Passage Barriers in the Mid-Puyallup Basin

ID # [a]	Location (ID)	Description
VO1-C01	Riverside Drive E 105 R052622a	■ This is a culvert on Van Ogles Creek. ■ This is a 4-foot, round, precast concrete pipe with a utility pipe running along the bottom, which could hinder fish.
VO1-C06	Driveway 105 R052717a	■ This is a culvert on Van Ogles Creek. ■ This is a 3-foot, round, corrugated steel pipe that is fully submerged at both ends and rusting.
VO1-C04	Driveway 105 R052717b	■ This is a culvert on Van Ogles Creek. ■ This is a 4-foot, round, corrugated steel pipe that has boards across the downstream end to create a backwater for an irrigation intake.
none	Abandoned road 105 R062319a	■ This is a culvert on an unnamed tributary. This road is inside the levee setback project and is no longer in use. ■ This is a 1.5-foot, round, corrugated steel pipe that has rocks covering the downstream end.
none	Levee Road 105 R111822a	■ This is an outfall pipe from an unnamed wetland. ■ This is a 0.3-foot, round, precast concrete pipe outlets to a 7-foot cascade over rock.
none	80th Street E 105 S020323a	■ This is an outfall pipe from an unnamed tributary. ■ The specifics of this pipe are not recorded.
none	80th Street E 105 S020323b	■ This is an outfall pipe from an unnamed tributary. ■ The specifics of this pipe are not recorded.
none	105 R121519b	■ This is an outfall pipe from Wapato Creek. ■ The creek spills through riprap and enters a grated concrete intake. The creek is piped for nearly 0.5 miles to the outfall at the Puyallup River.

a – ID numbers were assigned only to culvert on main tributaries.
Source: Pierce County Conservation District 2000

6. FLOODING PROBLEMS

6.1 Modeling and Analysis

Computer modeling was used to identify flooding problems and fish barriers on Ball, Horsehaven, and Fennel creeks. Fennel Creek had an existing model that was created by others for Federal Emergency Management Agency (FEMA) floodplain mapping. Models for Ball and Horsehaven creeks were created for this Mid-Puyallup Basin Plan. These models were used to identify problems and formulate conceptual solutions. Problem descriptions, specific analysis used, and recommended conceptual solutions follow the modeling discussion. Specific capital improvement project (CIP) recommendations are presented in Chapter 9.

Computer modeling was determined to be unnecessary for Van Ogles Creek and Canyon Falls Creek because each creek has only one public culvert to consider for replacement. Van Ogles Creek has a series of private culverts, some of which are potential fish barriers that were analyzed with simpler methods. The culverts along Van Ogles and Canyon Falls creeks are included in this chapter for completeness. Chapter 8 of this Basin Plan provides a complete discussion of the analysis of these culverts.

6.1.1 Hydrologic Modeling

The hydrologic analysis for the Mid-Puyallup Basin was performed using the "Hydrologic Simulation Program–FORTRAN" (HSPF) model. This model was selected because it uses historical rainfall records to generate a long-term series of stormwater flows and is suitable for addressing issues related to the cumulative impacts of development on water resources. Using long-term modeling is particularly important in the Puget Sound region where flooding often is caused by a series of smaller storms that occur back-to-back rather than by a single event.

Developing the HSPF model involved delineating the subbasins, analyzing land use (both discussed in Chapter 4), preparing rainfall and other meteorological data, conducting hydraulic system analysis, and performing statistical analyses. Precipitation used in the HSPF model was a 158-year synthetic time series. The time series was developed to better estimate the magnitude of peak flows beyond the range of one individual station. Precipitation records from Vancouver, B.C.; Seattle, Washington; and Salem, Oregon, were linked into a single, 158-year record with 15-minute intervals.

The HSPF model computes the water balance every 15 minutes as runoff is routed through the stream channel system. To make sure that the amount and timing of simulated stream flow accurately represents actual stream conditions, the model was calibrated using recorded stream flow. The accuracy of the model is judged by comparing the model's simulated stream flow with the recorded stream flow.

The Mid-Puyallup HSPF model results were compared with the recorded stream flow at the Pierce County gauge on the main stem of Horsehaven Creek upstream of the culvert crossing

under 188th Street East. Recorded stream flow data for the period of December 2001 through January 2003 were used to evaluate the model's ability to accurately simulate Horsehaven Creek stream flow. The stream flow gauge contained two data gaps as well as a sinusoidal fluctuation in the data recordings. For calibration purposes, the data gaps were not simulated and the sinusoidal fluctuation was removed by assuming an average daily stream flow.

The simulated flows match the recorded flows well. A few simulated peak flows vary from the observed values. The differences are probably due to the special variability in precipitation between the Des Moines gauge site and the location of Horsehaven Creek. Base flows match well throughout the calibration period. A lag is apparent in the observed flows and the differences are likely due to attenuation in wetlands along the stream corridor.

Long-term (158-year) stream flow simulations were made for current and future land use conditions using the calibrated model. These long-term simulations were used to compute flood frequency and to evaluate potential stream flow problems in the watershed. *Table 6-1* shows the results of the flood frequency analysis for each stream reach.

6.1.2 Hydraulic Modeling

Ball Creek and Horsehaven Creek were modeled using the HEC-RAS model. The HEC-RAS model was selected to analyze these systems because it is a backwater model specifically designed to simulate the hydraulics of open-channel systems. As a result, it contains many options that are useful in the analysis of open channels that other programs do not include. For example, HEC-RAS has options for simulating flow through a wide variety of culvert types and also accounts for contraction, expansion, and energy losses through culverts better than many other programs. The HEC-RAS model developed for the reach of Horsehaven Creek extends from 162nd Avenue East to the confluence of the Puyallup River. The HEC-RAS model developed for the reach of Ball Creek extends from Military Road to the confluence of the Puyallup River.

Development of a HEC-RAS model requires flow data and geometric data such as surveyed cross-sections, in-stream and over bank n-values (Manning's coefficients), and information on each bridge, culvert, or other hydraulic structure in the study area. Cross-sections were developed from 2-foot contours that were provided by the County. Cross-sections were located along Ball and Horsehaven creeks where specific hydraulic and hydrologic data are needed, at representative areas of a channel reach, and where there may be significant changes in hydraulic and/or hydrologic characteristics over short distances, such as changes in geometry, slope, roughness, or discharge. Because of the limitations of 2-foot contours to define streams of this size, each cross-section was modified to include a thalweg from an assumed typical channel. The typical channel was developed using field observations and photographs of both Horsehaven and Ball creeks.

Table 6-1
HSPF Modeled Peak Flow Frequencies for Mid-Puyallup Basin

Subbasin Reach	Total Drainage (acres)	Peak Flow (cfs)														
		2-year			10-year			25-year			50-year			100-year		
		Existing	Future	%Increase	Existing	Future	% Increase	Existing	Future	% Increase	Existing	Future	% Increase	Existing	Future	% Increase
Ball Creek																
BC-2	48.9	10.0	10.6	6.6	12.8	16.0	25.1	15.5	21.0	35.2	18.3	26.2	43.0	22.0	33.1	50.8
BC-1	1155.3	9.4	10.3	9.0	12.4	15.6	26.3	15.1	20.6	35.9	17.9	25.6	43.4	21.4	32.3	51.0
Fennel Creek																
0-0.68 mi	8320.0	n/a	n/a	n/a	473.0	694.0	46.7	n/a	n/a	n/a	642.0	894.0	39.3	720.0	980.0	36.1
0.68-2.02 mi	8192.0	n/a	n/a	n/a	484.0	712.0	47.1	n/a	n/a	n/a	647.0	914.0	41.3	719.0	1000.0	39.1
2.02-3.78 mi	7808.0	n/a	n/a	n/a	476.0	701.0	47.3	n/a	n/a	n/a	630.0	893.0	41.7	698.0	975.0	39.7
3.78-5.41 mi	5120.0	n/a	n/a	n/a	340.0	431.0	26.8	n/a	n/a	n/a	459.0	565.0	23.1	512.0	624.0	21.9
5.41-HW mi	3264.0	n/a	n/a	n/a	247.0	323.0	30.8	n/a	n/a	n/a	322.0	404.0	25.5	353.0	437.0	23.8
Horsehaven **Creek**																
HH-1	508.3	18.4	57.3	211.2	25.6	90.8	255.0	34.3	110.7	222.2	38.9	126.9	225.8	43.8	144.3	229.6
*HH-2	188.2	97.9	161.3	64.8	141.3	188.1	33.1	163.1	194.8	19.4	179.4	198.2	10.5	195.8	200.8	2.6
HH-3	706.7	62.1	128.1	106.5	89.3	181.9	103.7	103.3	209.0	102.4	113.8	229.3	101.4	124.6	249.7	100.5
HH-6	1825.6	40.0	97.4	143.6	56.3	137.1	143.6	64.7	157.1	142.6	71.2	172.1	141.8	77.8	187.2	140.8
HH-4	453.4	44.0	45.8	4.3	65.7	68.8	4.7	78.2	82.0	4.8	88.3	92.5	4.8	99.0	103.7	4.8
HH-5b	302.3	48.1	50.5	5.1	70.6	74.3	5.3	83.0	87.4	5.4	92.7	97.7	5.4	102.9	108.5	5.5
HH-5a	1005.0	35.5	37.3	5.1	53.4	56.2	5.2	63.6	66.9	5.3	71.7	75.5	5.4	80.2	84.6	5.4
HH-5c	238.7	5.8	6.0	3.8	8.2	8.5	3.9	9.5	9.9	3.9	10.5	10.9	3.8	11.5	11.9	3.8
HH-7	1213.2	32.1	35.1	9.3	46.1	50.5	9.5	53.3	58.5	9.7	58.8	64.6	9.8	64.4	70.8	9.9

cfs = cubic feet per second

* lowest reach

There is a total of 11 culverts along Ball Creek and 14 along Horsehaven Creek. In some cases, such as privately owned culverts, information about the size and structure of the culvert was not available and therefore these culverts could not be included in the model. The models include eight culverts on Ball Creek and seven on Horsehaven Creek, which encompasses all major road culverts along these streams. Descriptions of these culverts are presented in *Table 6-2*, which shows information on each culvert on the Mid-Puyallup tributaries. *Figure 6-1, Tributary Culverts*, shows the locations of these culverts. Most of the data were provided by the Pierce Conservation District fish passage inventory. These data were entered into the HEC-RAS model to configure the geometric components of the channel. Culvert and roadway information was input into the HEC-RAS model for each major structure in the study reach. Culvert inlet and outlet conditions and channel roughness were checked during the subbasin reconnaissance.

After the initial setup of the HEC-RAS models, a flow range was input into the HEC-RAS model to develop FTABLEs for use in the HSPF model. FTABLEs are used by HSPF to describe the stage-area-storage-discharge relationship of any given drainage. Because HSPF does not do backwater calculations, the FTABLE values used for Ball and Horsehaven creeks were generated with additional information from:

- GIS data provided by Pierce County
- Culvert data provided by the Conservation District used in conjunction with HEC-RAS
- Manning's equation for channels and culverts

Results from the hydrologic analyses were then input into the HEC-RAS model to simulate water surface profiles and water velocities for the 2-, 10-, 25-, and 100-year events for existing and future land use conditions. These results are shown in *Table 6-3* and *Table 6-4*. A discussion of the flood frequencies of each modeled culvert may be found in Section 6.3.1 along with recommendations for replacements.

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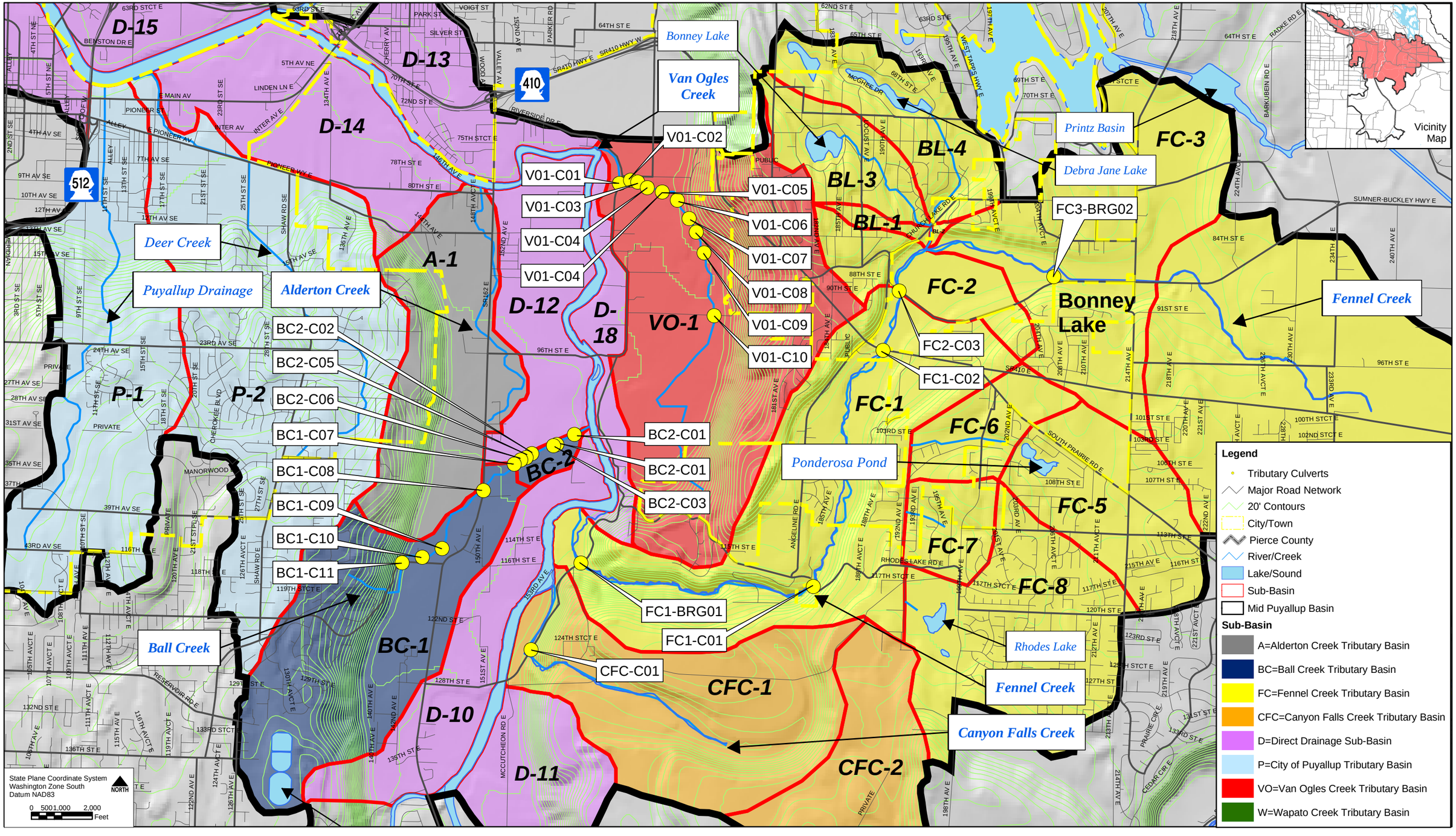

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Figure 6-1A: Tributary Culverts

Mid-Puyallup Basin Plan

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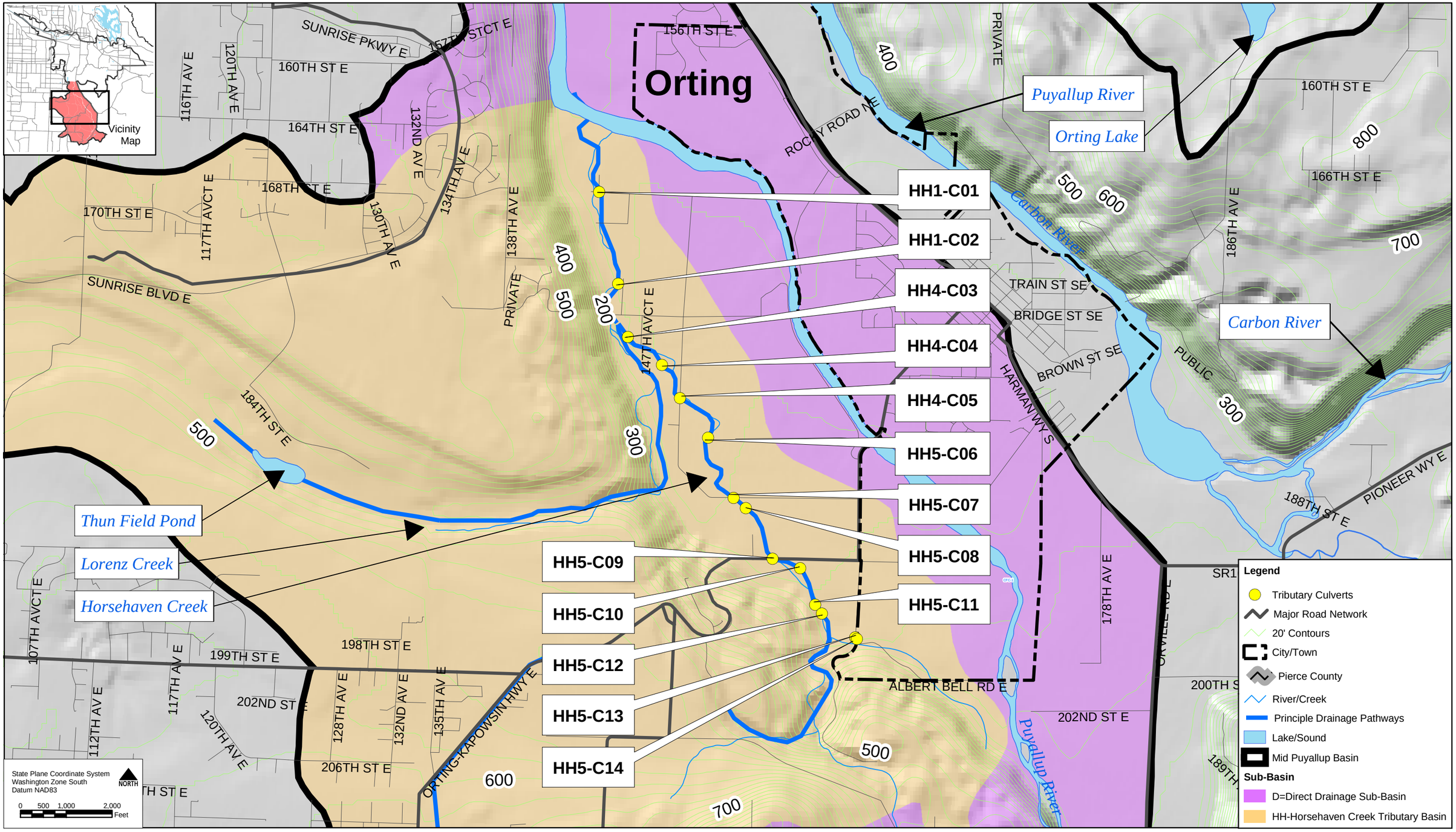

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Figure 6-1B: Tributary Culverts

Mid-Puyallup Basin Plan

PIERCE COUNTY

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For problem identification codes, see Section 6.2.1.

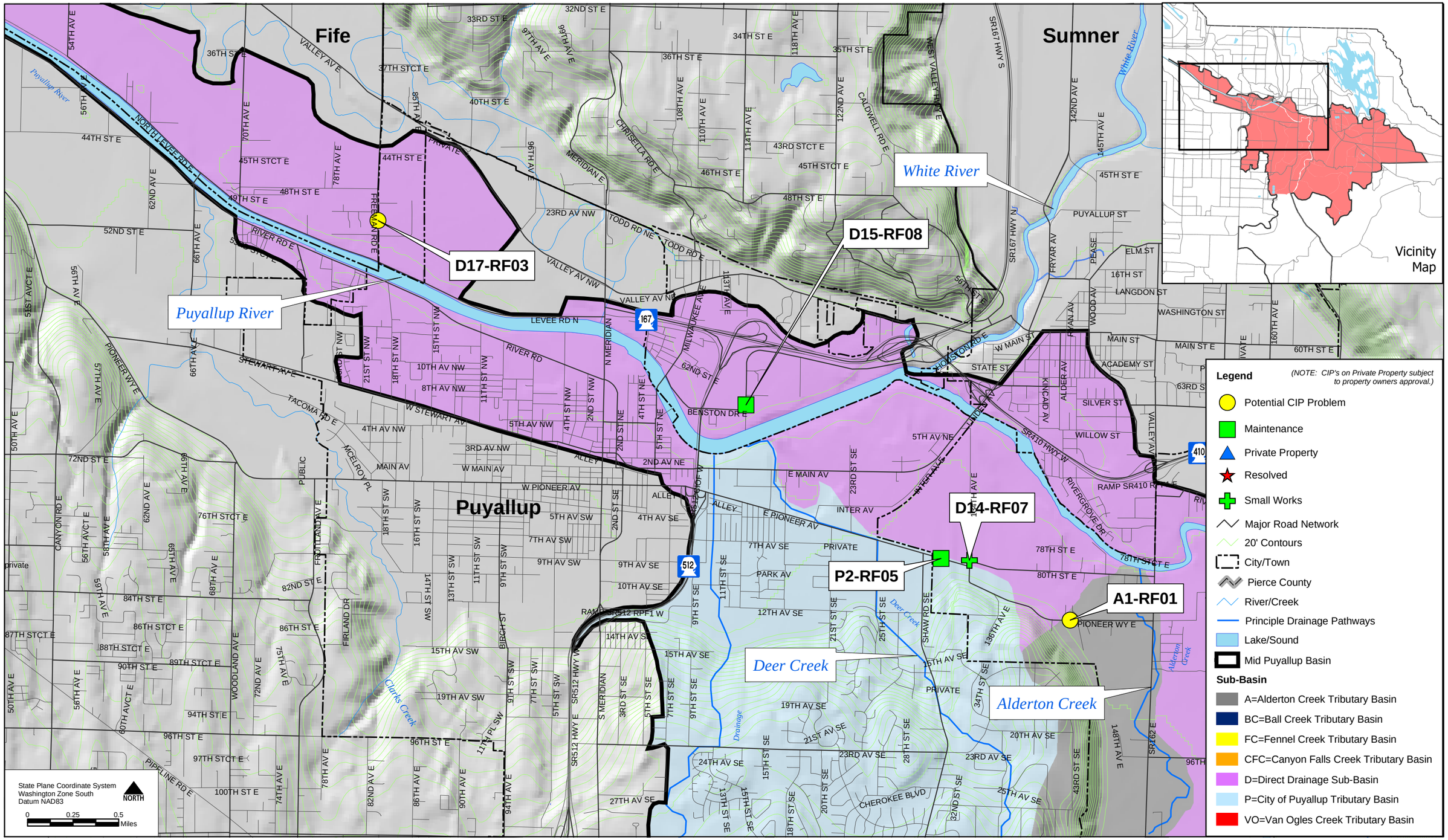

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Figure 6-2A: Drainage Investigation Sites

Mid-Puyallup Basin Plan

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For problem identification codes, see Section 6.2.1..

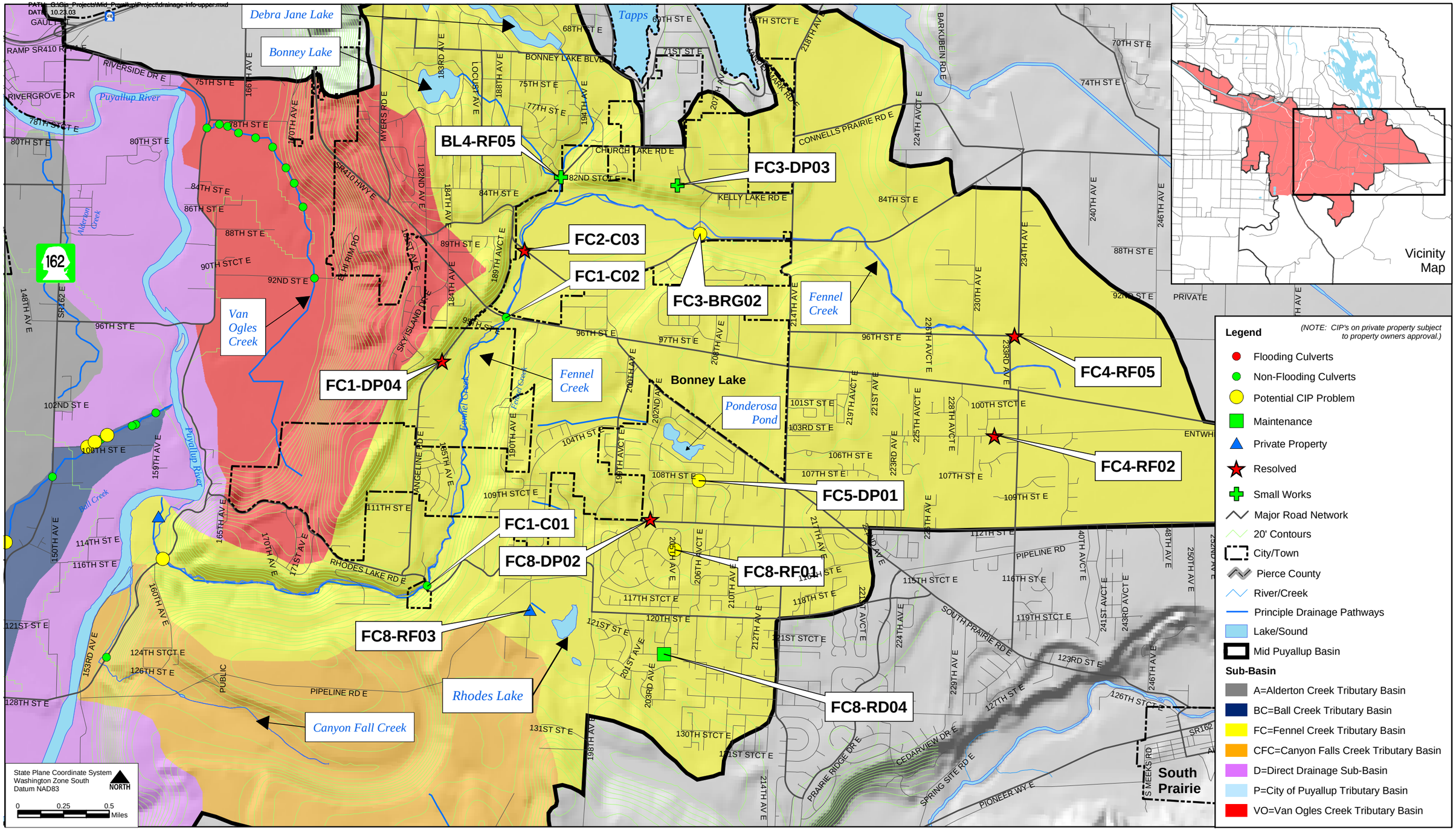

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Figure 6-2B: Drainage Investigation Sites

Mid-Puyallup Basin Plan

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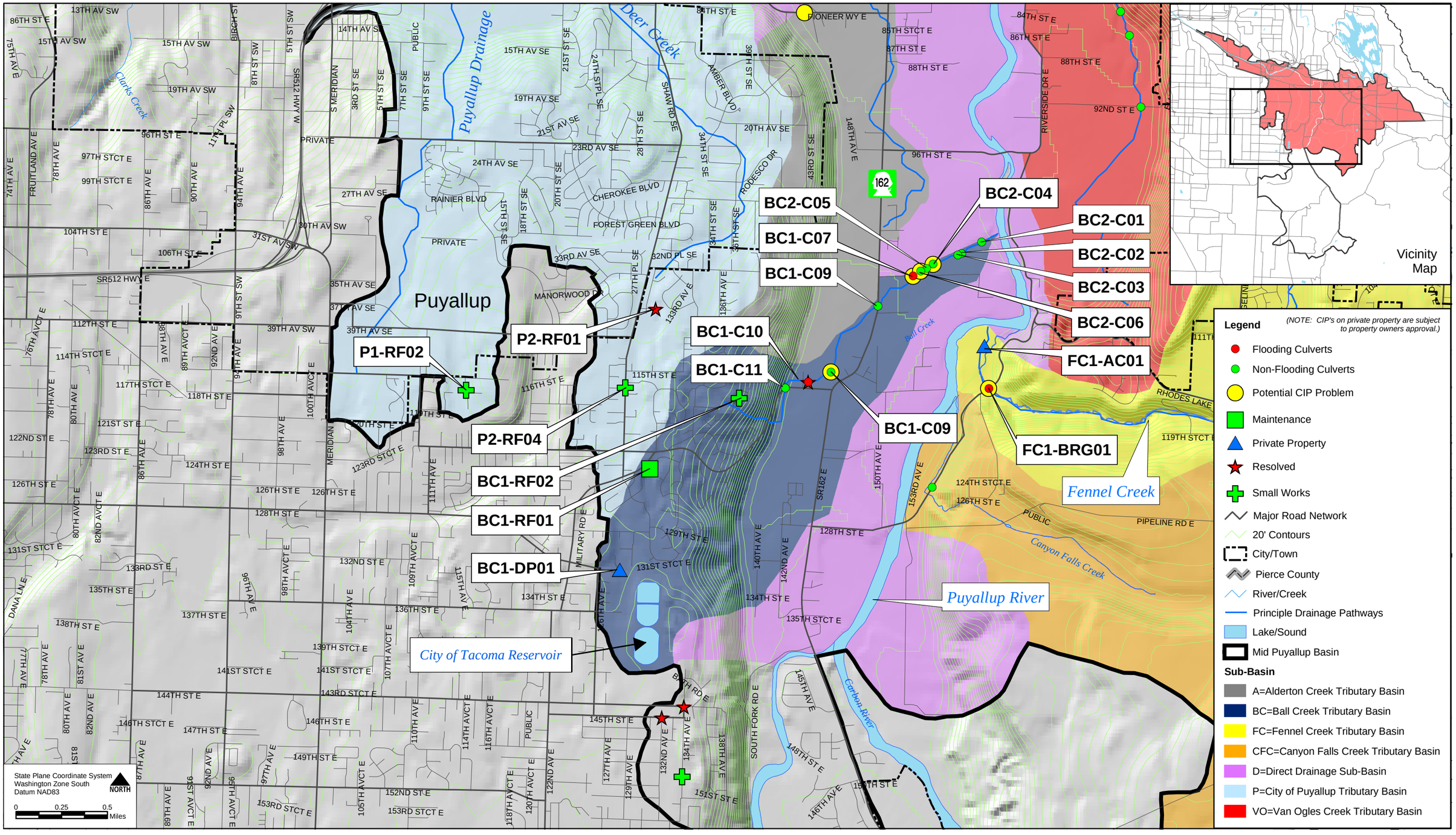

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Figure 6-2C: Drainage Investigation Sites

Mid-Puyallup Basin Plan

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For problem identification codes, see Section 6.2.1..

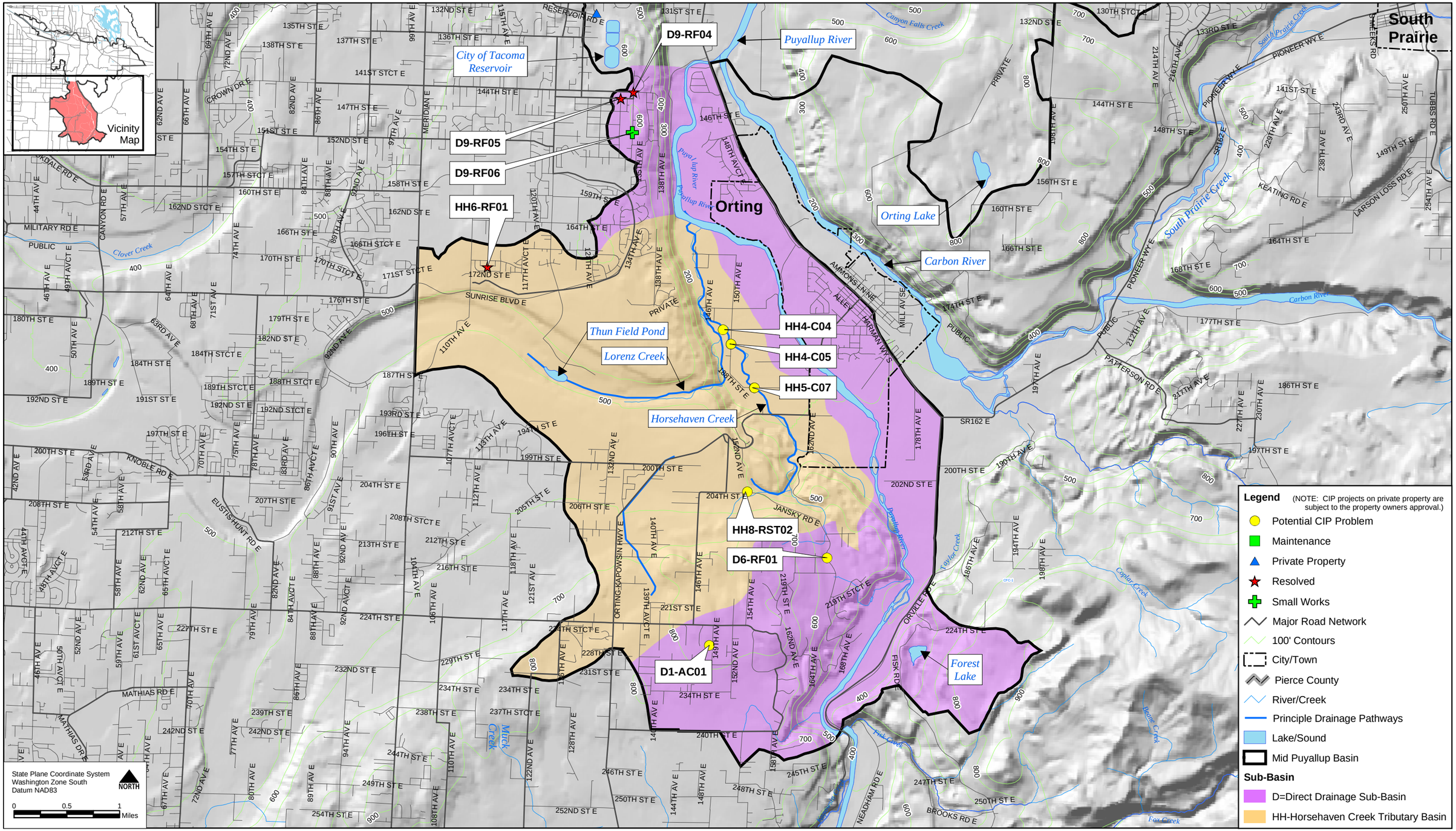

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Figure 6-2D: Drainage Investigation Sites

Mid-Puyallup Basin Plan

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Table 6-2
Culverts on Mid-Puyallup Tributaries

Culvert #	Conservation District Inventory #	Location	Ownership	Culvert Size	Notes[a]	Modeled
Ball Creek						
BC2-C01	n/a	Private road culvert (15725 106th Street E)	Private	n/a	Not Accessible	No
BC2-C02	n/a	Private road culvert (15725 106th Street E)	Private	n/a	Not Accessible	No
BC2-C03	n/a	Private road culvert (15725 106th Street E)	Private	n/a	Not Accessible	No
BC2-C04	R051720a	Footpath culvert (15507 106th Street E)	Private	24-inch dia, 16-foot long, PCC	Level B fish barrier [b]	Yes
BC2-C05	R051721a	Footpath culvert (15419 106th Street E)	Private	Twin 24-inch dia, 11-foot long, CMP	Fish barrier	Yes
BC2-C06	R051216b	Pond outlet culvert (15405 106th Street E)	Private	36-inch dia, 11-foot long, CMP	Not a fish barrier	Yes
BC1-C07	R051216c	106th Street E culvert	Public	36-inch dia, 31-foot long, PCC	Reported flooding, and fish barrier	Yes
BC1-C08	R051215a	Pioneer Way culvert	Public	18-inch dia, 58-foot long, CMP 24-inch dia, 59-foot long, CPC	Fish barrier	Yes
BC1-C09	R051217a	Access road (to Steel mfg) culvert	Public	Twin 18-inch, 38-foot long, CMP	Fish barrier	Yes
BC1-C10	R051218a	Private road culvert (14311 Military Road)	Private	36-inch dia, 39-foot long, CMP	Reported flooding, not a fish barrier	Yes
BC1-C11	R051216a	Military Road (west of SR 162) culvert	Public	42-inch dia, 63-foot long, PCC	Level B fish barrier [b]	Yes

Table 6-2 (Continued)
Culverts on Mid-Puyallup Tributaries

Culvert #	Conservation District Inventory #	Location	Ownership	Culvert Size	Notes[a]	Modeled
Horsehaven Creek						
HH1-C01	R050518a	168th Street E culvert	Public	Twin 42-inch dia, 20-foot long, PCC	Level B fish barrier [b]	Yes
HH1-C02	Not in inventory	Backyard access culvert (17310 146th Avenue E)	Private	Triple 24-inch dia, unknown length, PCC	Cows have access to the creek in this area.	No
HH4-C03	R051116a	Footpath culvert (14616 176th Street E)	Private	42-inch dia, 20-foot long, PCC	On Lorenz tributary	Yes
HH4-C04	R051115b	Private road culvert (17916 150th Avenue E)	Private	54-inch dia, 45-foot long, PCC 48-inch dia, 45-foot long, CMP	Level B barrier [b]	Yes
HH4-C05	R050517b	150th Avenue E culvert	Public	Twin 36-inch dia, 39-foot long, PCC	Fish barrier	Yes
HH4-C06	R051117a	Weir (18213 150th Avenue E)	Private	Broad crested weir	Level B barrier [b]	No
HH5-C07	R050517a	188th Street E culvert	Public	Twin 36-inch dia, 34-foot long, PCC	Reported Flooding	Yes
HH5-C08	n/a	Private road culvert (15418 188th Street E)	Private	36-inch dia, CMP	This private culvert was not assessed in the field	No
HH5-C09	R050516a	Orting-Kapowsin Hwy culvert	Public	5-foot span by 4-foot rise, 46-foot long CPC box	No flooding reports, not a fish barrier	Yes
HH5-C10	R051118a	Driveway culvert (19320 Orting-Kapowsin Hwy)	Private	36-inch dia, 38-foot long, PCC	Fish barrier	Yes
HH5-C11	R051118c	Driveway culvert (19318 Orting-Kapowsin Hwy)	Private	7-foot span by 5-foot rise, 19-foot long CMP arch	No flooding reports, not a fish barrier	No

Table 6-2 (Continued)
Culverts on Mid-Puyallup Tributaries

Culvert #	Conservation District Inventory #	Location	Ownership	Culvert Size	Notes[a]	Modeled
HH5-C12	R051118b	Driveway culvert (19318 Orting-Kapowsin Hwy)	Private	7-foot span by 5-foot rise, 18-foot long CMP arch	No flooding reports, not a fish barrier	No
HH5-C13	R050520a	Footpath culvert (19604 162nd Avenue E)	Private	24-inch dia, 48-foot long, PCC	Fish barrier	No
HH5-C14	R050520b	162nd Avenue E culvert	Public	24-inch dia, 21-foot long, HDPE	No flooding reports, not a fish barrier	No
Fennel Creek						
FC1-BRG01	Not in inventory	McCutcheon Road bridge	Public	Bridge; 25-foot open width by 2-foot high	Reported flooding, not a fish barrier	Yes
FC1-C01	Not in inventory	Rhodes Lake Road culvert	Public	8-foot span by 6-foot rise, 120-foot long CPC box	No reported flooding, no anadromous fish here	Yes
FC1-C02	Not in inventory	State Route 410 culvert	Public	Twin 6-foot span by 6-foot rise, 100-foot long CPC box	No reported flooding, no anadromous fish here	Yes
FC2-C03	Not in inventory	Old Sumner-Buckley Hwy culvert	Public	12-foot span by 7-foot rise, 50-foot long CMP arch	No reported flooding, no anadromous fish here	Yes
FC3-BRG02	Not in inventory	Kelly Lake Road bridge	Public	Bridge; 12-foot open width by 4-foot high	No reported flooding, no anadromous fish here	Yes
Canyon Falls Creek						
CFC1-C01	R031716a	McCutcheon Road culvert	Public	36-inch dia, 64-foot long, PCC	Level B barrier [b]	No

Table 6-2 (Continued)
Culverts on Mid-Puyallup Tributaries

Culvert #	Conservation District Inventory #	Location	Ownership	Culvert Size	Notes[a]	Modeled
Van Ogles Creek						
VO1-C01	R052622a	Riverside Drive culvert	Public	48-inch dia, 50-foot long, PCC	No reported flooding, fish barrier	No
VO1-C02	R052622b	Private driveway culvert (16402 78th Street E)	Private	4-foot span by 3-foot rise, 53-foot long CPC box	Level B barrier [b]	No
VO1-C03	R052716a	Private driveway culvert (16406 78th Street E)	Private	5-foot span by 4-foot rise, 32-foot long PCC box	Not a fish barrier	No
VO1-C04	R052717b	Private driveway culvert (16406 78th Street E)	Private	48-inch dia, 17-foot long, CMP	Fish barrier	No
VO1-C05	R052716b	Private road culvert (16406 78th Street E)	Private	48-inch dia, 19-foot long, CMP	Level B barrier [b]	No
VO1-C06	R052717a	Private road culvert (16406 78th Street E)	Private	36-inch dia, 21-foot long, CMP	Fish barrier	No
VO1-C07	n/a	Private road culvert (Near Elhi Road)	Private	n/a	This private culvert was not assessed in the field	No
VO1-C08	n/a	Private driveway culvert (8321 170th Avenue E)	Private	n/a	This private culvert was not assessed in the field	No
VO1-C09	n/a	Private road culvert (16819 92nd Street E)	Private	n/a	This private culvert was not assessed in the field	No
VO1-C10	n/a	92nd Street E culvert	Public	n/a	This private culvert was not assessed in the field	No

Source: Pierce County Conservation District Culvert Inventory, Pierce County GIS data, and existing HSPF models.

[a] Discussion of culvert replacements for fish passage purposes can be found in Chapter 8 of this Basin Plan.

[b] Level B culverts are those that need hydraulic analysis to determine if they are a fish barrier.

Table 6-3A
Water Surface Elevations from HEC-RAS Models for Existing Conditions and Future Land Use with Proposed Culverts

Culvert ID/ Location	Roadway Elevation[a]	2-year Water Surface Elevation		10-year Water Surface Elevation		25-year Water Surface Elevation		50-year Water Surface Elevation		100-year Water Surface Elevation		Flood Frequency	
		Existing	Future	Existing	Future	Existing	Future	Existing	Future	Existing	Future	Existing	Future
BC2-C04	96.0	95.1	93.8	95.5	94.1	95.8	94.3	96.0	94.5	96.1	94.7	50-year	>100-year
BC2-C05	96.9	95.5	95.5	95.7	95.9	96.0	96.2	96.3	96.5	96.5	96.9	>100-year	>100-year
BC2-C06	98.5	98.2	97.3	98.4	97.5	98.5	97.7	98.5	97.9	98.5	98.1	25-year	>100-year
BC1-C07	100.0	99.4	98.8	99.7	99.1	100.0	99.2	100.0	99.4	100.0	99.4	25-year	>100-year
BC1-C08	105.5	103.9	102.9	104.2	103.4	104.4	103.8	104.6	104.4	104.8	105.2	>100-year	>100-year
BC1-C09	112.0	112.0	110.9	112.0	112.0	112.0	111.1	112.0	111.3	112.0	111.5	10-year	>100-year
BC1-C10	113.8	112.1	111.9	112.3	112.3	112.4	112.7	112.5	112.9	112.7	113.2	>100-year	>100-year
BC1-C11	118.3	114.3	114.3	114.5	114.7	114.7	115.0	114.9	115.3	115.1	115.7	>100-year	>100-year
FC1-BRG01	103.69 (107)	n/a	n/a	104.5	n/a	n/a	n/a	104.8	n/a	104.9	106.5	10-year	>100-year
FC1-C01	402.3	n/a	n/a	385.6	n/a	n/a	n/a	388.4	n/a	389.9	397.4	>100-year	>100-year
FC1-C02	496.0	n/a	n/a	468.8	n/a	n/a	n/a	469.4	n/a	469.6	470.2	>100-year	>100-year
FC2-C03	480.7	n/a	n/a	478.1	n/a	n/a	n/a	479.2	n/a	479.8	481.3	>100-year	100-year
FC3-BRG02	500.26 (502)	n/a	n/a	500.8	n/a	n/a	n/a	501.4	n/a	501.6	502.0	10-year	100-year
HH1-C01	154.5	150.8	150.9	151.3	151.4	151.6	151.7	151.8	152.0	152.1	152.2	>100-year	>100-year
HH4-C03	163.3	163.1	162.0	163.4	162.3	163.4	162.5	163.5	162.6	163.5	162.7	10-year	>100-year
HH4-C04	168.3	166.7	165.9	167.4	166.4	167.8	166.6	168.1	166.8	168.4	167.0	>100-year	>100-year
HH4-C05	171.0	169.7	169.7	170.4	170.5	170.8	170.9	171.0	171.0	171.1	171.1	50-year	100-year
HH5-C07	185.5	184.8	184.1	185.5	184.6	185.6	184.9	185.6	185.1	185.6	185.3	10-year	>100-year
HH5-C09	196.0	192.4	192.5	193.0	193.1	193.3	193.3	193.5	193.6	193.6	193.8	>100-year	>100-year
HH5-C10	198.0	197.5	195.3	198.4	195.8	198.6	196.1	198.7	196.2	198.7	196.4	>100-year	>100-year

Table 6-3B
Water Surface Elevations from HEC-RAS Models for Existing Conditions and Future Land Use with Proposed Culverts

Culvert ID/ Location	Roadway Elevation[a]	Flood Frequency		Culvert Sizes	
		Existing	Future	Existing	Future
BC2-C04	96	50-year	>100-year	24-inch dia, 16-foot long, PCC	12-foot span by 5-foot rise, 16 feet long box culvert
BC2-C05	96.9	>100-year	>100-year	Twin 24-inch dia, 11-foot long, CMP	pedestrian bridge
BC2-C06	98.5	25-year	>100-year	36-inch dia, 11-foot long, CMP	12-foot span by 5-foot rise, 11 feet long box culvert
BC1-C07	100	25-year	>100-year	36-inch dia, 31-foot long, PCC	12-foot span by 5-foot rise, 31 feet long box culvert
BC1-C08	105.5	>100-year	>100-year	18-inch dia, 58-foot long, CMP 24-inch dia, 59-foot long, CPC	12-foot span by 5-foot rise, 60 feet long box culvert
BC1-C09	112	10-year	>100-year	Twin 18-inch, 38-foot long, CMP	12-foot span by 5-foot rise, 38 feet long box
BC1-C10	113.8	>100-year	>100-year	36-inch dia, 39-foot long, CMP	12-foot span by 5-foot rise, 20 feet long box culvert
BC1-C11	118.3	>100-year	>100-year	42-inch dia, 63-foot long, PCC	12-foot span by 5-foot rise, 63 feet long box culvert
FC1-BRG01	103.69 (107)	10-year	>100-year	Bridge; 25-foot open width by 2-foot high	Raise roadway 2 feet, and bridge low chord 1 foot, install high-flow conveyance along side the bridge
FC1-C01	402.3	>100-year	>100-year	8-foot span by 6-foot rise, 120-foot long CPC box	n/a
FC1-C02	496	>100-year	>100-year	Twin 6-foot span by 6-foot rise, 100-foot long CPC	n/a
FC2-C03	480.7	>100-year	100-year	12-foot span by 7-foot rise, 50-foot long CMP arch	n/a

Table 6-3B-CONTINUED
Water Surface Elevations from HEC-RAS Models for Existing Conditions and Future Land Use with Proposed Culverts

Culvert ID/ Location	Roadway Elevation[a]	Flood Frequency		Culvert Sizes	
		Existing	Future	Existing	Future
FC3-BRG02	500.26 (502)	10-year	100-year	Bridge; 12-foot open width by 4-foot high	raise road 2 feet and widen bridge opening 8-feet
HH1-C01	154.5	>100-year	>100-year	Twin 42-inch dia, 20-foot long, PCC	12-foot span by 5-foot rise, 20 feet long box culvert
HH4-C03	163.3	10-year	>100-year	42-inch dia, 20-foot long, PCC	12-foot span by 3.5-foot rise, 20 feet long box culvert
HH4-C04	168.3	>100-year	>100-year	54-inch dia, 45-foot long, PCC 48-inch dia, 45-foot long, CMP	12-foot span by 3.5-foot rise, 45 feet long box culvert
HH4-C05	171	50-year	100-year	Twin 36-inch dia, 39-foot long, PCC	6-foot dia CMP with low flow baffles, 39 feet long
HH5-C07	185.5	10-year	>100-year	Twin 36-inch dia, 34-foot long, PCC	12-foot span by 5-foot rise, 34 feet long box culvert
HH5-C09	196	>100-year	>100-year	5-foot span by 4-foot rise, 46-foot long CPC box	12-foot span by 4-foot rise, 46 feel long box culvert
HH5-C10	198	>100-year	>100-year	36-inch dia, 38-foot long, PCC	8-foot span by 4-foot rise, 38 feet long box culvert

Table 6-4
Water Velocities from HEC-RAS Models for Existing Conditions and Future Land Use

Culvert ID/ Location	2-year Flow Velocity (ft/sec)		10-year Flow Velocity (ft/sec)		25-year Flow Velocity (ft/sec)		50-year Flow Velocity (ft/sec)		100-year Flow Velocity (ft/sec)	
	Existing	Future	Existing	Future	Existing	Future	Existing	Future	Existing	Future
BC2-C04	3.6	1.2	3.8	1.4	4.0	1.5	4.1	1.6	4.3	1.9
BC2-C05	1.4	4.3	1.2	4.8	1.1	5.2	1.0	5.5	0.8	5.8
BC2-C06	1.3	3.1	1.4	3.5	2.5	3.8	3.0	4.1	2.3	4.4
BC1-C07	0.4	0.5	0.3	0.6	0.3	0.7	0.4	0.8	0.4	1.0
BC1-C08	0.9	3.9	1.0	4.3	1.0	4.6	1.1	3.3	1.2	3.6
BC1-C09	0.8	0.8	0.8	0.0	0.9	3.4	0.9	3.7	0.9	3.9
BC1-C10	0.5	1.9	0.6	2.5	0.7	2.1	0.7	2.7	0.8	4.1
BC1-C11	2.7	1.8	3.1	2.3	3.4	2.8	3.7	3.2	4.0	3.6
FC1-BRG01	n/a	n/a	3.6	n/a	n/a	n/a	3.2	n/a	3.3	1.4
FC1-C01	n/a	n/a	8.3	n/a	n/a	n/a	8.0	n/a	7.7	6.4
FC1-C02	n/a	n/a	9.5	n/a	n/a	n/a	10.5	n/a	10.9	11.7
FC2-C03	n/a	n/a	5.2	n/a	n/a	n/a	5.8	n/a	6.0	1.1
FC3-BRG02	n/a	n/a	0.4	n/a	n/a	n/a	0.4	n/a	0.4	0.4
HH1-C01	2.0	2.1	2.4	2.5	2.6	2.6	2.7	2.7	2.8	2.9
HH4-C03	2.2	1.9	0.4	2.5	0.5	2.7	0.5	2.9	0.5	3.1
HH4-C04	1.3	1.9	1.5	2.3	1.6	2.5	1.7	2.6	0.4	2.7
HH4-C05	1.9	1.9	2.1	2.1	2.2	2.2	1.6	1.7	1.8	1.8
HH5-C07	1.7	2.5	0.6	2.8	0.7	3.0	0.7	3.1	0.8	3.2
HH5-C09	3.0	3.1	3.7	3.8	4.0	4.1	4.2	4.3	4.4	4.5
HH5-C10	2.1	2.6	2.4	3.0	2.8	3.2	3.0	3.3	3.3	3.5

6.2 Flood and Drainage Problems within the Basin

The Mid-Puyallup Basin has been primarily an agricultural area for the last century. In recent years, the Basin has begun to see rapid changes toward residential development. Several areas of the Basin have closed depressions, and development in these poorly drained areas has increased the number of flooding issues in the Basin. This chapter discusses these flooding problems and others along with suggested conceptual solutions for resolving them. None of the flooding problems identified in the Mid-Puyallup Basin impact critical facilities that serve the Basin.

To develop solutions, the 31 flooding problems identified in "Phase 1" of the Mid-Puyallup Basin Plan were divided into four categories:

- Problems requiring CIPs and other projects that will require significant effort
- Problems that can be addressed by small works projects (estimated cost of up to $25,000)
- Problems on private property (and therefore not the responsibility of Pierce County)
- Problems that are believed to be resolved and require no further action

Table 6-5 lists problems that have been resolved or were found to occur on private property. *Figure 6-2, Drainage Investigation Sites*, shows the drainage investigation sites for the Mid-Puyallup Basin. The remaining sections of this chapter focus on recommended CIP projects and small works projects.

6.2.1 Problem Identification Codes

Each problem was assigned a problem identification code. These codes consist of a series of codes that describe the type of problem. For example BC2-RST01 is a problem in subbasin BC2, it is a restoration problem (RST) and it is the first (01) of this problem type in this tributary basin.

Subbasin	Project Type	Project Order Number
BC2	RST	01

Subbasin: The reach or subbasin identified within the Basin Plan.

Project Type: General category that best fits the project activities. They include:

AC	Acquisition	IP	Infiltration Pond
C	Culvert	RST	Restoration
DP	Detention Pond	BRG	Bridge
RF	Road Flooding	REG	Regulatory
ST	Study	RP	Regional Pond
WL	Wetland	ENF	Enforcement
EDU	Education	RP	Retention Pond
RD	Raised Road	WQ	Water Quality

Table 6-5
Resolved Flooding Problems and Problems on Private Property

Resolved Problems	BC1-C10	Hydraulic modeling shows no flooding at this site.
	FC4-RF02	Flooding along Entwhistle Road – resolved by improving the conveyance system with ditches and catch basins.
	FC8-DP02	Pond overtopping at 112th St E and 203rd Ave E – resolved by completion of upstream pond.
	D9-RF04	14400 Block of 134th Ave E – resolved by increasing the storage volume of nearby pond.
	D9-RF05	Poor drainage near 145th Ave E – resolved by an underground infiltration gallery.
	P2-RF01	Brighton Park Development – the pooling of water in this cul-de-sac is by design.
Private Property Issues	BC2-C04	15507 106th Street E – Ball Creek culvert floods at a 50-year event.
	BC2-C06	15405 106th Street E – Ball Creek culvert floods at a 25-year event.
	BC1-DP01	13121 127th Ave Ct E – Decorative pond overtops.
	FC1-AC01	11122 McCutcheon Road – Property flooding, the County would consider buying the property if the owner consents and funding is available.
	FC8-RF03	11818 193rd Avenue E – Private road floods but no property damage occurs.
	HH4-C03	14616 176th Street E – Horsehaven culvert floods at a 10-year event.
	HH4-C04	17916 150th Avenue E – Horsehaven culvert floods at a 100-year event.

6.3 Flooding Problems and Conceptual Solutions

The following drainage problems require capital improvement projects (CIPs) or some other significant effort to be resolved. Each problem is described briefly in Section 6.3.1 through Section 6.3.14 along with a summary of the analytical approach and recommended conceptual solution. Low Impact Development (LID) techniques are suggested at many of the sites that could accommodate this approach. LID is a recommended programmatic approach to reducing development impacts on hydrology and thereby reducing flooding. Chapter 9 discusses LID techniques.

Fish passable culverts designed as specified in the 1999 Washington State Department of Fish and Wildlife (WDFW) Fish Passage Design at Road Culverts Manual typically exceed the capacity necessary for flood flows. Therefore, to design the appropriate culvert replacements, we first used the WDFW fish passage criteria and then ensured adequate flow capacity with available models or other computational methods. All culvert replacements in streams that support fish will need to comply with fish passage and habitat restoration requirements.

6.3.1 Culvert Flooding as Shown in Hydraulic Modeling

Problem Description

Some culverts along the Basin tributaries were reported by residents for flooding problems, other culverts are known to be fish barriers (see Chapter 8 for a full discussion of fish barriers and habitat problems). To determine which culverts posed flooding problems within the Basin, hydrologic and hydraulic models were developed for Ball Creek and Horsehaven Creek to determine flood frequencies for the culverts on these creeks. A model developed by others for FEMA flood mapping was used to determine flood frequencies for the Fennel Creek culverts.

Analytical Approach

Flood frequencies for the culverts on Ball, Horsehaven, and Fennel creeks were determined using a HEC-RAS hydraulic model with input from an HSPF hydrologic model as discussed in Section 6.1. Sizes for replacement culverts were determined with the stream simulation method described in the WDFW Fish Passage Design at Road Crossings Manual. This method uses channel width as the primary factor in determining culvert size. Since both Ball Creek and Horsehaven Creek are relatively short streams, it was assumed that there is little change in width downstream to upstream along the channel. Therefore, a single mean channel width was used for the entire length of each stream. A 9-foot width was used for Horsehaven Creek and an 8-foot width for Ball Creek, which both result in a standard culvert width of 12 feet for all crossings.

Conceptual Solution

Culverts that show flooding only at events greater than the 100-year event do not need to be replaced (see *Table 6-6* for flood frequencies). Several of the culverts flood at intervals less than 100 years and proposals for CIP replacements are described in Chapter 9. Culverts that should be replaced on the basis of fish passage are discussed in Chapter 8 with CIP recommendations provided in Chapter 9.

Only culverts on public property that flood at the 100-year return interval or less are proposed for replacement. Some culverts on private property have been included in the models for accuracy. Some private property culverts are recommended for replacement if they impact fish passage downstream of public culverts that are to be replaced. An example of this is on Ball Creek where there are several privately owned culverts below 106th Street East that would block fish passage to this culvert project. In these cases, culvert replacements on private properties will be referred to the Conservation District for implementation. Private culverts in this category are identified in *Table 6-6*.

Box culverts are recommended for all replacements so that every culvert will be fish passable. The limited height between the streambed elevation and the surface of the roadway or crossing, in most cases, make box culverts the only option for providing enough width to accommodate fish. Therefore box culverts are recommended, which will provide adequate width for fish passage yet will not elevate the ground surface above the culvert.

Table 6-6 summarizes analytical results for all culverts and the recommended solutions. All culverts are listed in this table for completeness, with discussions of the fish barrier culverts presented in Chapter 8.

6.3.2 Neighborhood Flooding along Pioneer Way (A1-RF01)

Problem Description

Water ponds at the side of the road along Pioneer Way from 142nd Avenue Court East to the BNSF railroad crossing but does not go over the roadway. There are no roadside ditches at this location. Runoff pools in low spots and infiltrates. This is a potential site for using LID techniques since relatively minor ponding currently infiltrates.

Analytical Approach

The Pierce County drainage inventory was used to locate existing drainage pathways. Field visits were made to evaluate options on site.

Table 6-6
Recommended Replacements for Tributary Culverts

Culvert #	Location	Ownership	Existing Culvert Size	Flood Frequency	Recommended Replacement	CIP #
Ball Creek						
BC2-C01	Private road culvert (15725 106th Street E)	Private	Not accessible	N/A	Fish-passable replacement: 48-inch dia, CMP	CIP-23-BC2-C01.06
BC2-C02	Private road culvert (15725 106th Street E)	Private	Not accessible	N/A	Fish-passable replacement: 48-inch dia, CMP	CIP-23-BC2-C01.06
BC2-C03	Private road culvert (15725 106th Street E)	Private	Not accessible	N/A	Fish-passable replacement: 48-inch dia, CMP	CIP-23-BC2-C01.06
BC2-C04	Footpath culvert (15507 106th Street E)	Private	24-inch dia, 16-foot long, PCC	50-year	Flooding replacement: 12-foot span by 5-foot rise, 16 feet long box culvert	CIP-23-BC2-C01.06
BC2-C05	Footpath culvert (15419 106th Street E)	Private	Twin 24-inch dia, 11-foot long, CMP	> 100-year	Fish-passable replacement: pedestrian bridge	CIP-23-BC2-C01.06
BC2-C06	Pond outlet culvert (15405 106th Street E)	Private	36-inch dia, 11-foot long, CMP	25-year	Flooding replacement: 12-foot span by 5-foot rise, 11 feet long box culvert	CIP-23-BC2-C01.06
BC1-C07	106th Street E culvert	Public	36-inch dia, 31-foot long, PCC	25-year	Flooding replacement: 12-foot span by 5-foot rise, 31 feet long box culvert	CIP-23-BC1-C07
BC1-C08	Pioneer Way culvert	Public	18-inch dia, 58-foot long, CMP 24-inch dia, 59-foot long, CPC	> 100-year	Fish-passable replacement: 12-foot span by 5-foot rise, 60 feet long box culvert	CIP-23-BC1-C08
BC1-C09	Access road (to Steel mpg) culvert	Public	Twin 18-inch, 38-foot long, CMP	10-year	Flooding Replacement: 12-foot span by 5-foot rise, 38 feet long box culvert	CIP-23-BC1-C09

Table 6-6 (Continued)
Culverts on Modeled Tributaries

Culvert #	Location	Ownership	Existing Culvert Size	Flood Frequency	Recommended Replacement	CIP #
BC1-C10	Private road culvert (14311 Military Road)	Private	36-inch dia, 39-foot long, CMP	> 100-year	No action	No CIP
BC1-C11	Military Road (west of SR 162) culvert	Public	42-inch dia, 63-foot long, PCC	> 100-year	Fish-passable Replacement: 12-foot span by 5-foot rise, 63 feet long box culvert	CIP-23-BC1-C11
Horsehaven Creek						
HH1-C01	168th Street E culvert	Public	Twin 42-inch dia, 20-foot long, PCC	> 100-year	No action	No CIP
HH1-C02	Backyard access culvert (17310 146th Avenue E)	Private	Triple 24-inch dia, unknown length, PCC	N/A	No action	No CIP
HH4-C03	Footpath culvert (14616 176th Street E)	Private	42-inch dia, 20-foot long, PCC	10-year	No action	No CIP
HH4-C04	Private road culvert (17916 150th Avenue E)	Private	54-inch dia, 45-foot long, PCC 48-inch dia, 45-foot long, CMP	100-year	Fish barrier. Will be referred to PCCD for implementation	No CIP
HH4-C05	150th Avenue E culvert	Public	Twin 36-inch dia, 39-foot long, PCC	50-year	Flooding Replacement: 6-foot dia CMP with low flow baffles, 39 feet long	CIP-23-HH4-CUL05
HH4-C06	Weir (18213 150th Avenue E)	Private	Broad crested weir	N/A	Fish Barrier. Will be referred to PCCD implementation	No CIP
HH5-C07	188th Street E culvert	Public	Twin 36-inch dia, 34-foot long, PCC	10-year	Flooding Replacement: 12-foot span by 5-foot rise, 34 feet long box culvert	CIP-23-HH5-C07

Table 6-6 (Continued)
Culverts on Modeled Tributaries

Culvert #	Location	Ownership	Existing Culvert Size	Flood Frequency	Recommended Replacement	CIP #
HH5-C08	Private road culvert (15418 188th Street E)	Private	3-foot dia, CMP	N/A	Will be referred to PCCD for determination and implementation	No CIP
HH5-C09	Orting-Kapowsin Hwy culvert	Public	5-foot span by 4-foot rise, 46-foot long CPC box	> 100-year	No action	No CIP
HH5-C10	Driveway culvert (19320 Orting-Kapowsin Hwy)	Private	36-inch dia, 38-foot long, PCC	10-year	Fish barrier. Referred to PCCD for implementation.	No CIP
HH5-C11	Driveway culvert (19318 Orting-Kapowsin Hwy)	Private	7-foot span by 5-foot rise, 19-foot long CMP arch	N/A	No action	No CIP
HH5-C12	Driveway culvert (19318 Orting-Kapowsin Hwy)	Private	7-foot span by 5-foot rise, 18-foot long CMP arch	N/A	No action	No CIP
HH5-C13	Footpath culvert (19604 162nd Avenue E)	Private	24-inch dia, 48-foot long, PCC	N/A	Fish barrier. Referred to PCCD for implementation.	No CIP
HH5-C14	162nd Avenue E culvert	Public	24-inch dia, 21-foot long, HDPE	N/A	No action	No CIP
Fennel Creek						
FC1-BRG01	McCutcheon Road bridge	Public	Bridge; 25-foot open width by 2-foot high	10-year	Flooding replacement: Raise the roadway 2 feet, and bridge low chord 1 foot, install high-flow conveyance alongside the bridge	CIP-23-FC1-BRG01
FC1-C01	Rhodes Lake Road culvert	Public	8-foot span by 6-foot rise, 120-foot long CPC box	> 100-year	No action	No CIP

Table 6-6 (Continued)
Culverts on Modeled Tributaries

Culvert #	Location	Ownership	Existing Culvert Size	Flood Frequency	Recommended Replacement	CIP #
FC1-C02	State Route 410 culvert	Public	Twin 6-foot span by 6-foot rise, 100-foot long CPC box	> 100-year	No action	No CIP
FC2-C03	State Route 410 culvert	Public	12-foot span by 7-foot rise, 50-foot long CMP arch	100-year	No action	No CIP
FC3-BRG02	Old Sumner-Buckley Hwy culvert	Public	Bridge; 12-foot open width by 4-foot high	10-year	Flooding replacement: raise road 2 feet and widen bridge opening 8-feet	CIP-23-FC3-BRG02
Canyon Falls Creek						
CFC1-C01	McCutcheon Road culvert	Public	36-inch dia, 64-foot long, PCC	N/A	Fish-passable replacement: 12-foot span by 10-foot rise, 64 feet long box culvert	CIP-23-CFC1-C01
Van Ogles Creek						
VO1-C01	Riverside Drive culvert	Public	48-inch dia, 50-foot long, PCC	N/A	Fish-passable Replacement: 12-foot span by 10-foot rise, 50 feet long box culvert	CIP-23-VO1-C01
VO1-C02	Private driveway culvert (16402 78th Street E)	Private	4-foot span by 3-foot rise, 53-foot long CPC box	N/A	Does not need to be replaced	No CIP
VO1-C03	Private driveway culvert (16406 78th Street E)	Private	5-foot span by 4-foot rise, 32-foot long PCC box	N/A	Does not need to be replaced	No CIP
VO1-C04	Private driveway culvert (16406 78th Street E)	Private	48-inch dia, 17-foot long, CMP	N/A	Will be referred to PCCD for implementation	No CIP

Table 6-6 (Continued)
Culverts on Modeled Tributaries

Culvert #	Description	Ownership	Existing Culvert Size	Flood Frequency	Recommended Replacement	CIP #
VO1-C05	Private road culvert (16406 78th Street E)	Private	48-inch dia, 19-foot long, CMP	N/A	No action	No CIP
VO1-C06	Private road culvert (16406 78th Street E)	Private	36-inch dia, 21-foot long, CMP	N/A	Will be referred to PCCD for implementation	No CIP
VO1-C07	Private road culvert (Near Elhi Road)	Private	Not accessible	N/A	Will be referred to PCCD for determination and implementation	No CIP
VO1-C08	Private driveway culvert (8321 170th Avenue E)	Private	Not accessible	N/A	Will be referred to PCCD for determination and implementation	No CIP
VO1-C09	Private road culvert (16819 92nd Street E)	Private	Not accessible	N/A	Will be referred to PCCD for determination and implementation	No CIP
VO1-C10	92nd Street E culvert	Public	Not accessible	N/A	Will be referred to PCCD for determination and implementation	No CIP

Conceptual Solution

The low spots that hold water serve as depressional storage within the Basin. To maintain this benefit to the Basin, swales could be installed to contain runoff, which would infiltrate over time in the same manner as the low spots do currently. To reduce flooding during high flows, an overflow route could be constructed to direct flows east down Pioneer Way and then connect to an existing drainage path on the other side of the railroad tracks. This would require installing 12-inch culverts under driveways and under the railroad tracks.

Because this is a road related project, implementation of this project will need to be coordinated with Pierce County Public Works & Utilities/Transportation Services Division. The conceptual solution for this problem is presented in Chapter 9 as CIP-23-A1-RF01.

6.3.3 Ball Creek Crossing at 106th Street E (BC1-C07)

Problem Description

Roadway flooding occurs at the 36-inch precast concrete culvert (BC1-C07) under 106th Street East on Ball Creek. Hydraulic modeling indicates that the flood capacity at the culvert is exceeded at the 25-year event. Large amounts of sediment are present in this channel due to the agricultural nature of the Basin. The sediment deposits at the upstream end of the culvert have reduced capacity and fish passage for the coho salmon and cutthroat trout that are reported to spawn in Ball Creek. Also, erosion is occurring at a bend in the stream just upstream from the culvert. This erosion is cutting into private property on the right bank side of the creek.

Analytical Approach

This culvert is both a flooding and fish blockage problem. Culverts sized for fish passage typically exceed the necessary design capacity for flood flows. Therefore, the conceptual solution for this culvert uses the fish passage criteria for the stream simulation option presented in the WDFW Fish Passage Design at Road Crossings Manual. Average stream width was estimated to be 8-feet based on field observations. The model developed for Ball Creek was used to verify that this culvert is adequate for carrying flood flows.

Conceptual Solution

The existing culvert should be replaced with a 12-foot-wide culvert for fish passage. A circular culvert of this size, counter sunk to 50 percent (50%), would increase the elevation of the roadway over the culvert by about 4-feet. Therefore, we recommend a 12-foot by 5-foot box culvert that is 31-feet long, counter sunk and filled with 3-feet of streambed gravel so that there is at least a 2-foot opening above the bed. This would allow the road elevation to remain consistent and still provide the needed width. The conceptual solution for this problem is presented in Chapter 9 as CIP-23-BC1-C07.

The eroded bank upstream of the culvert should be restored to reestablish the mean channel width at this location. This will help reduce the amount of sediment that accumulates in this area. The bank on the outside of the bend should be reinforced with a combination of rock and large wood with flow deflectors to further protect the bank from high velocity flows in a manner consistent with WDFW's Integrated Streambank Protection Guidelines (2003). Identifying and controlling upstream sediment sources would also reduce the influx of sediment to the stream, which would slow the accumulation of sediment within the channel.

Downstream conditions for both flooding and fish passage should be addressed either before or in conjunction with replacing the 106th Street East culvert. Increasing the capacity of this culvert will increase flow in the downstream reaches during large events. Six culverts on private land below 106th Street East will be affected by this replacement. This Basin Plan recommends replacing several of these culverts to address either for fish passage or flooding problems or both. Culverts that are not replaced either before or in conjunction with replacing the 106th Street East culvert may see increased flooding.

Designing the 106th Street East culvert for fish passage is only beneficial if there is accessibility to the culvert throughout the lower stream reach. Some of the downstream culverts are known to be barriers to fish and are recommended for replacement in this Basin Plan. Three culverts near the mouth of the creek are inaccessible because they are on private property and therefore have not been evaluated for fish passage. These culverts are discussed in more detail in Chapter 8 and will also need to be addressed in connection with the 106th Street East culvert replacement.

6.3.4 Ball Creek Crossing at Pioneer Way (BC1-C08)

Problem Description

This culvert (comprised of two pipes) sits under the railroad on the west side of Pioneer Way. The twin 2-foot CMPs are 38-feet long and are impassable to fish because the slope exceeds one percent. Ball Creek modeling indicates that flooding occurs at this culvert at less than a 10-year storm.

Analytical Approach

This culvert is both a flooding and fish blockage problem. Culverts sized for fish passage typically exceed the necessary design capacity for flood flows. Therefore, the conceptual solution for this culvert uses the fish passage criteria for the stream simulation option presented in the WDFW Fish Passage Design at Road Crossings Manual. Average stream width was estimated to be 8-feet based on field observations. The model developed for Ball Creek was used to verify that this culvert is adequate for carrying flood flows.

Conceptual Solution

It is recommended that this culvert be replaced with a 12-foot by 5-foot box culvert, 40-feet long, that is counter sunk along the gradient of the stream.

6.3.5 McCutcheon Road Flooding at Fennel Creek (FC1-BRG01)

Problem Description

Based on output from a HEC-RAS model developed by others for FEMA floodplain mapping, McCutcheon Road floods during the 10-year event where it crosses Fennel Creek. This crossing is a small bridge. The road runs along the slope break between the steep valley wall and the flat valley bottom. Sediment moving down the channel accumulates at this slope break and reduces the capacity of the bridge.

Analytical Approach

A HEC-RAS computer model developed for FEMA mapping was used to determine the frequency of road flooding at this site. The model also was used to develop a general design that provides a bridge opening large enough to pass the 100-year flow.

Conceptual Solution

The elevation of the roadway will need to be raised two feet to achieve the capacity necessary to convey a 100-year event under the bridge. Elevating the roadway will provide the height needed to raise the low chord of the bridge as much as a foot or more. Additional capacity will be required for high flows. This can be accomplished by installing culverts under the roadway next to the bridge. The physical restrictions of the roadway geometry prohibit using a standard size box culvert. Instead we recommend installing a series of six circular, 30-inch, CMPs. The conceptual solution for this problem is presented in Chapter 9 as CIP-23-FC1-BRG01.

Pierce County Public Works, Transportation Services Division, is conducting a corridor study for the potential construction of a new road that would supplement the Rhodes Lake Road access to the plateau. This study is currently (September 2003) in the preliminary stages; however, elevating McCutcheon Road and the construction of a new bridge should be coordinated with this potential road project.

6.3.6 Fennel Creek Crossing at Kelly Lake Road (FC3-BRG02)

Problem Description

Kelly Lake Road (206th Avenue East) crosses Fennel Creek near river mile 5.3. The HEC-RAS model developed by others for generating FEMA maps of this creek shows that this bridge floods over the roadway at less than a 10-year event.

Analytical Approach

A HEC-RAS hydraulic model, developed for FEMA mapping, was used to evaluate this bridge.

Conceptual Solution

To provide sufficient capacity under the bridge for passing a 100-year event, we recommend the road surface be raised two feet and one of the bridge abutments be set back eight feet from its current location to expand the bridge opening. The conceptual solution for this problem is presented in Chapter 9 as CIP-23-FC3-BRG02.

6.3.7 Fir Ridge Pond Overtopping (FC5-DP01)

Problem Description

The stormwater pond at the intersection between 108th Street Court East and 206th Avenue Court East that serves the Fir Ridge development (formerly Wembley Park) is an infiltration facility with a history of overtopping. The pond was enlarged in the early 1990s but overtopped again during the major flood in winter of 1996–97. The pond sits at a relative low point with no defined or constructed outlet for flow. One home adjacent to the pond was purchased and removed by Pierce County because of frequent flooding.

The Ponderosa neighborhood is north of Fir Ridge and surrounds Ponderosa Pond, which is in a closed depression that overtops to the northwest. To improve infrastructure in the neighborhood, the Ponderosa homeowners association created a group called the Road Services District (RSD). This group hired an engineering consultant to design improvements to the roadways in the neighborhood and to reduce flooding. Two stormwater ponds were recommended and have been constructed.

One of the newly constructed ponds is at the southeast end of the lake; the other pond is on the west side of the lake and serves as the outlet. Water from the outlet pond passes through an 18-inch pipe and is released into a wetland at the end of 104th Street East. From here, flow runs west through wetlands, crosses 200th Avenue Court East in an 18-inch culvert, and enters an infiltration pond at the Brookwater development. The surface flow path ends here with water migrating to Fennel Creek as subsurface flow.

Analytical Approach

Multiple options are proposed for solving overtopping at this pond. Three options are presented below under Conceptual Solutions along with an analysis of each option.

Conceptual Solution

Option 1 – Purchase adjacent properties and expand existing pond

Adjacent properties north of the Fir Ridge stormwater pond have flooded frequently because of overtopping of the pond. The County has already purchased one of these properties. Conceptual Solution "Option 1" proposes that the County purchase two additional adjacent properties north of the pond and use this land to enlarge the existing storage capacity. Because these properties would be purchased with FEMA funds, there may be some restrictions on the construction of any structures including stormwater facilities.

Calculations performed for the 1992 retrofit design of the existing Fir Ridge Pond identified a 100-year peak volume of 142,013 cubic feet (Wembley Park Pond Redesign Calculations, LeRoy Inc., June 1992, pg 6 [LeRoy]). This volume was determined using full build-out conditions. The current available pond storage with one foot of freeboard is 46,414 cubic feet. The additional volume required for the 100-year event with one foot of freeboard is 95,599 cubic feet (LeRoy, pg 3).

The three adjacent properties north of the Fir Ridge Pond would provide approximately 0.58 acre of additional area. The additional storage volume of the expanded pond was determined, based on the following assumptions:

- Top of berm elevation of 626.5 feet to match the existing pond
- Water table elevation of 624.0 feet, (LeRoy, pg 3)
- 3H:1V side slopes to match the existing pond

The total additional volume of the expanded pond with 1 foot of freeboard is 31,427 cubic feet (*Table 6-7*). The expanded pond completely full with no freeboard would only be able to contain the runoff volume of up to a 25-year event.

During design, when more detailed survey data are available, it may be determined that it would be feasible to increase the berm height of the existing and expanded pond, which would increase the pond's storage capacity. This option was not considered in the calculations reported in *Table 6-7*.

Table 6-7
Fir Ridge Pond Available Storage

Ponds	Total Area (acres)	Storage Volume with One-Foot Freeboard (ft^3)	Storage Volume with No Freeboard (ft^3)
Existing Pond	1.06	46,414	79,725
Expanded Pond	0.58	31,427	53,918
Total	1.64	77,841	133,643

Option 2 – Direct flow to Ponderosa

"Option 2" proposes constructing a piped connection between Fir Ridge Pond and the Ponderosa Pond. Ponderosa Pond is currently functioning at design capacity and so adding flow may be an unlikely solution. However, it can be assumed that the water currently overtopping Fir Ridge Pond during large events is already contributing volume to Ponderosa Pond. Further investigation through more extensive modeling and data collection would be needed to confirm this assumption.

Based on the above assumption, the "Hydrologic Engineering Center – Hydrologic Modeling System" (HEC-HMS, version 2.2.1) computer model was used to evaluate the potential for formally routing overflow to Ponderosa Pond. The calculated total discharge volume for the 100-year, 24-hour event was 148,178 cubic feet. This is slightly higher than the predicted peak volume determined by LeRoy, Inc in 1992 for the Wembley Pond redesign. The primary outlet in the model was set to engage at an elevation of 625.5 feet, one foot below the berm's elevation. The modeling results predicted a total outflow from Fir Ridge Pond of 99,910 cubic feet and a peak discharge of 4.72 cubic feet per second (cfs) to Ponderosa Pond. This volume is equivalent to a 3.75-inch rise of the surface elevation of Ponderosa Pond if added instantaneously to the pond.

Any increase in the surface water elevation of Ponderosa Pond above the existing design would result in property flooding. Therefore, to accommodate additional water volume, the outlet control structures need to be modified, the flow path that conveys water to the infiltration pond needs to be expanded, and the infiltration pond itself needs to be enlarged.

During final design, it might be determined useful to incorporate a low-flow outlet feature from the Fir Ridge Pond to the Ponderosa Pond. This feature would help maintain greater storage capacity in the Fir Ridge Pond in anticipation of recurrent storms. This approach may improve the effectiveness of the Fir Ridge Pond and reduce the peak volume of the flow routed to the Ponderosa Pond. This option was not included in the model described above.

Option 3 – Pump overflow to a new pond in Tract B

The County currently owns a parcel of Fir Ridge known as "Tract B." "Option 3" proposes constructing a pond in "Tract B" to receive excess flows from the Fir Ridge Pond. It is uphill from the Fir Ridge Pond; therefore excess flow would need to be pumped to the new pond. The pond constructed on "Tract B" would need to be clay lined to ensure that subsurface seepage did not occur.

"Option 3" was also modeled using HEC-HMS. The subbasin modeling remained the same as "Option 2" with a total discharge of 148,178 cubic feet. A pump simulated in the model was set to engage when the Fir Ridge Pond reached an elevation of 625.5 feet. Assuming an 8-inch piping system was used, the pump would need to be able to handle over 1,500 gallons per minute with a total head of 18 feet. The 1,500 gallons per minute is the minimum discharge rate predicted by the model to prevent the pond from overtopping.

Under this option, permanent underground piping would be installed. A permanent pump in the field that would be triggered automatically by water level is not recommended because of the frequency of power outages that accompany large storms and the infrequency of use. Therefore, a portable pump would need to be delivered and set up as needed when flooding is imminent. This means that Fir Ridge Pond would need to be monitored during large events, preferably by neighbors who could contact County crews when a pump is needed.

"Option 2" was selected as the final conceptual solution for this problem and is presented in Chapter 9 as CIP-23-FC5-DP01.

6.3.8 Road Flooding at 114th Street cul-de-sac (FC8-RF01)

Problem Description

This area is an older neighborhood with drainage that consists of ditches and 8-inch concrete culverts under each driveway. One street, 114th Street East, extends off of 205th Avenue East toward the west and ends in a cul-de-sac. The cul-de-sac is a low spot that collects water from 205th Avenue East in addition to runoff from 114th Street East. Excessive road runoff forms pools in front of driveways at the end of the street.

Analytical Approach

Topography maps and Pierce County GIS drainage inventory layers were used to determine flow routing along these streets. Field visits were made to identify possible routing for ponded water.

Conceptual Solution

The only place with sufficient gradient to remove water from the cul-de-sac is in a community park behind the residential properties. A catch basin could be installed at the low point of the cul-

de-sac and runoff routed to a perforated infiltration pipe buried on the park property. To implement this option, the pipe would need to be routed across private property. It is recommended that a catch basin and 12-inch pipe be installed to route runoff 250-feet to an infiltration well in the park.

It is recommended that this project be referred to the Pierce County Roads Department for implementation (see *Table 6-8*).

6.3.9 Horsehaven Creek Crossing at 150th Avenue E (HH4-C05)

Problem Description

There are twin culverts under 150th Avenue East. Each culvert is a 3-foot precast concrete pipe that is 39-feet long. The property owner has placed boards across the upstream end of these culverts to form a landscaped pond in the front yard. Because of these boards, the Conservation District fish passage inventory lists this culvert as a fish barrier, however, the owner reports that salmonids are seen passing beyond this culvert on a regular basis. These boards are removed during high flows to prevent flooding. This road crossing flooded during the 1996–97 100-year event to a depth of up to six inches and is shown in the HEC-RAS model to flood at a 50-year event. Although the flooding here is infrequent, combined with the fish passage issue, it places a greater need on replacing this culvert.

Analytical Approach

The hydraulic model developed for Horsehaven Creek was used to determine the capacity needed for this culvert.

Conceptual Solution

The new culvert must be able to provide fish passage, flow capacity up to the 100-year event, and provide low-flow restriction to maintain the upstream pond. This can be achieved by placing baffles within a 6-foot circular culvert, 40-feet long, that provide a narrow, but fish passable, opening for low flows and a large opening for high flows. *Figure 6-2* provides an example of this culvert type. Boards can be placed in the narrow section of the baffle to allow adjustment of the water level during low flows. The elevation of the roadway may need to be raised locally as much as one foot to accommodate a culvert of this size. The conceptual solution for this problem is presented in Chapter 9 as CIP-23-HH4-C05.

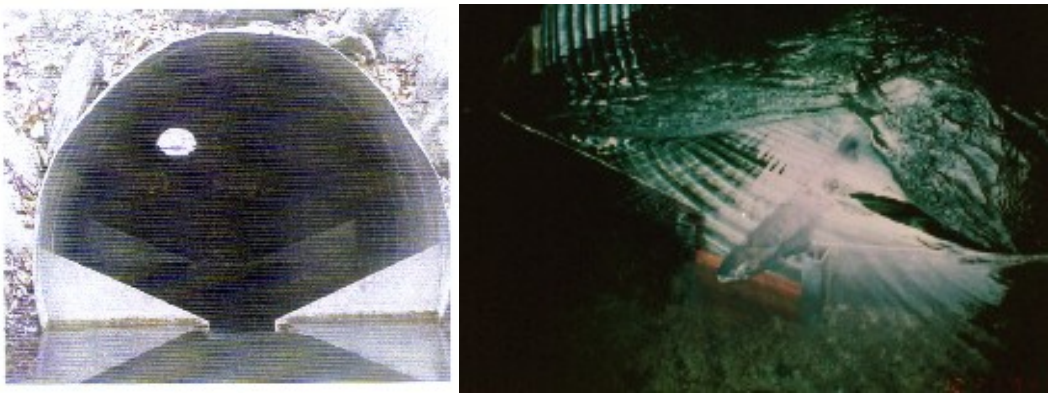

Figure 6-1
Examples of Fish Passable Culverts with Baffles

6.3.10 Horsehaven Creek Crossing at 188th Street E (HH5-C07)

Problem Description

The 36-inch precast concrete culvert (HH5-C07) under 188th Street E on Horsehaven Creek floods over the roadway in storms less than the 10-year event. This road runs across the valley bottom and is very flat at the point where it crosses Horsehaven Creek.

Analytical Approach

Replacement of this culvert will need to comply with the requirements for fish passage. Culverts sized for fish passage typically exceed the necessary flow capacity. Therefore, the conceptual solution for this culvert uses the fish passage criteria presented in the WDFW Fish Passage Design at Road Crossings Manual. No survey data are available for Horsehaven Creek. Average stream width was estimated to be 9-feet based on field observations. The model developed for Horsehaven Creek was used to verify that this recommended replacement culvert is adequate for carrying flood flows.

Conceptual Solution

The existing culvert should be replaced with a 12-foot-wide culvert for fish passage. A circular culvert of this size, counter sunk to 50 percent (50%), would increase the elevation of the roadway over the culvert by almost three feet. Therefore, a 12-foot by 5-foot box culvert, 34-feet long, with an opening of three feet above the bed is recommended; this would allow the road elevation to remain consistent and still provide the needed width to pass both fish and 100-year flows underneath the roadway. The conceptual solution for this problem is presented in Chapter 9 as CIP-23-HH5-C07.

6.3.11 Flooding along Jansky Road (HH8-RST02)

Problem Description

During flooding (approximately 10-year event), water flows east along the south side of Jansky Road and crosses near 15200 block Jansky Road. This culvert under Jansky Road is currently too small and excess water overtops the road.

Horsehaven Creek is on the north side of the road. Severe erosion is occurring on Horsehaven Creek just upstream of twin 24-inch driveway culverts. There are no anadromous fish this high in the watershed, but erosion sends sediment to downstream spawning reaches.

Analytical Approach

Topographic maps and Pierce County GIS drainage system layers were used to determine flow routing in this area. The contributing area was delineated and modeled using the Soil Conservation Services Technical Release 55 (SCS TR-55). The roadway ditches and culverts were sized according to the graphical peak discharge. Field visits were made to assess the extent of erosion.

Conceptual Solution

The area contributing to the roadway and residential flooding along Jansky Road is approximately 518 acres. The 100-year, 24-hour predicted peak discharge from this area is 70 cfs. The roadside ditch along the south side of Jansky Road needs to be enlarged and regraded. The 12-inch culvert, crossing under Jansky Road also needs to be replaced to sufficiently convey the peak discharge of 70 cfs. We recommend two 24-inch culverts based on the results of the SCS model, however, the size of the new culvert will ultimately depend on the slope at which it is placed.

It is recommended that the channel upstream of the existing twin 24-inch driveway culverts be stabilized according to WDFW's Integrated Streambank Protection Guidelines (2003) to prevent further erosion. A rock sill could be installed where the gradient begins to drop to hold sediment. Below the rock sill, one or two log drops could be installed to anchor the gradient. Planting the banks with willows and fencing it off from livestock would further stabilize the channel. The conceptual solution for this problem is presented in Chapter 9 as CIP-23-HH8-RST02.

6.3.12 Flooded Properties along 149th Avenue E (D1-AC01)

Problem Description

A culvert was placed at a low point along 224th Street East near 149th Avenue East. The culvert is not along a stream channel but rather is there to pass stormwater under the roadway in this depressional area. From here, the water flows south across open ground and infiltrates. The water does not infiltrate fast enough during large storms and ponds on two properties.

Analytical Approach

Field investigation was conducted to evaluate solution options for this flooding problem.

Conceptual Solution

Ponded water is restricted to the two properties mentioned above and does not affect public roads. Therefore, it is recommended that these properties be purchased, if the property owner agrees, and the building removed to reserve this land as an infiltration area. The conceptual solution for this problem is presented in Chapter 9 as CIP-23-D1-AC01.

6.3.13 21411 Jansky Road Flooding (D6-RF01)

Problem Description

Extensive roadway and residential flooding occurs along Jansky Road in the vicinity of address 21400 block. Sheet flow over the road occurs when runoff coming down the hill slope to the west of Jansky Road fills the ditch on that side of the road and overtops across the roadway.

Analytical Approach

Topographic maps and Pierce County GIS drainage system layers were used to determine flow routing in this area. The contributing area was delineated and modeled using the SCS TR-55. The roadway ditches and culverts were sized according to the graphical peak discharge. Field visits were made to assess the extent of flooding.

Conceptual Solution

Approximately 0.7 mile of roadway ditches and eleven driveway culverts need to be improved and enlarged to convey higher flows. Nearly all roadside ditches and driveway culverts are undersized. The area contributing to the roadway and residential flooding along Jansky Road is approximately 212 acres. The 100-year, 24-hour predicted peak discharge from this area is 30 cfs.

The roadside ditches and driveway culverts need to be enlarged and regraded to sufficiently convey the peak discharge of 30 cfs. The size of each driveway culvert will vary depending on culvert slope and location. Based on a discharge of 30 cfs, the majority of culverts would fall in the 18-inch to 24-inch-diameter range. It is recommended that all driveway culverts be replaced with 24-inch culverts.

It is recommended that this project be referred to the Pierce County Roads Department for implementation (see *Table 6-8*).

6.3.14 Neighborhood Flooding along Freeman Road E (D17-RF03)

Problem Description

Flooding along Freeman Road between 45th Street East and 52nd Street East occurs because water ponding along the roadside has no clearly defined flow path. The roadway itself does not flood, but runoff from the road contributes to water ponding on adjacent private properties. Several of the properties are lower than the roadway by as much as two or three feet. A wetland is at the southern end of Freeman Road.

Analytical Approach

The Pierce County drainage inventory was reviewed to identify existing drainage pathways in this area. No drainage infrastructure is recorded for Freeman Road. The two-foot contours on the GIS layer shows that this area is very flat with no natural drainage pathway. Field visits were made to evaluate design options for this site. This site was determined to be a good candidate for an LID approach because much of the flooding here consists of water ponding at the shoulder of the road. A full discussion of the intent behind the LID approach is provided in the programmatic recommendation in Chapter 9.

Conceptual Solution

The water that ponds along the roadway is currently held as depressional storage for the Basin. Draining this water to the nearest receiving water body will further contribute to the widespread difficulty of hydrologic alteration commonly associated with urbanization. Because the ponding along Freeman Road is relatively minor, it is recommended that bioretention swales be constructed that can hold roadway runoff from minor events and infiltrate it. If future storms create ponded water that becomes a roadway hazard, 12-inch culverts can be installed across driveways with inverts set at the top elevation of the biofiltration swale to carry high flows south to the wetland at the corner of Freeman Road and 52nd Street East. The conceptual solution for this problem is presented in Chapter 9 as CIP-23-D17-RF03.

6.4 Sites to be Monitored for Future Flooding

The following sites should be watched to see how they respond during significant runoff events before any further action is taken. Conceptual solutions are provided here to provide a course of action if improvements are deemed necessary in the future. These sites recommended for monitoring are shown on *Figure 9-2, Monitoring Sites*, in Chapter 9.

6.4.1 Stormwater Ponds along Angeline Road (FC1-DP04)

Problem Description

Two stormwater ponds serve areas of Sky Island and are located along Angeline Road. The Sky Island development is upslope from the ponds at the top of a hill. Water is routed down the slope to the ponds via a 12-inch HDPE tightline. There are two concerns associated with these ponds. One is that they may be too small for the area that they are serving. The other concern is that there is no defined overflow pathway.

Analytical Approach

The infiltration ponds located along Angeline Road were designed to infiltrate the runoff from the embankment above the Sky Island sewer access road and the runoff from the road itself. The volume of runoff was determined using the Zone 2 Pierce County Retention/Detention Basin Equations and percolation rates determined by consultants. The original design calculations were reviewed and the volume provided by the ponds (7,192 cubic feet) was found to far exceed the volume required for the 100-year event (2,527 cubic feet).

The pond design is based on the Pierce County Stormwater Management and Site Development Manual criteria. The design includes a 5-foot-wide overflow spillway, which spills into an existing ditch. The design also includes 20-foot-long, 12-inch-diameter, concrete pipes under driveway approaches along Angeline Road. These culverts have previously filled with sediment and should be regularly maintained.

Conceptual Solution

Adequate storage is available in these ponds, provided they are regularly maintained. If, during future floods, the ponds do not provide sufficient storage and roadway flooding becomes problematic, a culvert could be installed that would direct overflow under Angeline Road. A drainage easement would need to be obtained to allow overflow from the ponds to pass through private property and discharge into Fennel Creek.

6.4.2 Roadway Flooding at Intersection of 96th Street E and 233rd Avenue E (FC4-RF05)

Problem Description

Roadway flooding occurred periodically at the intersection of 96th Street East and 233rd Avenue East (Werron Road). In response, the County routed flow from the south side of 96th Street East through an 18-inch culvert under the road and north along the east side of 234th Avenue East. During high flows, backwater could cause the upstream end of the culvert to overtop sending water west along 96th Street East and contributing to further flooding at the 233rd Avenue East intersection.

Analytical Approach

This flooding problem was recently addressed by the Pierce County Roads Department by installing an 18-inch culvert under 96th Street East and under driveways along the flow path. To verify that the ditches and culverts were adequately sized, topographic maps and Pierce County GIS drainage system layers were used to determine flow routing in this area. The contributing area was delineated and modeled using the SCS TR-55.

Conceptual Solution

The area contributing to the past flooding at the intersection of 96th Street East and 233rd Avenue East is approximately 163 acres. The 100-year, 24-hour predicted peak discharge from this area is 20 cfs. The culvert at the intersection of 234th Avenue East and 96th Street East is currently 18-inches in diameter and is capable of conveying approximately 13 cfs. The remaining 7 cfs will overtop and flow west along 96th Street East to the 233rd Avenue East intersection.

If the intersection continues to flood, the culvert at the intersection of 234th Avenue East and 96th Street East and the driveway culverts along 234th Avenue East could all be increased to 24-inches in diameter. Increasing these culverts to 24-inches in diameter would reduce or eliminate flooding problems at the intersection of 96th Street East and 233rd Avenue East.

6.4.3 Road Flooding at Culvert under Old Sumner-Buckley Highway (FC4-C04)

Problem Description

The culvert crossing on Fennel Creek under the Old Sumner-Buckley Highway was included in the FEMA study of this creek. This culvert is a CMP arch culvert with a span of 12-feet and a rise of 7-feet. The model indicates that this creek overtops the road during a 500-year event under current conditions and will overtop the road during a 100-year event under future conditions. The future conditions scenario assumes no detention has been used to mitigate for increased impervious surface area and therefore represents a worst-case scenario.

Analytical Approach

This culvert was analyzed with an HSPF and HEC-RAS model developed for mapping FEMA floodplains.

Conceptual Solution

This culvert currently has the capacity to convey up to a 100-year event. Future development in the Basin currently requires stormwater mitigation that in theory will not increase future flows. Therefore, it is assumed that this culvert will not become problematic, though this culvert should

be watched during high-flow events for flooding in the years to come. If flooding becomes a frequent problem here, then replacement of this culvert should be considered.

6.5 Potential Small Works Projects

The remaining nine site-specific flooding issues identified for the Mid-Puyallup Basin are small works projects. *Table 6-9* describes the small works drainage problems. Small works problems are issues that can likely be resolved for less than $25,000, and do not need extensive evaluation, analysis, or design. Typical solutions are likely to include:

- Replacement of damaged culverts
- Stream channel maintenance—removal of invasive plant species and debris removal
- Small infiltration enhancements
- Small drainage and conveyance improvements

Table 6-8
Small Works Drainage Issues Identified for Mid-Puyallup Subbasins

ID No.	Location	Problem Description	Potential Solutions
	11000 block Jennifer Ct E 11000 block 138th Avenue E 11000 block 136th Avenue E	This neighborhood has very steep streets and driveways and residential flooding occurs when roadway runoff enters private driveways.	Install, where appropriate, a raised asphalt lip to prevent runoff from entering residential driveways.
FC3-DP03	204th Avenue Ct E	Flooding due to the overtopping of the existing stormwater pond beyond the 204th Avenue Ct E cul-de-sac.	Build up berm on cul-de-sac side and improve emergency spillway.
BL4-RF05	194000 block Church Lake Rd	Roadway flooding occurs near culvert, which passes a sizable creek.	Fill in and regrade a large depression in the shoulder and roadway so that runoff can drain into creek.
D14-RF02	Corner of 134th Avenue E and 80th Street E	Roadway flooding from ponded water	Regrade parking area adjacent to railroad and install a culvert under 134th Avenue E.
D9-RF06	15000 block 134th Avenue E	Residential flooding occurs in low spots along 134th Avenue E.	Install asphalt berm or regrade to keep runoff out of residential property and draining to the east side of the road only, where it is mostly wooded.

7. WATER QUALITY PROBLEMS ANALYSIS

This chapter analyzes the water quality information and problems identified in Chapter 4, Existing Conditions and Chapter 5, Identification of Problems. Each problem is described, and then a conceptual solution and rationale is presented. The water quality problems listed represent one or more of following: (1) a concern that a potential water quality problem exists at a particular location as reported in a questionnaire, in an "Service Response System" (SRS) entry, or by a member of the project team; (2) potential problems suggested by water quality monitoring results; and (3) field observations of erosion and sediment deposits in streams.

In 2003, the Washington State Department of Ecology (Ecology) released new State water quality standards. The standards are anticipated to be implemented in 2004 following approval by the U.S. Environmental Protection Agency. The biggest changes will be in the way that streams are classified (according of fish characteristics); the addition of temperature parameters to protect temperature-sensitive fish, such as bull trout and Dolly Varden; addition of a new indicator (enterococci) to measure bacteria in fresh water; and the addition of new values for ammonia in waters without salmon species. When the changes are finalized, the Mid-Puyallup tributaries will be reclassified under the new standards. Revisions to the stormwater/surface water monitoring program of Pierce County Water Programs will be required and the water quality problems in the Mid-Puyallup Basin can be reassessed.

7.1 Site-Specific Issues

Locations of the water quality problem sites can be seen on *Figure 5-2, Water Quality Problem Areas*, in Chapter 5.

7.1.1 Iron Bacteria in Alderton Creek, WQ-1

Problem Description

Iron bacteria in Alderton Creek proliferate in the open channel portion of the creek near the corner of Pioneer Way East and 88th Street East. Thick mats of the orange bacteria grow in the streambed during the summer at this location. The site is on the flat Puyallup valley bottom where the groundwater table is shallow. Much of Alderton Creek is fed by groundwater that has a high iron concentration. Water samples collected here in the summer of 2002 had dissolved iron levels of 40.8 milligrams per liter (mg/l). This is four times the typical levels of iron in groundwater and two orders of magnitude higher than the federal drinking water standard for iron (0.3 mg/l). Although the presence of iron bacteria is unsightly in Alderton Creek, it is neither toxic nor hazardous to public health.

Conceptual Solution

Dissolved metals can be removed from water by either fine filtration or flocculation methods. Both technologies are difficult to apply to a stream environment and are costly. Because the iron

bacteria in Alderton Creek present no public health hazard and they are present only during the warm summer months, costly cleanup for aesthetic reasons is difficult to justify. Therefore, it is recommended that no action be taken.

7.1.2 Commercial Landfill, WQ-2

Problem Description

A commercial sanitary landfill sits within the headwaters of Horsehaven Creek near Thun Field. The land operated as a gravel mine and landfill from 1967 to 1989. The landfill accepted liquids, solids, industrial wastes, and heavy metal sludges in addition to household garbage until 1985. Of the 92-acre landfill, 56 acres had no groundwater protection. This portion of the landfill was closed in 1989 and capped to prevent rainwater from draining into waste materials below. The remaining part of the landfill is lined and uses a leachate collection system. The entire landfill stopped accepting waste in 1998 and was capped by 2000.

An investigation of the landfill conducted in the early 1980s found that groundwater quality had been affected down gradient from the landfill. Underlying groundwater in the upper regional aquifer flows in a northwesterly direction toward Clover Creek. Contaminants included dissolved iron and manganese, chloride, ammonia, nitrate, sulfate, and low intermittent levels of volatile organic compounds including benzene, chlorobenzene, 1,1-dichloroethane, and 1,4-dichlorobenzene (Kleinfelder 2001). This site was placed on the National Priority List (Superfund) in April 1989. According to Tacoma-Pierce County Health Department, Source Protection Program staff, the deep aquifer flows east.

Cleanup operations continue in cooperation with Ecology. They consist primarily of methods that either: (1) prevent precipitation from penetrating the landfill cover and generating leachate; or (2) leachate pretreatment followed by discharge to the sewer lines of the Pierce County Wastewater Utility. Leachate is a solution resulting from the extraction of soluble materials by water or other liquids as they move through landfilled waste. Pretreatment reduces biological oxygen demand, metals and solids, and neutralizes pH so that treated liquids meet County sewer utility influent limits. Biological treatment takes place at the Chambers Creek Wastewater Treatment Plant. Liquids collected in the composting center

Stormwater runoff from the landfill cap collects in channels that lead to a retention pond where the runoff seeps into the ground. Water quality of the pond is tested on a regular basis by an independent contractor and reported to the Tacoma-Pierce County Health Department in accordance with State requirements.

Water quality monitoring has demonstrated an overall improvement in groundwater quality following implementation of these measures. Seventeen (17) groundwater monitoring wells of varying depth around the landfill are regularly tested. Water supply wells within 4,000 feet (3/4 mile) of the landfill provide drinking water to nearby communities. Regular monitoring of wells indicates that drinking water quality is typically within federal standards with sporadic exceedences of nitrate levels.

The SRS contained no complaints about water quality in the vicinity of the landfill. Contaminants associated with the landfill have not been found in the tributaries to Horsehaven Creek to date.

Conceptual Solution

The landowner, through an independent contractor, has conducted regular groundwater testing at monitoring wells around the landfill. Additional groundwater monitoring does not appear to be warranted. Benthic Index of Biotic Integrity (BIBI) sampling and analysis is the best indicator of stream health. BIBI sampling occurred in 2002 (see *Table 4-10* in Chapter 4) for Horsehaven Creek. BIBI sampling occurs in approximately five-year cycles. Periodic BIBI sampling of Horsehaven Creek and the tributary nearest the landfill will provide the best indicator of biological health of the stream over time. If BIBI scores start to fall, more specific water quality monitoring could be initiated. For a cost estimate for this solution, see Chapter 9, PRG-23-07.

7.1.3 Copper Contamination in Fennel Creek, WQ-3

Problem Description

In 1999, Foster Wheeler Environmental Corporation conducted an environmental analysis of the Fennel Creek corridor for the City of Bonney Lake. Grab samples were taken at five points along the stream for water quality analysis. Elevated levels of copper were detected at several sites. An investigation of likely sources found that an algaecide containing copper was being used in Debra Jane Lake upstream of the sampling sites. The practice has since been stopped. Pierce County sampled for copper again in 2002 and found concentrations had diminished greatly. No other metals, with the exception of a slight elevation of mercury at Site 1, exceeded State standards. Supporting data are shown in Section 4.8.2 of this Basin Plan. Sampling sites are shown on *Figure 4-13, Water Quality Sampling Sites*.

Copper concentrations within the bed sediments of the creek may be elevated; no sediment sampling has been done to confirm or deny this. The conditions under which metals resolubilize from attached sediments are dependent on pH, organic matter, level of aeration, and other factors. In this instance, it would be expected that resolubilization of copper would be low. Even if bed sediments are temporarily suspended during storm flows, the bonded copper would resettle with the sediment particles. Any copper in the bed sediments will eventually be transported downstream and out of the system.

Conceptual Solution

Recent sampling of Fennel Creek has demonstrated that the copper contamination present in the early 1990s is no longer an issue. No remedial actions are recommended.

7.1.4 Fish Hatchery and Rearing Facility –WQ-4

Problem Description

A commercial hatchery that produces Rainbow trout brood stock in addition to eggs is located roughly 0.8 mile upstream from the mouth of Canyon Falls Creek. Potential pollutants of concern from this type of facility include total suspended solids (TSS), biochemical oxygen demand (BOD_5), dissolved oxygen (DO), nutrients, and disease control chemicals. The hatchery is permitted under a General NPDES Permit for Upland Fin-Fish Hatching and Rearing Facilities. Ecology is responsible for ensuring compliance of the hatchery with water quality standards. Settling ponds to remove settleable solids are used to improve water quality prior to discharge.

Water samples collected by the Puyallup Tribe in Canyon Falls Creek downstream of the hatchery have not indicated water quality problems for monitored parameters related to hatcheries. Supporting data are presented in Section 4.8.2 of this Basin Plan. Sampling sites are shown on *Figure 4-13, Water Quality Sampling Sites*.

Conceptual Solution

Although regular water quality testing and reporting of discharge from the hatchery occurs, water quality downstream of the McCutcheon Road East culvert has not been regularly monitored. BIBI sampling and analysis is the best indicator of stream health and need only be performed once every three-to-five years. Placing Canyon Falls Creek downstream of the McCutcheon Road East culvert on a regular BIBI sampling schedule is recommended. If BIBI scores drop, more extensive water quality testing should be considered (Chapter 9, PRG-23-07).

7.1.5 Potential Untreated Sewage from Trailer Park

Problem Description

Residents in the vicinity of a trailer park at the easterly end of 176th Street East reported concern that the on-site sewer system associated with the address has failed and could be releasing untreated seepage into Horsehaven Creek. The location of this site is indicated on *Figure 5-2, Water Quality Problems*. The property is in an area designated rural by the County Comprehensive Plan.

The trailer park has been abandoned and is involved in litigation. The Tacoma-Pierce County Health Department has lead responsibility for on-site sewer systems.

Conceptual Solution

Report the concern to an environmental health officer at the Health Department and work with the Health Department to clean up sources of contamination..

7.2 Basin-Wide Issues

7.2.1 Failing On-Site Sewer Systems Above High Groundwater, WQ-5

Problem Description

Several citizens have complained that flooding has caused their on-site sewer systems to fail. The groundwater table is shallow in the Puyallup River Valley. Groundwater levels rise in the wet winter months and fall during the dry summer period. Land in this area has been designated rural and is mostly agricultural with nodes of urban and suburban intensity development. The combination of high groundwater and on-site sewer systems presents a potential for failed on-site sewer systems, but the extent of failed on-site sewer systems due to groundwater flooding or surface water flooding has not been examined.

Conceptual Solution

Investigate the extent to which reported failures of on-site sewer systems in the valley portion of the Mid-Puyallup Basin are related to groundwater flooding and surface water flooding.

7.2.2 Bank Erosion, WQ-6

Problem Description

Bank erosion along stream channels contributes to elevated turbidity levels, sediment accumulations, degraded habitat, and can cause other property damage. In agricultural areas such as the valley portion of the Mid-Puyallup Basin, lack of vegetated stream corridors expose stream banks to wind and rain, increasing their susceptibility to erosion. Allowing livestock access to streams damages stream banks. Livestock trample the banks and destroy vegetation. Citizens have reported that livestock continue to have access to Horsehaven Creek in some areas. Increased urban development also affects stream bank erosion by changing hydrology patterns and increasing erosive peak flows.

Figure 7-1
Examples of Degraded Stream Banks on Ball and Horsehaven Creeks

Three of the Mid-Puyallup tributaries—Alderton Creek, Ball Creek, and Horsehaven Creek—flow along the flat valley bottom and have unprotected stream banks through agricultural areas.

The low gradient of these creeks compounds the problem by making it difficult for sediments from bank erosion to be flushed downstream. All three of these creeks have thick layers of fine material covering their gravel beds and smothering spawning gravel. This fine sediment reduces the flow of oxygen rich water to developing eggs and fills cobble spaces where insects live that provide food for developing fingerlings.

An investigation into the primary sources of sediment on each of these streams would be beneficial in focusing restoration efforts most effectively. Reduction in sediment input is essential to stable restoration and long-term recovery of these streams for salmonid habitat. A study, ST-1, is recommended in Chapter 9 to obtain this information.

Conceptual Solution

Solutions to bank erosion overlap with solutions to several other water quality and habitat issues in this basin. These solutions include mitigating for increases in stormwater volume due to urban growth, planting streamside riparian areas, restricting livestock access to creeks, and educating the public about what is important for channel integrity. Stormwater mitigation (such as regional detention ponds, on-site facilities, or low impact development techniques) helps reduce hydrologic impacts from urbanization that can scour and damage stream banks. Programmatic recommendations PRG-23-01 and PRG-00-02 in Chapter 9 will help reduce urban impacts, which will reduce stream bank erosion. Vegetation along streams provides root structures that support bank integrity, limit livestock access to the stream and thereby prevent trampling of the banks, and provide a source of woody debris that can deflect flowing water from banks and increase channel complexity. Program PRG-00-05 described in Chapter 9 will provide for revegetating riparian corridors along the Mid-Puyallup tributaries. Limiting livestock access to creeks reduces bank erosion caused by trampling damage. Restricting livestock from creeks also helps to reduce fecal coliform bacteria levels in the creeks. Providing incentives and educating landowners adjacent to streams helps bring bank and stream protection to a local level and provides people with a sense of stewardship in their own backyard. Program PRG-00-06 described in Chapter 9 provides public education for this purpose.

7.2.3 Land Use Impacts, WQ-7

Problem Description

Land use impacts to water quality in the Mid-Puyallup Basin are primarily a result of historical agriculture use. Much of the Puyallup River Valley has been used for agriculture since the early 1900s and continues to be used this way today. Impacts to Mid-Puyallup tributary streams resulting from agriculture include elevated stream temperatures from lack of vegetated stream corridors; high fecal coliform levels from herd animals; and for herbicides and insecticides in the water. Elevated temperatures during the summer on both Ball Creek and Horsehaven Creek are addressed as part of WQ-8 below. Grab samples collected by the Puyallup Tribe found fecal

coliforms levels exceeding State standards six times during the years 1999 to 2001 in Fennel Creek and Canyon Falls Creek. The data are summarized in Section 4.8.2 of this Basin Plan.

The water quality of stormwater runoff from urban areas is an increasing concern in the Mid-Puyallup Basin as urban and suburban growth increases. Urban stormwater runoff typically has elevated levels of nutrients, metals, and fine sediment (Horner, et al. 1994) among others. As urban growth increases, water quality in local streams could be adversely affected unless the aspects of urban development that degrade water quality.

Some parts of the Mid-Puyallup Basin are planned for future growth that could more than double effective impervious area (EIA) in the contributing area. This is true in the northern headwaters of the Fennel Creek Basin, particularly within subbasins FC-2, FC-3, BL-3, and BL-4. In the Horsehaven Creek Basin, subbasins HH-1, HH-3, and HH-6 show that EIA more than doubles under future conditions, primarily along the Lorenz tributary. All subbasins contributing to Canyon Falls Creek show dramatic growth in the future. However, water quality is not expected to be affected from the proposed Cascadia Development, which covers much of the area, because no surface water will be released from the development site. Several subbasins that drain directly to the Puyallup River may also experience dramatic growth in the future, including D-2, D-3, D-4, D-8, D-9, D-14, D-17.

The unique topography of this basin (plateaus surrounding river valley) introduces issues of water interaction between the upper areas of the Basin and the flat river valley. The Horsehaven Creek Tributary Basin is a prime example of new urban development being constructed on the plateau above rural homes in the valley. Multiple springs emerge from the hillside between the plateau and the valley. The springs serve as water sources for the homes below. These springs are fed by infiltration up on the plateau. An increase in impervious surfaces on the plateau could affect both the quantity and quality of water from the springs. Impervious surfaces reduce the amount of infiltration feeding the springs. Infiltration ponds may not be the best solution because they concentrate infiltration to limited areas.

Conceptual Solution

Recommended solutions for land use impacts on water quality are the same as for protecting stream banks (Section 7.2.2) but with a different emphasis. In this case, mitigation for stormwater emphasizes providing water quality treatment along with detention to reduce the pollutant loads entering streams from urban and agricultural land uses (Chapter 9, PRG-23-01, PRG-23-02, and PRG-23-03). Planting stream corridors reduces sheet flow from lawns and compacted soils, and also provides some filtering to reduce pollutant loading (Chapter 9, PRG-23-05). Public education about water quality can help reduce pollution from lawn and garden maintenance, motor oil dumping, car washing, and domestic animal waste (Chapter 9, PRG-23-06). Regular water quality monitoring can provide feedback on the effectiveness of implemented programs (Chapter 9, PRG-23-07). In addition, Pierce County has been under a “Phase I” NPDES municipal permit since 1995. All other jurisdictions within the Basin will be issued permits from Ecology in 2005. Interlocal coordination and common requirements and standards for stormwater quality among the various jurisdictions should be pursued.

Currently, there is not enough information on the hydrologic interaction between the plateaus and the valley bottom. ST-4 described in Chapter 9 would fill this information gap and help engineers and policy makers better determine the most appropriate mitigation of problems within this unique area.

7.2.4 Elevated Temperatures, WQ-8

Problem Description

Elevated temperatures have been recorded in several Mid-Puyallup Basin tributaries, notably Ball Creek, Fennel Creek, and Horsehaven Creek. Creeks that flow through pastures and have no riparian corridor to provide shade commonly have summer time water temperatures that exceed the State water quality standards. In the summers of 2001 and 2002, temperatures were measured above the standard (18°C for "Class A" waters) in several Mid-Puyallup Basin tributaries both by field measurements and by permanently mounted recording stations. Field measurements taken during August 2001 were 18.2^{o}C in Ball Creek and 19.3^{o}C in Horsehaven Creek. The day and time of these measurements were not targeted to obtain the highest temperature reading. The permanent monitoring stations on Fennel Creek and Horsehaven Creek recorded summer high temperatures of 21.3^{o}C and 21.4^{o}C respectively for summer 2002. No permanent monitoring equipment was available on Ball Creek. The data are summarized in Section 4.8.2 of this Basin Plan.

During 2002, Ball Creek was proposed to be listed on the State's 303(d) list of impaired waters for both temperature and fecal coliforms.

Conceptual Solution

The key element in maintaining water temperature is to maintain or create a vegetated riparian corridor that shades the stream. Riparian corridors are difficult to restore in many areas because much of the creek property in the Mid-Puyallup Basin is private. In many areas along these creeks, the lot sizes are large, so participation from even just a few landowners could have a substantial benefit. Program PRG-00-05 recommended in Chapter 9 provides for restoration of riparian vegetation that will provide shade and lower summertime stream temperatures.

7.2.5 Trash Dumping, WQ-9

Problem Description

Although specific trash laden sites along streams were found during the basin characterization, the potential for dumping trash into streams exists throughout the basin. Trash in streams is not only unsightly; it also poses a hazard to fish and other aquatic creatures that can become trapped in the debris. Public health can also become a concern depending on the nature of what is discarded.

Conceptual Solution

Pierce County Responds is a County program which aims to reduce illegal dumping and its adverse health effects. Components of the program include: support for neighborhood cleanups

and adopt-a-road or park volunteer programs; a hotline to report illegal dumping and public nuisance junk vehicles; a public education program with resource guides to where recyclables and other waste can be taken; assistance to those who want help in removing junk vehicles; and legal action against the owners of the worst sites.

Three aspects of the Responds program may be particularly useful for helping to clean-up trash and other illegally dumped items in streams:

1. Assistance to individual property owners;
2. Support for neighborhood volunteer clean-up of a particular site; or
3. Long-term support for volunteer adopt-a-stream programs under the guidance of the Pierce Conservation District's Stream Team.

Under the first and second options, property owners or neighborhood volunteers may apply for a one-time credit where they supply the labor to clean-up a property and the County arranges to cover up to $100 of the disposal costs. Under the third option, volunteers working with the Stream Team adopt a stream and agree to clean-up a length of stream a specified number of times a year. The County arranges for pick-up and disposal of the waste.

For junk vehicles abandoned in streams, the County has a number of options for working with property and vehicle owners to get the vehicles removed. More information can be found on the Pierce County Responds Hotline (253) 798-4636, or go to the Responds website at www.piercecountyresponds.org.

7.2.6 Fecal Coliform Bacteria, WQ-10

Problem Description

Fecal coliform bacteria enter streams and other waters from the feces of animals. Allowing cattle to have free access to streams elevates fecal coliform levels and can pose health risks to both humans and fish. Elevated fecal coliform levels have been recorded in several of the Mid-Puyallup tributaries. The data are provided in Section 4.8.2 of this Basin Plan. In 2002, Ball Creek was proposed to be listed on the State's 303(d) list for both fecal coliform and temperature.

Conceptual Solution

Reducing and eliminating fecal sources is the best way to reduce fecal coliform in any water body. Restricting livestock access to the streams will provide a large reduction. Program PRG-00-05 described in Chapter 9 would help restrict livestock access by restoring riparian vegetation and where necessary installing fencing.

8. FISH HABITAT PROBLEMS

Key elements integral to healthy stream habitat include cool, clean water, vegetated riparian corridors, clean bed material, a high degree of channel complexity, and a stable channel. A vegetated riparian corridor is land adjacent to the creek that has mature trees and shrubs for a distance from the creek of at least one tree height (Kondolf et al. 1996).

Vegetated riparian corridors serve several purposes. They provide shade to maintain cool water temperatures, reduce bank erosion, provide a source of large woody debris (LWD), and filter stormwater runoff before it enters the stream.

Clean bed gravel is characterized by an absence or low quantity of sand and silt. Sand and silt can fill the interstitial spaces between larger grains reducing the movement of water through the stream bed. Clean bed gravel provides spawning habitat for salmonids. Clean gravel also provides habitat for benthic macroinvertebrates that in turn provide food for fish. Channel complexity is an indication of how much variety there is in a channel habitat. A channel with high complexity typically has many pools and riffles, lots of LWD, active gravel bars, side channel refuge areas, riparian wetlands, and meandering flow.

These features create the myriad conditions needed to support life in streams. Many of the conceptual solutions discussed below and in Chapter 9 are based on the premise that restoring these features to the Mid-Puyallup Basin tributaries whenever feasible, will lessen the need for costly artificial facilities to correct the water quality and aquatic habitat impacts of land development. Creek locations, culvert locations and reaches recommended for restoration are shown on *Figure 8-1, Fish Habitat and Barriers*. Refer to *Figure 4-11* to view habitat ratings by reach.

8.1 Alderton Creek

Field surveys during the "Basin Characterization Phase" of this Basin Plan found that about half the length of Alderton Creek now flows underground through pipes, including the first 300-feet at the mouth of the creek. These pipes are barriers to fish passage. The open-channel sections that lie upstream of the pipe are mostly roadside ditches. Flow is intermittent. For this reason, a formal stream type change has been submitted to the Washington State Department of Natural Resources to reclassify this stream as "Type 5" (non-fish bearing). See also Section 4.5.1 of Chapter 4.

Restoration of this creek would require daylighting over 3,000 feet of channel and restoring the remaining open-channel sections and riparian corridors. Although there are benefits from regaining about 1.3 miles of off-channel rearing habitat, the cost to benefit ratio is poor. Therefore, restoration of this creek is not recommended under the Mid-Puyallup Basin Plan.

8.2 Van Ogles Creek

Van Ogles Creek is considerably degraded in many areas with sparse riparian corridors, high fine sediment content, low channel complexity, and at least three fish blocking culverts in the lower reaches. Despite its degraded condition, the Puyallup Tribe reports that coho, chum, and, cutthroat use this stream for spawning and rearing.

The creek could be restored (at least in part) if the barriers were removed, riparian vegetation planted, and the streambed cleared of fine sediment. The first .3 mile of the creek lies in the 100-year floodplain of the Puyallup River. The lower reaches of the channel could also serve as off-channel rearing habitat for juvenile salmonids in the Puyallup River. A discussion of the various aspects of the stream condition follows in Section 8.2.1.

The capital improvement that can restore fish habitat in Van Ogles Creek is CIP-23-VO1-RST01, in conjunction with programs PRG-00-02, PRG-00-04, PRG-00-05, PRG-00-06, and PRG-00-09. These programs and CIPs are described further in Chapter 9. The CIP restorations project will improve all aspects of stream conditions as they are described below.

8.2.1 Sparse or Absent Riparian Corridors

Problem Description

Most of the length of Van Ogles Creek has a sparse or absent riparian corridor. The first 0.3 river mile (RM) of the creek flows between Riverside Drive East and the Riverside County Park before passing through a culvert under Riverside Drive East. The riparian corridor along this reach exists only on one side of the creek (the park side).

Beyond the Riverside Drive culvert, the stream passes through industrial and then agricultural land areas up to its headwaters where it becomes ditches for farm drainage. The riparian corri-dors here are very narrow, with sparse trees providing sporadic shade. Invasive vegetation, such as reed canarygrass and Himalayan blackberry, grow in several places along the stream banks.

Conceptual Solution

It is recommended that riparian corridors be widened and planted along the first 1.5 miles of channel from the mouth to 92nd Street East. This is easily achieved where the creek runs through the Riverside County Park. However, beyond that the park is private property. Approval, cooperation and participation by landowners will be essential. Public education will be useful in helping the property owners understand the benefits of participation in stream enhancement for them and the community.

Providing shade along riparian corridors will help maintain stream temperatures, shade out non-native invasive plants, and provide a source of woody debris to the stream.

8.2.2 Fine Sediment Burying Streambed Gravel

Problem Description

The agricultural nature of the Van Ogles Creek and lack of riparian corridor to filter fine sediments from runoff results in much fine sediment in the creek. In addition to this, the topography is very flat so the low slope along the creek is not sufficient to move the sediment downstream efficiently. Significant quantities of fine sediment can be seen in the channel burying spawning gravel and also building up along the banks.

Conceptual Solution

Providing a riparian corridor along the stream to protect banks and placing sediment traps at farm discharge points are the primary actions that will help reduce sediment to Van Ogles Creek. The more structure and complexity that can be naturally restored to the stream, the more the channel will be able to return to its inherent sediment transporting processes.

If sediment continues to accumulate once these measures are in place, a more detailed study should be made of the creek to identify remaining sediment sources. If necessary, sediment traps could be built in key places along the channel to capture and retain fines. Sediment traps require regular maintenance to remove sediment and retain capacity.

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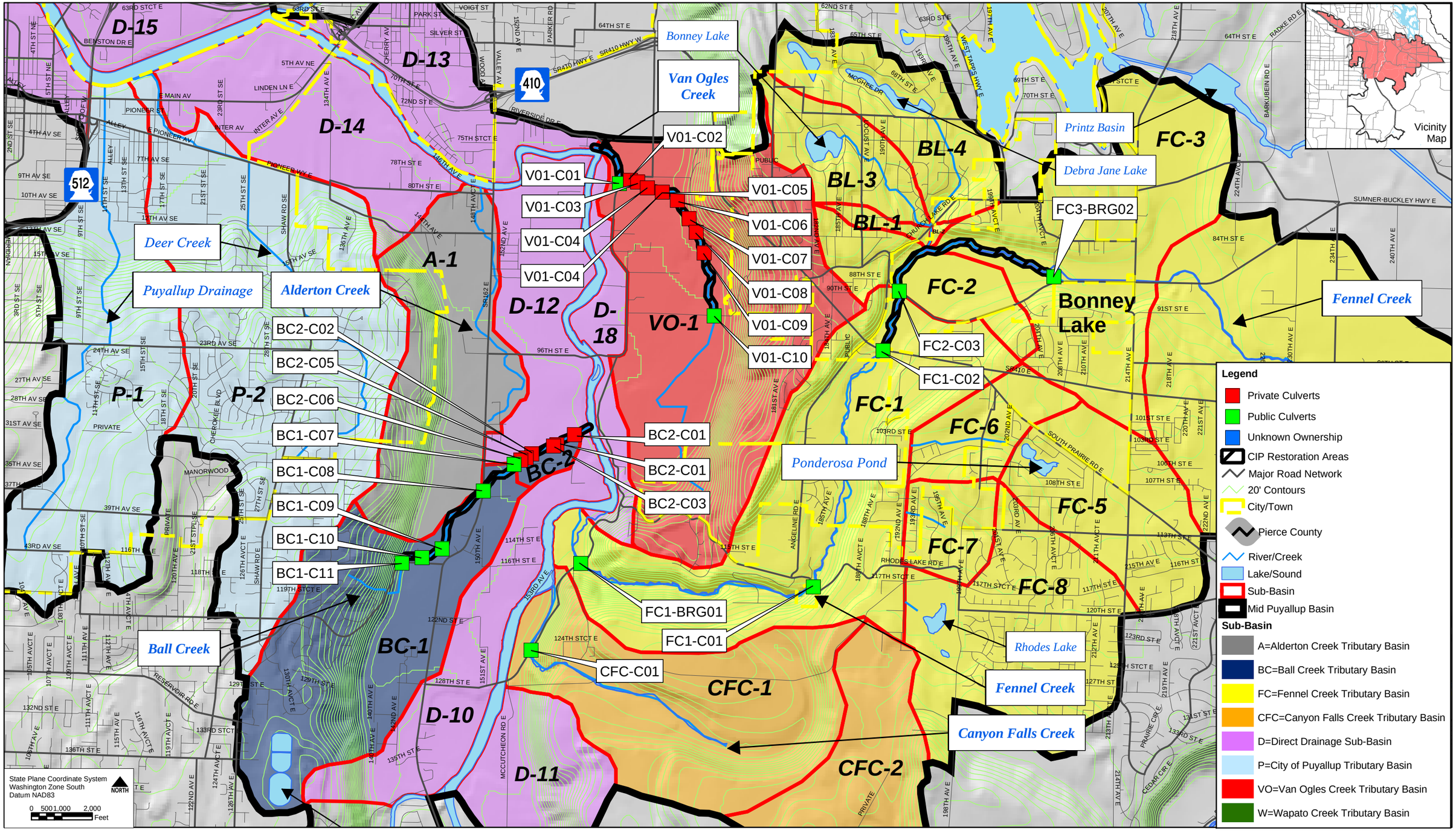

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Figure 8-1A: Fish Habitat and Barriers

Mid-Puyallup Basin Plan

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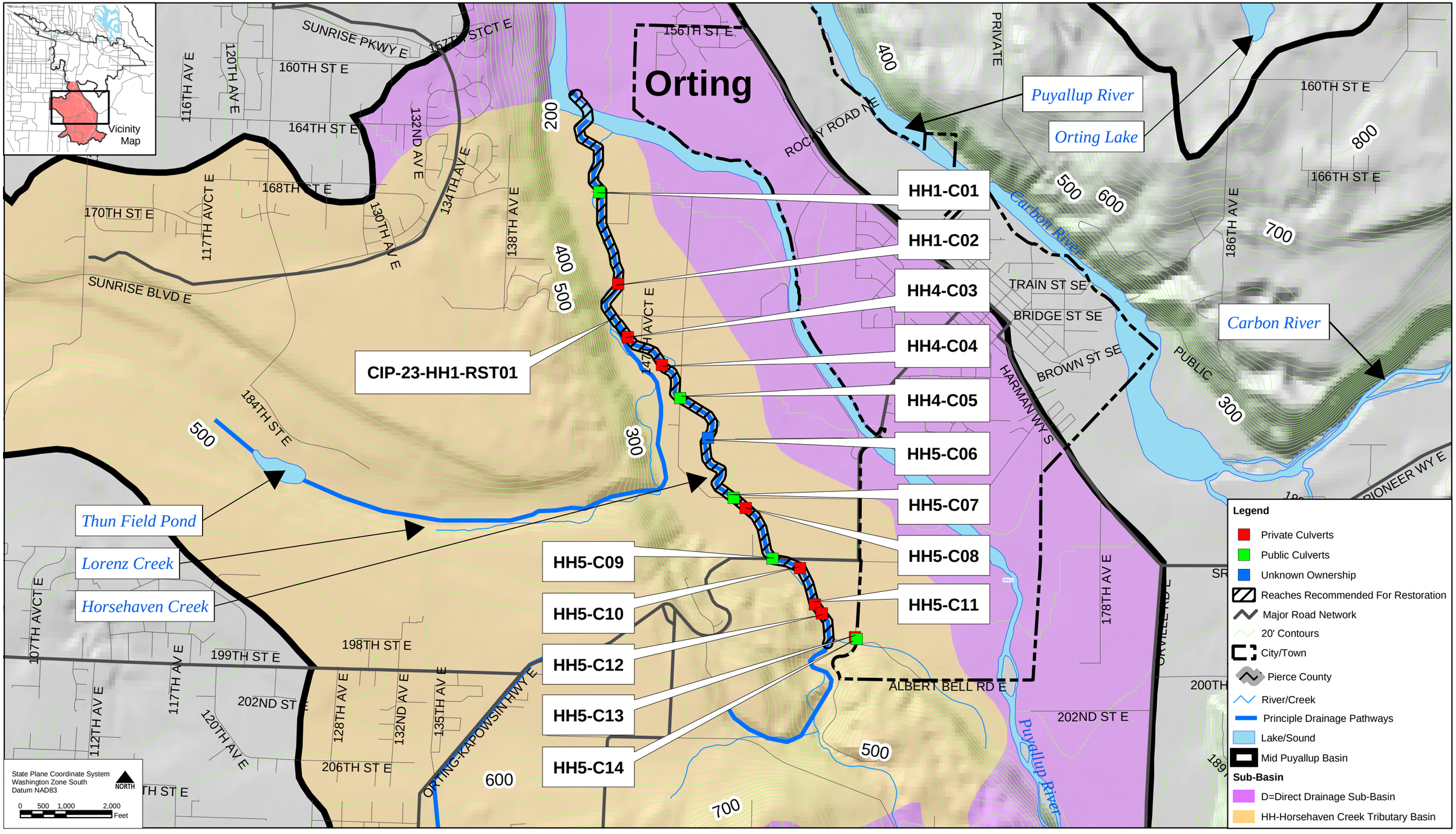

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Figure 8-1B: Fish Habitat and Barriers

Mid-Puyallup Basin Plan

PIERCE COUNTY entranco Momentum

8.2.3 Low Channel Complexity

Problem Description

Over the past century, Van Ogles Creek has lost much of the channel complexity that provides prime habitat conditions for fish because of historic agricultural practices. Complex features such as LWD, pool riffle intervals, sinuosity, gravel bars, and bank vegetation have been removed from the stream, greatly reducing the habitat value.

Conceptual Solution

Significant portions of the length of Van Ogles Creek could benefit from recreating a riparian corridor. Over time, the complex features found in forested channels would reestablish with LWD recruitment from the riparian corridor generating pools and stabilizing the bed and banks. Restoring these stream features provides quality habitat, clean spawning gravel, stable banks, and improved water quality.

Since most of the stream corridor is privately owned, we recommend the programmatic actions described in Chapter 9 for initiating stream restoration on private properties including education, incentive programs, and acquisition programs.

8.2.4 Fish Barrier Culvert VO1-C01

Problem Description

The culvert that conveys Van Ogles Creek under Riverside Drive E is a 48-inch round precast concrete pipe that is listed in the Pierce County Conservation District (Conservation District) culvert inventory as a fish passage barrier. The slope of the existing culvert is 1.5 percent overall with a slope break that has resulted from sectional pipe segments coming apart. This blockage is only a partial barrier because residents have reported fish further upstream.

Analytical Approach

The stream simulation method from the Washington State Department of Fish and Wildlife (WDFW) manual was used to design fish passage at road crossings (WDFW 1999). This is the most conservative method in the manual. With this method, culvert sizes are determined using the following formula:

$$W_{culvert} = 1.2\ W_{channel\ bed} + 2\ ft \qquad (W = width)$$

Because no flooding occurred with the existing culvert, an enlarged new culvert sized according to the formula will not create flooding.

Conceptual Solution

Replace the existing culvert with a box culvert that is 12-feet wide by 8-feet high, and 50-feet long. The culvert should be countersunk by three-feet, filled with streambed gravel and aligned with the natural gradient of the channel. More information on this solution is presented in Chapter 9 as CIP-23-VO1-C01.

8.2.5 Fish Barrier Culvert VO1-C04

Problem Description

The culvert under a private driveway (164th and 78th Street East) is a barrier to fish passage. It consists of a 48-inch diameter CMP that is 17-feet long. The property owner has placed boards across the downstream end to create a backwater pool for an irrigation intake. Notes in the Conservation District culvert inventory suggest that this is "probably not a barrier at most flows."

Analytical Approach

The stream simulation method from the WDFW manual was used to design fish passage at road crossings (WDFW 1999). This is the most conservative method in the manual. With this method, culvert sizes are determined using the following formula:

$$W_{culvert} = 1.2\ W_{channel\ bed} + 2\ ft \qquad (W = width)$$

No flooding occurred with the existing culvert. A new enlarged culvert will not flood.

Conceptual Solution

Replace the existing 48-inch culvert with a box culvert that is 12-feet wide by 5-feet high and 17-feet long. The culvert should be countersunk by two-feet, filled with streambed gravel and aligned with the natural gradient of the channel. Because these culverts are on private properties, the replacement projects will be referred to the Conservation District.

8.2.6 Fish Barrier Culvert VO1-C06

Problem Description

This barrier to fish passage is a culvert that conveys Van Ogles Creek between agricultural fields at a farm at (164th and 78th Street East). The existing culvert is a 36-inch CMP that is 21-feet long. It is fully submerged at both ends. This part of the creek is very slow flowing, with associated wetland areas both upstream and downstream.

Analytical Approach

The stream simulation method from the WDFW manual was used to design fish passage at road crossings (WDFW 1999). This is the most conservative method in the manual. With this method, culvert sizes are determined using the following formula:

$$W_{culvert} = 1.2\ W_{channel\ bed} + 2\ ft \qquad (W = width)$$

No flooding occurred with the existing culvert. A new enlarged culvert should not increase flooding.

Conceptual Solution

Replace the culvert with a box culvert that is 12-feet wide by 5-feet high, and 21-feet long. The culvert should be countersunk by two-feet, filled with streambed gravel and aligned with the natural gradient of the channel. Because these culvert occurs on private property, the replacement projects will be referred to the Conservation District.

8.2.7 Undetermined Fish Barriers[1]

Problem Description

Six culverts along Van Ogles Creek are undetermined fish barriers. Two of these culverts were surveyed by Conservation District and listed as a "Level B" culvert that will require hydraulic analysis to determine if it is a blockage or not. The other four culverts are not in the Conservation District inventory but appear on aerial photographs as road crossings. All but one of these culverts is on private property. The culvert farthest upstream on 96th Street East lies under a public road.

The six culverts needing further analysis to determine whether they are barriers to fish passage, from downstream to upstream, are as follows (locations provided on *Figure 8-1*):

- VO1-C02 – culvert under private driveway (78th Street E and Riverside Drive E)
- VO1-C05 – culvert under private access road (164th Avenue E at 78th Street E)
- VO1-C07 – culvert under private access road (near Elhi Road)
- VO1-C08 – culvert under private driveway (83rd Street E and 170th Avenue E)
- VO1-C09 – culvert under private access road (168th Avenue E and 92nd Street E)
- VO1-C10 – culvert under public road at 92nd Street E

[1] A barrier to fish passage is undetermined when an initial survey was not able to establish whether the culvert is a barrier to fish and further analysis is needed.

Analytical Approach

To determine fish passage for "Level B" culverts, velocities and flow depth through the culvert at the two-year event must be determined. This was done for all culverts listed as "Level B" in the Conservation District's culvert inventory. Modeling data were unavailable for Van Ogles Creek. Therefore, flows were estimated by scaling flow values from Ball Creek with a ratio of basin areas from the Ball and Van Ogles basins. The obtained values for velocity and depth were then compared to criteria for fish passage as stated in WAC 220-110-070.

Recommended culvert designs were based on the stream simulation method from the WDFW manual (WDFW 1999). This is the most conservative method in the manual. With this method, culvert sizes are determined using the following formula:

$$W_{culvert} = 1.2\ W_{channel\ bed} + 2\ ft \qquad (W = width)$$

Conceptual Solution

Culverts VO1-C02 and VO1-C05 are listed as "Level B" in the Conservation District fish passage inventory. Hydraulic analysis was used to determine that neither of these two culverts is a barrier to fish passage. However, notes in the Conservation District inventory say that the property owner has placed boards across the culvert to create a backwater area for irrigation intake. These boards may create a blockage to fish and dialog with the property owner to work out an equitable agreement is recommended.

Culverts VO1-C07, VO1-C08, and VO1-C09 are located on private properties. No access has been provided to evaluate these culverts and no other information is available at this time. These culverts will be referred to the Conservation District for resolution.

8.3 Ball Creek

Ball Creek flows from the west across the flat valley bottom and is known to support coho salmon and cutthroat trout even though the creek is listed as degraded. The habitat value in this stream is moderate but could be greatly improved by removing barriers to fish passage and working with property owners to restore riparian corridors. Below is a discussion of the various aspects of the stream condition and conceptual solutions.

CIPs that will serve to restore fish habitat in Ball Creek are CIP-23-BC2-RST01, CIP-23-BC2-AC01, and CIP-23-BC2-RST02 in conjunction with the following programmatic recommendations: PRG-00-02, PRG-00-04, PRG-00-05, PRG-00-06, and PRG-00-09. These programs and CIPs are described in greater detail in Chapter 9.

8.3.1 Fish Blockage at Mouth of Ball Creek

Problem Description

At the mouth of Ball Creek, there is a cascading drop to the Puyallup River. The cascade is made up of several large boulders. From observations of the site, the cascade presents a partial fish barrier to the rest of the creek. Some fish have been seen within the creek both by property owners and by the Consultants during field assessments. This indicates that the mouth is not entirely blocked.

Conceptual Solution

Restore Ball Creek to allow for fish passage. If necessary, the boulders should be removed and the stream regraded. The creek should be designed consistent with WDFW's Integrated Streambank Protection Guidelines (2003) to prevent the drop in gradient at the mouth from becoming a nick-point that migrates upstream. A short reach of log weirs could be used to form cascading pools. The property at the mouth of the creek may need to be acquired for this project to be implemented (Section 8.3.2).

8.3.2 Potential Property Acquisition

Problem Description

Unfortunately, little is known about the condition of the creek on the property at the mouth of Ball Creek. Three or four culverts exist on the property; however, little is known of their construction or whether they present barriers to fish passage. Aerial photographs indicate a very thin patchy riparian corridor exists along the creek. Based on channel conditions upstream, it is likely that fine sediment has buried any spawning gravel here.

Conceptual Solution

The 40-acre property at the mouth of Ball Creek is available for acquisition. Acquiring this property would allow the County to restore the creek in this area for spawning and rearing by coho salmon and to reconfigure the mouth to allow unobstructed fish passage (Section 8.3.1).

8.3.3 Sparse or Absent Riparian Corridors

Problem Description

The majority of Ball Creek, from the mouth to the culvert under Old Military Road, has sparse riparian corridors if any at all. The 1.5 miles of stream flows through mostly agricultural and residential land with lawns right up to the banks in many places.

Conceptual Solution

Revegetating as much of the riparian corridor along Ball Creek as possible will help improve both water quality and fish habitat. Providing shade along riparian corridors will help maintain stream temperatures, shade out non-native invasive plants, and provide a source of woody debris to the stream. This would best be achieved by CIP-23-BC2-RST02 for restoring stream riparian corridors as recommended in Chapter 9.

Most of Ball Creek flows through private property so efforts to replant riparian corridors would need to be with the approval of, and in cooperation with landowners. Recommended projects for restoring riparian corridors are shown on *Figure 8-1*.

8.3.4 Fine Sediment Burying Streambed Gravel

Problem Description

Fine sediment in Ball Creek is elevated above natural levels due to agricultural practices over the last century. The shallow gradient of this stream is inefficient at keeping fine sediment suspended so that it can be transported out of the system. Narrow culverts that constrict flow also deter the passage of fine material. Therefore the rate of sediment delivery has exceeded the transport capacity of the channel causing a build up of material in the channel. Field surveys found coarser gravel in the stream at a depth of up to two-feet below the fines in some places. The coarse material was the streambed gravel prior to the deposition of fine sediments. This fine material prevents these areas from being used for spawning by salmonids.

Conceptual Solution

Providing riparian corridors along the stream to protect banks and requiring sediment traps at farm discharge outfalls are the primary actions that will help reduce sediment accumulation in Ball Creek. This can be achieved through the stream restoration projects discussed in Chapter 9. The more natural structure and complexity that can be restored to the stream, the more the channel will be able to return to its natural sediment transporting processes. Widening culverts along the channel will also help fine sediment to move through the system.

If sediment continues to accumulate once these measures are in place, a more detailed study should be made of the creek to identify remaining sediment sources. Sediment traps could be built in key places along the channel to capture and retain fines. Sediment traps require regular maintenance to remove sediment and retain capacity.

8.3.5 Low Channel Complexity

Problem Description

Over the past century, Ball Creek has lost much of the channel complexity that provides prime habitat conditions for fish. Complex features such as LWD, pool riffle intervals, sinuosity, gravel bars, and bank vegetation have been removed from the stream to accommodate development, greatly reducing the stream's habitat value.

Conceptual Solution

Significant portions of the length of Ball Creek could benefit from recreating a riparian corridor. Over time, the complex features seen in natural channels would be reestablished in Ball Creek. LWD recruitment from the riparian corridor (trees falling into the stream) would create pools and other stream features that help stabilize the bed and banks. Restoring these stream features would provide quality habitat, clean spawning gravel, stable banks, and improved water quality.

Where stream corridors are privately owned and CIPs are difficult to implement, we recommend the programmatic actions described in Chapter 9 for initiating stream restoration on private properties. Specifically recommended are PRG-00-04 to acquire riparian land and PRG-00-06 to educate land owners and encourage public participation in restoration.

8.3.6 Fish Barrier Culvert BC2-C05

Problem Description

This culvert is under a footpath on private property (154th Avenue East and 106th Street East). A generalized location is shown on *Figure 8-1*. The footpath provides access to the portion of a backyard that is north of the creek. The culvert consists of twin 24-inch corrugated metal pipes (CMPs) that are 11-feet long. The culvert is listed as a barrier because the slope of the culvert invert is more than 1 percent (1%).

Analytical Approach

This culvert is listed as a fish barrier in the Conservation District culvert inventory. The Conservation District used the method provided in the WDFWs Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual to determine the status of each culvert in their inventory.

Conceptual Solution

Because this footpath is over a small stream, a solution may be to construct a small bridge across the stream for pedestrian access to the back portion of the lot. Because this is private property, the property owner's permission would be required. Removing the culvert would open about 0.1 mile

of channel upstream until the next culvert. Though this is not much of the overall channel, the culvert is furthest downstream of all the blockage problems and would need to be replaced before fish could access any of the other reaches.

There is a possibility that other fish blockages are present further downstream on a property where access was denied by the property owner. The uncertainty could be rectified if this property is acquired as suggested in Section 8.3.2.

8.3.7 Fish Barrier Culvert BC1-C07

Problem Description

A 36-inch precast concrete culvert conveys Ball Creek under 106th Street East. This culvert is not only a fish passage barrier, but also creates frequent flooding problems. The culvert is listed in the Basin Plan as a flooding problem and is addressed in Section 6.2, which recommends replacing the culvert to reduce flooding and to make it fish passable. Opening this culvert to fish passage would allow fish access to an additional 0.3 mile of stream upstream from the culvert under Pioneer Way East (Section 8.3.8).

This culvert is also responsible for periodic flooding. See also Section 6.3.3.

Analytical Approach

The culvert is both a flooding and fish blockage problem. Culverts sized for fish passage typically exceed the necessary design capacity for flood flows. Therefore, to avoid constructing another barrier to fish passage, the conceptual solution for this culvert uses the fish passage criteria for the stream simulation option presented in the WDFW Fish Passage Design at Road Crossings Manual. Average stream width was estimated to be eight-feet based on field observations. The hydraulic model developed for Ball Creek was used to verify that this culvert is adequate for carrying flood flows.

Conceptual Solution

The existing culvert should be replaced with a 12-foot-wide culvert for fish passage. A circular culvert of this size, counter sunk to 50 percent (50%), would increase the elevation of the roadway over the culvert by about four-feet. Therefore, we recommend a 12-foot by 5-foot box culvert that is 31-feet long, counter sunk and filled with three-feet of streambed gravel so that there is at least a two-foot opening above the bed. This would allow the road elevation to remain consistent and still provide the needed width. The conceptual solution for this problem is presented in Chapter 9 as CIP-23-BC1-C07.

The project should include stabilizing (through restoration) the eroded bank upstream of the culvert to reestablish the mean channel width. This will help reduce the amount of sediment that accumulates in the area. The bank on the outside of the bend should be reinforced with a

combination of rock and large wood with flow deflectors to further protect the bank from high velocity flows in a manner consistent with WDFW's Integrated Streambank Protection Guidelines (2003). Identifying and controlling upstream sediment sources could also reduce the influx of sediment to the stream.

Downstream conditions for both flooding and fish passage should be addressed in conjunction with replacing the 106th Street East culvert. Increasing the capacity of this culvert will increase flow in the downstream reaches during large events. Six culverts on private land below 106th Street East could be affected by this replacement. This Basin Plan recommends replacing several of the downstream culverts to address fish passage and flooding problems. Downstream culverts that are not replaced either before or in conjunction with replacing the 106th Street East culvert may see increased flooding.

Designing the 106th Street East culvert to allow fish passage is only beneficial if there is accessibility to the culverts in the lower stream reach. Some of the downstream culverts are known to be barriers to fish and are recommended for replacement in this Basin Plan. Three culverts near the mouth of the creek are inaccessible because they are on private property and therefore have not been evaluated for fish passage. Nevertheless, the culverts will also need to be addressed in connection with the 106th Street East culvert replacement.

8.3.8 Fish Barrier Culvert BC1-C08

Problem Description

This is the culvert under Pioneer Way south of 106th Street East. The culvert consists of two pipes; one is an 18-inch CMP that is 58-feet long, and the other is a 24-inch cast-in-place concrete (CPC) pipe that is 59-feet long. On the downstream end, both pipes are 18-inch precast concrete pipes. This indicates that there is likely a slope break somewhere along this culvert. The culvert is considered a fish barrier for this reason and because both pipes have a slope of more than 1 percent (1%). Upstream of this barrier is 0.5 mile of stream before the next barrier is encountered.

Analytical Approach

The stream simulation method from the WDFW manual was used to design fish passage at road crossings (WDFW 1999). This is the most conservative method in the manual. With this method, culvert sizes are determined using the following formula:

$$W_{culvert} = 1.2\ W_{channel\ bed} + 2\ ft \qquad (W = width)$$

No flooding occurred with the existing culvert. No flooding is expected to occur due to an enlarged new culvert.

Conceptual Solution

Replace the existing culvert with a 12-foot by 5-foot box culvert, 60 feet long, that is counter sunk along the gradient of the stream.

8.3.9 Fish Barrier Culvert BC1-C09

Problem Description

This culvert (comprised of two pipes) sits under a publicly owned dirt road that parallels the railroad on the west side of Pioneer Way. The twin 24-inch CMPs are 38-feet long and are impassable to fish because the slope exceeds one percent (1%). This is the last identified fish barrier at the top of the creek and would open an additional 0.4 mile of creek habitat if replaced. The location of this culvert is shown on *Figure 8-1*.

Analytical Approach

The stream simulation method from the WDFW manual was used to design fish passage at road crossings (WDFW 1999). This is the most conservative method in the manual. With this method, culvert sizes are determined using the following formula:

$$W_{culvert} = 1.2\ W_{channel\ bed} + 2\ ft \qquad (W = width)$$

No flooding occurred with the existing culvert. No flooding is expected to occur due to the new enlarged culvert.

Conceptual Solution

It is recommended that this culvert be replaced with a 12-foot by 5-foot box culvert, 40-feet long, that is counter sunk along the gradient of the stream.

8.3.10 Undetermined Fish Barriers

Problem Description[2]

Two culverts on Ball Creek are listed in the Pierce County Conservation District Inventory as undetermined. In addition, three or possibly four culverts near the mouth of the creek are potentially unknown barriers because the property owner has not given permission for these culverts to be evaluated.

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[2] Ball Creek has only one culvert, BC2-C06, which has been established as being neither a flooding problem nor a fish passage barrier.

The two culverts in the inventory are (shown on *Figure 8-1*):

- BC2-C04 – Culvert under a backyard footpath on private property, currently 24-inch-diameter, 16-foot-long
- BC1-C11 – Culvert under Old Military Road East, currently 42-inch-diameter, 63-foot-long

Analytical Approach

The culverts were analyzed according to the method described in the WDFW Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual for analysis of "Level B" culverts. Manning's equation was used to calculate flow velocities. The hydraulic model, developed to evaluate flooding, was used to provide input flow data to confirm the results.

Conceptual Solution

Culvert BC2-C04 was found in the analysis to be passable by fish. However, the culvert was also determined by modeling (see Chapter 6) to flood at a 50-year event. Therefore, this culvert is recommended for replacement on the basis of flooding.

Culvert BC1-C11 was found to exceed the velocity threshold of four-feet per second (fps) (as listed in WAC 220-110-070 for adult trout and other salmonids) at high flows. Following the WDFW fish passage design manual, a 12-foot by 5-foot box culvert, 63-feet long, is recommended as a replacement. The slope of the culvert should follow the gradient of the streambed if possible.

Replacement of this culvert is not critical because it lies near the stream headwaters where habitat value is low and spawning or rearing is unlikely.

8.4 Fennel Creek

Fennel Creek drains most of the upland plateau in the northeast part of the Basin. Chinook and coho salmon use the lower reaches up to Victor Falls, which acts as a natural fish barrier restricting anadromous fish from the upper reaches.

The Fennel Creek Basin is undergoing rapid residential development. Following, is a discussion of the various aspects of the stream condition.

The CIP that will serve to restore fish habitat in Fennel Creek is as follows: CIP-23-FC1-RST01, in conjunction with programs PRG-00-02, PRG-00-04, PRG-00-05, PRG-00-06, and PRG-00-09. These programs and CIPs are further described in Chapter 9.

8.4.1 Sparse or Absent Riparian Corridors

Problem Description

Riparian corridors are sparse or absent along most of the upper reaches from the headwaters of Fennel Creek down to Rhodes Lake Road near Victor Falls. Beyond this location, the riparian corridors are fully forested to the creek's mouth. Most areas adjacent to the creek are agricultural and rural-residential areas.

Conceptual Solution

Replanting trees along the stream banks in as many locations as possible will help to revegetate and reconnect the riparian corridor. This can be facilitated by the programmatic and proposed CIP recommendations discussed in this section and Chapter 9. Providing shade along the stream will help maintain stream temperatures, shade out non-native invasive plants, and provide a source of woody debris to the stream channel.

A restoration project (CIP-23-FC1-RST01) could be undertaken to restore the three reaches of Fennel Creek between SR-410 and Kelly Lake Road. The project could address the loss of the riparian corridor and loss of channel complexity described in Section 8.4.2 below. Most of the land adjacent to the creek is private property. Several properties are large hobby farms. Cooperation of these landowners could benefit long reaches of the stream while involving a few property owners.

Public education of the people with stream corridors across their property would also help improve habitat for the creek's resident trout on private property and help to maintain water quality. This could be accomplished by implementing PRG-00-06, the Education, Outreach, and Technical Assistance Program. A part of the program is intended for property owners who want to be good stewards of streams and floodplain areas on their property, but could use information on the practical means of doing so.

8.4.2 Low Channel Complexity

Problem Description

The loss of channel complexity in Fennel Creek has taken place mostly in the reaches upstream of Victor Falls. Although the creek has resident cutthroat trout in the upper reaches, this part of the creek is not accessible to salmonids because of the natural barrier at the falls. Nevertheless, the character of the upper reaches affects temperature, dissolved oxygen levels and similar water quality characteristics.

Conceptual Solutions

Restoration of the upper sections of Fennel Creek would not only benefit resident cutthroat, but also anadromous fish in the lower reaches. Restoring stream complexity would provide quality habitat, clean spawning gravel, stable banks, and improved water quality. Restoration of the full 1.6 miles of this creek can be broken down by the segments of the creek defined during the stream assessment (shown on *Figure 4-11*) and divided into phases as described in CIP23- FC1-RST01.

Public education of the people with stream corridors across their property would also help improve habitat for the creek's resident trout on private property and help to maintain water quality. This could be accomplished by implementing PRG-00-06, the Education, Outreach, and Technical Assistance Program.

8.5 Canyon Falls Creek

Canyon Falls Creek flows from springs on the east valley wall south of Fennel Creek. The creek supports small runs of coho, chum, and pink salmon and winter steelhead as far as McCutcheon Road.

8.5.1 Fish Barrier Culvert CFC1-C01

Problem Description

The Conservation District inventoried the culvert under McCutcheon Road and listed it as an unknown fish passage barrier. McCutcheon Road crosses Canyon Falls Creek at about 0.6 river mile from its mouth. The 36-inch precast concrete pipe was submerged on either end with a slope of 1.3 percent, which created a partial blockage to fish due to high velocities. Fish passage through this culvert was possible but difficult. This is confirmed by field visits during spawning season where many salmon carcasses were found on the downstream end but only a few on the upstream side.

There is approximately 0.25 mile of spawning habitat above this culvert. The upstream reaches are good habitat with clean gravel, fully forested riparian corridors, and adequate water quality. At the end of the 0.25-mile stream reach is a commercial fish hatchery. Migrating fish are unable to go beyond the hatchery.

Conceptual Solution

This culvert was replaced by the Roads Division during the summer of 2003.

8.6 Horsehaven Creek

Horsehaven Creek has its headwaters on the plateau above the Puyallup River valley wall in the southwestern corner of the Basin. The creek flows down into the valley and then across the flat valley bottom to the Puyallup River. The creek supports coho and chum salmon and cutthroat trout. A discussion of the various aspects of the stream condition follow. CIPs that will serve to restore fish habitat in Horsehaven Creek are CIP-23-HH1-RST01, CIP-23-HH1-AC01, and CIP-23-HH1-AC02 in conjunction with programs PRG-00-02, PRG-00-04, PRG-00-05, PRG-00-06, and PRG-00-09. These programs and CIPs are further described in Chapter 9.

8.6.1 Sparse or Absent Riparian Corridors

Problem Description

Aerial photographs show sparse or absent riparian corridors along Horsehaven Creek in a number of places. The first river mile of the creek is relatively shaded with a healthy riparian corridor. However, upstream from 176th Street East, the stream passes into mostly agricultural and residential land with only a few areas of trees along the river. This condition persists upstream for about 1.7 river miles until well beyond the Orting-Kapowsin Highway. Beyond the Orting-Kapowsin Highway, the forest canopy returns and extends up the valley wall to the stream's headwaters.

Conceptual Solution

Replanting trees along the stream banks in as many locations as possible will help to reconnect the riparian corridor, also will shade Horsehaven Creek to help maintain stream temperatures, shade out non-native invasive plants, and provide a source of woody debris to the stream for channel complexity. Please refer also to the CIP projects for riparian corridor restoration discussed in Chapter 9.

Most of the adjacent land along the creek is private property and will need the cooperation of landowners for restoring riparian corridors. Many of the lots are large hobby farms so gaining cooperation with even a few landowners could significantly enhance the creek's riparian corridor.

8.6.2 Sediment Accumulation in Lower Reaches

Problem Description

Fine sediment has built up in the lower reaches of Horsehaven Creek burying spawning gravels to a depth of several feet. This section of creek near the confluence with the Puyallup River provides valuable refuge for spawning fish and rearing area for fingerlings. Much of the sediment is assumed to come from local hobby farms and other agricultural practices upstream.

Conceptual Solution

The property from 168th Street East to the mouth of the creek is undeveloped and has relatively high habitat value with fully vegetated riparian areas. This property should be preserved through acquisition to protect its existing floodplain habitat value. Additional actions could include removing fine sediment from the streambed to provide 0.5 mile of spawning and rearing habitat for salmonids. It is recommended that upstream sediment sources be identified and eliminated or reduced to prevent further accumulation of fines in the future.

8.6.3 Stream Bank Damage from Livestock

Problem Description

At several locations along Horsehaven Creek, stream banks have been damaged or continue to be damaged by livestock. These places are highly susceptible to erosion and contribute fine sediment and fecal coliform bacteria to the stream.

Conceptual Solution

It is recommended that livestock access to the stream be controlled with either fencing or vegetated riparian corridors (CIP-23-HH1-RST01) or a combination of both (see recommendations in Chapter 9). Controlling cattle access reduces the amount of bank trampling. Public education and financial support to implement other ways to water livestock could be a valuable part of gaining participation from landowners.

8.6.4 Fine Sediment Burying Streambed Gravel

Problem Description

Fine sediment is abundant in Horsehaven Creek from agricultural practices and site development activities. Dairy farms, hobby farms, and other operations that allow livestock to access the creek have been a major contributor. Land development practices have allowed soil to stay exposed during rains without sufficient erosion and sedimentation controls. Fine grains fall out of the water often far from their origin. The shallow gradient of most of these streams is not effective at keeping fine sediment suspended so that it can be transported out of the system.

Conceptual Solution

The fine sediment in Horsehaven Creek can be dealt with in a variety of ways. It is recom-mended that sediment sources be identified and eliminated or reduced. Sediment traps could also be built along the channel to capture and retain fines. Revegetating stream corridors will also help filter silt-laden runoff and reduce fine sediments from entering the stream (see Section 8.6.1).

The more natural structure and complexity that can be restored to the stream (see Section 8.6.5), the more the channel will be able to return to its natural sediment transporting processes.

8.6.5 Low Channel Complexity

Problem Description

Over the past century, Horsehaven Creek has lost much of the channel complexity that provides prime habitat conditions for fish. Complex features such as LWD, pool riffle intervals, sinuosity, gravel bars, and bank vegetation have been removed from the stream greatly reducing habitat value.

Conceptual Solution

Significant portions of Horsehaven Creek could benefit from replacing the riparian corridor. Over time, the complex features could be reestablished through LWD recruitment from the riparian corridor, which would help generate pools and stabilize the bed and banks.

Since the stream corridor is privately owned, we recommend the programmatic actions and CIPs described in Chapter 9 for initiating stream restoration on private properties including education, incentive programs, and acquisition programs.

8.6.6 Fish Barrier Culvert HH4-C05

The culvert allowing Horsehaven Creek to pass under 150th Avenue East (a public road) consists of twin pipes. The culvert is twin 36-inch diameter precast concrete pipes.

The homeowner at the upstream end of the pipes has placed boards across the lower half of the pipe opening to create a decorative pond on his property. The Conservation District culvert inventory claims that these boards create a barrier because they cause the flow to drop into the upper end of the pipe and suggest that if the boards were removed, the culvert would not be a barrier.

The property owner has reported that fish pass through this culvert very regularly and the owner does not believe the boards create a barrier. The property owner removes the boards during high flows to prevent flooding. There is roughly 1.0 mile of channel upstream of this culvert before the next blockage is encountered as shown on *Figure 8-1*.

The road at this location flooded once to a depth of six (6) inches during the 1996–97 storm. Conceptual solutions to the barrier to fish passage problem are discussed in Chapter 6 with the flooding problems; this chapter recommends a culvert replacement design with baffles to accommodate low-flow fish passage and high-flow stormwater conveyance.

8.6.7 Fish Barrier Culvert HH5-C10

Problem Description

A private driveway culvert just north of the Orting-Kapowsin Highway conveys Horsehaven Creek under the residential driveway. The culvert is a 36-inch-diameter precast concrete pipe that is 38-feet long. The slope of this culvert is severe, at 2.3 percent (2.3%), and is the reason this culvert is listed as a barrier to fish. Upstream of this culvert is about 0.35 mile of channel before the next barrier is encountered.

Analytical Approach

The stream simulation method from the WDFW manual was used to design fish passage at road crossings (WDFW 1999). This is the most conservative method in the manual. With this method, culvert sizes are determined using the following formula:

$$W_{culvert} = 1.2\ W_{channel\ bed} + 2\ ft \qquad (W = width)$$

Because no flooding occurred with the existing culvert, the new culvert will also not flood because it has much greater capacity.

Conceptual Solution

Replace this culvert with a 12-foot-wide by 5-foot-high box culvert, 38-feet long, that can allow the natural bed material to move through and the slope of the channel to equilibrate. Because this culvert is on private property, this project will be referred to the Conservation District.

8.6.8 Fish Barrier Culvert HH5-C13

Problem Description

This culvert is under a footpath on private property only a few feet from the culvert under 162nd Avenue East. The culvert is a 24-inch diameter precast concrete pipe with a steep slope of 2.3 percent (2.3%).

According to the culvert inventory, this culvert is a barrier because it is submerged and has riprap blocking the downstream end of the pipe. There is also significant sediment in the pipe creating the potential for clogging.

Above this point, the stream becomes smaller and merges with its headwater wetlands.

Analytical Approach

The stream simulation method from the WDFW manual was used to design fish passage at road crossings (WDFW 1999). This is the most conservative method in the manual. With this method, culvert sizes are determined using the following formula:

$$W_{culvert} = 1.2\ W_{channel\ bed} + 2\ ft \qquad (W = width)$$

Because no flooding occurred with the existing culvert, the new culvert will also not flood because it has much greater capacity.

Conceptual Solution

Since this is a footpath over a small stream, we recommend a small bridge as a replacement for the blocking culvert. This would allow a natural channel to be restored underneath. Coordination with the property owner would be needed and could be facilitated by programmatic recommendations related to public education discussed in Chapter 9.

Because this culvert is on private property, this project will be referred to the Conservation District for implementation.

8.6.9 Unknown Fish Barriers[3]

Four culverts have been identified on Horsehaven Creek and are listed in the Conservation District drainage inventory as "Level B" barriers. A "Level B" barrier is a culvert that has been assessed with the WDFW fish barrier screening criteria and needs hydraulic analysis to make a final determination if it is fish passable. These four culverts are listed below in order from downstream to upstream:

1. HH1-C01 – Culvert under 168th Street E (168th Street E culvert, public)
2. HH4-C04 – Culvert under private road off 150th Avenue (17916 150th Avenue E, private)
3. HH4-C06 – Culvert under 184th Street E (18213 150th Avenue E, private)

In addition to these culverts, two more were found during field visits. One of these is a driveway culvert on private property off of 188th Street East where the stream gauge was placed for this Basin Plan. There is a 36-inch CMP here that is unlikely to be a fish barrier.

The other culvert is a backyard livestock crossing with a 36-inch precast concrete pipe. These culverts are shown on *Figure 8-1*.

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[3] Four culverts on Horsehaven Creek present neither a flooding nor a fish barrier problem. These are HH5-C09, HH5-C11, HH5-C12, and HH5-C14.

Analytical Approach

These culverts were analyzed according to the method described in the WDFW Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual for analysis of "Level B" culverts. Manning's equation was used to calculate flow velocities. The hydraulic model developed to evaluate flooding was used to provide input information and also to verify the results.

Conceptual Solution

Velocities for culvert HH1-C01 are below the threshold value of 4 fps (as listed in WAC 220-110-070 for adult trout and other salmonids) at high flows and the minimum depth requirement is also met. Therefore, this culvert is not a fish barrier and does not need to be replaced.

HH5-C04 consists of twin culverts. These twin culverts allow the Horsehaven Creek to pass under a private road just west of 150th Ave East. This is likely to be a fish barrier based on visual inspection, but no formal investigation has been done. This project will be referred to the Conservation District for determination and implementation.

Field visits to barrier HH4-C06 revealed that this is not a culvert but rather a small dam created by a property owner to make a decorative pond on the property. The owner has observed fish passing beyond this weir. This site is most likely a partial fish barrier. Because the obstruction is on private property, this case can best be addressed with programmatic measures related to public education regarding stream function, which is discussed in Chapter 9.

It is recommended that culverts HH5-C15 and HH5-C16 be formally evaluated and added to the inventory. These projects will be referred to the Conservation District for determination and implementation.

8.7 Coordination with Pierce Conservation District

Culverts on private property that are fish passage barriers or that have an unknown status will be referred to the Conservation District. The Conservation District has a program for working with land owners on an individual basis to determine if culverts are fish passable and assisting in replacing those that present barriers to fish passage. The culverts that will be referred to the Conservation District are presented in *Table 8-1*.

Table 8-1
Private Property Culvert/Fish Barrier Issues

ID No.	Conservation District ID No.	Location	Status
VO1-CO2	R052622b	7800 block Riverside Drive	Unknown barrier
VO1-C04	R052717b	16400 block78th Street E	Barrier
VO1-C05	R052716b	16400 block 78th Street E	Unknown barrier
VO1-C06	R052717a	16400 block 78th Street E	Barrier
VO1-C07	No ID number	Near Elhi Road	Unknown
VO1-C08	No ID number	8300 block 170th Avenue E	Unknown
VO1-C09	No ID number	16800 block 92nd Street E	Unknown
HH5-C04	R051115b	17900 block 150 Ave E.	Barrier
HH5-C10	R051118a	Orting Kapowsin Road	Barrier
HH5-C13	R050520a	19600 block 162nd Avenue E	Barrier

9. BASIN PLAN

This Chapter contains the Mid-Puyallup Basin Plan, a set of recommended capital improvement projects (CIP), programmatic measures, and activities to close information gaps, that if implemented, will solve the flooding, water quality, fish habitat and other storm drainage problems identified and analyzed in previous chapters.

Programmatic measures are nonstructural solutions. They are recommendations to solve certain problems by doing things differently, such as: changing particular Pierce County procedures or operational policies; providing technical assistance; compliance assurance; and public outreach and information programs.

All of the recommendations focus on feasible solutions that achieve the goals of the basin plan; i.e., to reduce flood hazards, improve water quality, improve fish habitat related to stormwater management methods, ensure coordinated and responsible use of public resources, and influence the location and methods for new development.

The Chapter is organized as follows:

- Summary of Plan Recommendations
- Plan Approach to Basin Issues
- Individual Basin Plan Recommendations

This Chapter establishes the direction that the Water Programs Division will take within the Mid-Puyallup Basin over the next five to ten years.

9.1 Plan Summary

The Mid-Puyallup Basin Plan contains 23 capital improvement projects, 11 programmatic measures and five studies to address flooding, erosion, water quality, and stream habitat problems resulting from stormwater runoff in the Basin.

Several of the recommended actions address multiple problems. For example, a culvert replacement may reduce flooding due to the backwater effects of an undersized culvert and remove a barrier to fish passage. A stormwater infiltration pond can help recharge groundwater that provides the base flow (perennial flow) for basin streams, and the pond can reduce downstream flooding during storm events by containing peak flows.

The CIP's and programmatic measures have been individually ranked using a common system employed in all County basin plans, put in rank order, and distributed into "High-Priority," "Medium-Priority," or "Low-Priority" groups. Estimated costs of the resulting recommendations are as follows:

"High-Priority" Recommendations:	**$1,091,000**
"Medium-Priority" Recommendations:	**$14,317,200**
"Low-Priority" Recommendations:	**$1,080,500**

In theory, implementation starts with "High-Priority" projects and recommended activities, then "Medium-Priority," followed by "Low-Priority" projects and activities in turn. In practice, the order of project implementation could vary to reflect such factors as: availability of funds; staff and professional service resources availability; 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, new regulations, or new public concerns.

The specific strategy for CIP's will be reflected in the County's annual Capital Facilities Element of the Comprehensive Plan for Pierce County, Washington. Programmatic measures and CIP's will appear in the annual budget for Water Programs.

9.1.1 Capital Improvement Projects

For the Mid-Puyallup Basin, 23 CIP's have been recommended to improve drainage, solve flooding problems, protect floodplain and water quality, and improve fish habitat. These CIP's are grouped by tributary basin so that links between projects can be easily identified. The flooding problems identified in this Basin Plan do not affect any critical facilities (described in Section 4.3.1). The number of projects in each tributary basin is:

- Alderton Creek Basin – 1
- Van Ogles Creek Basin – 2
- Ball Creek Basin – 8
- Fennel Creek Basin – 4
- Horsehaven Creek Basin – 6
- Direct Discharge Subbasins – 2

Table 9-1 shows how each project ranks. Descriptions of each CIP and its links to other projects are provided in Section 9.3.2. The total estimated cost for the recommended CIP's is $14,851,200.

9.1.2 Programmatic Recommendations

This Basin Plan recommends a variety of activities that will help Pierce County achieve its water resource-related goals if implemented. The programmatic activities are:

- Low Impact Development (LID) Pilot Study
- Update Stormwater Management Standards
- Inspection Increases for Stormwater Compliance
- Land Acquisition Program
- Restoration and Enhancement Program
- Education, Outreach, and Technical Assistance Program
- Monitoring Program
- Best Management Practices (BMPs) for Maintenance Manual
- Invasive Species Management Program
- Flood Disclosure Statements in Property Titles
- Enhanced Cooperative Arrangement with cities and other jurisdictions

Most of the recommended programs apply county-wide. Cost estimates for implementing the county-wide programs in the Mid-Puyallup Basin are based on a 10.2 percent share of the overall county-wide costs over a 10-year period. 10.2 percent is the Mid-Puyallup Basin's current proportionate annual contribution to Surface Water Management revenues. A period of 10 years was chosen for the purpose of estimating cost although most programs are expected to continue indefinitely. The total estimated cost to implement the recommended programs in the Mid-Puyallup Basin is $1,637,500.

9.1.3 Additional Studies

Five studies are recommended to gain a better understanding of the Basin's conditions. These studies are as follows:

- Identify sources of fine sediment on Van Ogles Creek, Ball Creek, and Horsehaven Creek to enable focused habitat restoration.
- Assess the extent to which septic systems failures in the valley of the Mid-Puyallup Basin are related to surface water and groundwater flooding.
- Confirm the Basin boundary based on a combination of surface and groundwater hydrology.
- Identify the contribution that groundwater makes to flow in the tributaries along the valley bottom.
- Identify critical wetland areas.

Total estimated cost for the recommended studies is $415,000.

Table 9-1
Summary Recommendations

Project Name	Project No	Score	Estimated Cost
HIGH-PRIORITY RECOMMENDATIONS			
Update Stormwater Management Standards	PRG-00-02	380	$3,000
BMP Maintenance Manual	PRG-00-08	427	$21,000
Invasive Species Management Program	PRG-00-09	437	$21,000
Develop Land Acquisition Program	PRG-00-04	389	$27,000
Jansky Road Channel Stabilization	CIP-23-HH8-RST02	331	$99,000
LID Pilot Study	PRG-23-01	346	$100,000
Education, Outreach, and Technical Assistance	PRG-00-06	397	$102,000
106th Street E Culvert Replacement	CIP-23-BC1-C07	332	$106,000
Inspection Increases for Stormwater Compliance Requirements and NPDES Permit	PRG-00-03	398	$612,000
Total estimated cost of High-Priority Projects			$1,091,000

Table 9-1 (Continued) Summary Recommendations

MEDIUM-PRIORITY RECOMMENDATIONS			
Ball Creek Fish Barrier Culvert Replacements	CIP-23-BC2-C01-C06	234	$39,000
Horsehaven Riparian Property Acquisition	CIP-23-HH1-AC02	297	$79,200
188th Street E Culvert Replacement	CIP-23-HH5-C07	302	$87,000
Mouth of Ball Creek Fish Passage	CIP-23-BC2-RST01	198	$131,000
Enhanced Cooperative Arrangement with Cities and other Jurisdictions	RRG-00-11	315	$150,000
150th Avenue Culvert Replacement	CIP-23-HH4-C05	206	$151,000
Fir Ridge Infiltration Pond	CIP-23-FC5-DP01	274	$205,000
Mouth of Horsehaven Creek Property Acquisition	CIP-23-HH1-AC01	300	$264,000
Mouth of Ball Creek Property Acquisition	CIP-23-BC2-AC01	220	$264,000
Restoration and Enhancement Program	PRG-00-05	325	$102,000
McCutcheon Road Bridge Replacement	CIP-23-FC1-BRG01	197	$345,000
Monitoring Program	PRG-00-07	265	$474,000
Van Ogles Creek Replacement	CIP-23-V01-RST01	262	$2,362,000*
Fennel Creek Restoration	CIP-23-FC1-RST01	294	$2,494,000*
Ball Creek Restoration	CIP-23-BC2-RST02	272	$2,494,000*
Horsehaven Creek Restoration	CIP-23-HH1-RST01	289	$4,676,000*
Total estimated cost of Medium-Priority Projects			$14,317,200

LOW-PRIORITY RECOMMENDATIONS			
Flood Disclosure Statements in Property Titles	PRG-00-10	85	$25,500
Military Road Culvert Replacement	CIP-23-BC1-C11	120	$44,000
Pioneer Way Conveyance Improvements	CIP-23-A1-RF01	132	$53,000
Freeman Road Conveyance Improvements	CIP-23-D17-RF03	62	$86,000
Railroad Culvert Replacement	CIP-23-BC1-C09	132	$96,000
Pioneer Way Culvert Replacement	CIP-23-BC1-C08	142	$142,000
Riverside Drive E Culvert Replacement	CIP-23-V01-C01	75	$148,000
Flooded Property Acquisition	CIP-23-D1-AC01	72	$197,000
Kelly Lake Road Bridge Replacement	CIP-23-FC3-BRG02	80	$289,000
Total estimated cost of Low-Priority Projects			$1,080,500

* These costs are total cost of multiphase projects; see CIP descriptions in 9.3.2 for breakdown.

9.1.4 Implementation Strategy

The capital improvement projects and programmatic measures have been individually ranked according to a common ranking system used by all the basin plans for Pierce County. Each potential CIP and programmatic recommendation was evaluated using a spreadsheet that assigned points for the project/program's potential for various aspects of flood reduction (approximately 35% of total score), water quality protection or improvement (30%), natural resource improvement (30%), and other factors such as multiple use, education, and recreation (5%). Each project and program was reviewed and scored using approximately 40 specific criteria. Scoring sheets are included in Appendix J for the CIP's and in Appendix K for the programmatic recommendations.

Recommended projects and programs were put in rank order based on their numeric benefit score, and grouped in descending order. Then, high, medium, or low status was assigned as follows:

- High-Priority: 25% of total number of recommendations
- Medium-Priority: 50% of total number of recommendations
- Low-Priority: 25% of total number of recommendations

After the order was established, projects and programs were ranked within their priority category from lowest cost to highest cost. This was done to direct County financial resources to where they do the most good for the financial resources invested. The recommended actions will be implemented according to the prioritized groupings of high, medium and low with high-priority recommendations being done first.

The order of project implementation will be flexible, reflecting factors such as:

- Available funds
- Availability of County staff and professional service needs
- Links between projects with differing priorities
- Cooperation from private landowners
- Projects completed by agencies other than Pierce County Public Works and Utilities
- New information, regulations, or emerging issues

Following adoption of the Mid-Puyallup Basin Plan (Basin Plan), Pierce County Water Programs will develop an implementation strategy designed to sequence, schedule, and assign resources for the various recommended actions, including the proposed studies.

The strategy for CIP's will be reflected in the Capital Facilities Element of the Comprehensive Plan for Pierce County, Washington and in the Pierce County Water Program's budget. This strategy will be developed in collaboration and coordination with other stakeholders and will consider the availability of financial and staff resources. The implementation strategy will include performance measures and provide for periodic evaluation of performance and progress.

Pierce County is responsible for implementing the recommendations in this Basin Plan with Pierce County Water Programs serving as the principal, frequently in partnership with other entities. Funding will be mainly derived from surface water management fees collected within the Mid-Puyallup Basin, but may also include federal grants and other local funds. Cost estimates are based on a 10-year period. The actual duration of full implementation and the timing of specific projects and programs are determined through annual budget decisions and annual updates to the Capital Facilities Element of the Comprehensive Plan.

9.2 Discussion of Basin Needs

Many issues in the Mid-Puyallup Basin are widespread problems that cannot be corrected by addressing a single site. Several drainage problems are a result of past practices in agriculture, landscaping, and land development. Such problem conditions can be improved by implementing local programs that guide and educate landowners and stakeholders to change how land and water are used. This section describes the considerations and basis for specific programmatic recommendations presented in Section 9.3.

9.2.1 Stormwater Impact Mitigation through Low Impact Development

Controlling runoff from impervious surfaces is a continuing challenge throughout the Pacific Northwest. Flow control can be achieved either at a regional level with large stormwater facilities or at the local level with smaller on-site facilities. Each approach has advantages and disadvantages; therefore a combination of both techniques is frequently used.

Regional detention and local stormwater ponds have been in use for many decades. Pierce County currently has its standards for stormwater control. The County is updating its standards to be equivalent to those in the 2001 Washington State Department of Ecology (Ecology) Stormwater Management Manual for Western Washington (Ecology Manual).

A more recent technique for controlling runoff is called "Low Impact Development" (LID). The approach is a best effort to mimic the predevelopment runoff process. Basic hydrologic processes involved in precipitation and runoff include interception storage (the volume of precipitation trapped and held by vegetation and air before reaching the ground), evapotranspiration, infiltration, surface storage, and runoff. LID includes integrated techniques to emulate each process. Such techniques include:

- **Vegetation** – Interception of precipitation and evapotranspiration by trees and shrubs accounts for about 40 percent (40%) of the precipitation volume in forested basins. Increasing vegetation in urban environments helps reduce how much water reaches the ground and becomes runoff. The more mature the trees and shrubs, the greater the interception storage.

  Vegetation can be increased by reducing the limits of clearing and grading for new development, clustering development on buildable areas of the site and leaving more of the site as vegetated open space, encouraging landowners to retain and plant trees, and increasing the size and number of vegetation strips and buffers in parking lots and other public spaces.

- **On-Site Infiltration** – Precipitation that reaches the ground in forested basins is almost immediately infiltrated to subsurface soils. LID techniques infiltrate as much water as possible where it falls. This reduces the need for drainage conveyance facilities.

  Methods for achieving on-site infiltration include directing discharge downspouts from rooftops onto lawns or other vegetated areas, retaining natural site features that encourage infiltration, incorporating rain gardens for drainage and infiltration of road and parking runoff, applying soil amendments to improve infiltration in open areas such as parks and playfields, and encouraging porous driveways in residential areas.

- **Surface Storage** – Infiltration rates are lower in compacted urban soil than in forested environments. Because of this, rainfall rates can often exceed infiltration rates and generate surface runoff. Storing excess water on site helps reduce the amount of surface runoff that leaves the site while allowing more time for infiltration to take place. Means of storing precipitation include bioretention, cisterns, rain barrels, and vaults.
- **Runoff** – Ideally, on-site flow controls greatly reduce the volume and, therefore, the rate of surface runoff leaving a site. However, during storm events some runoff is expected. When surface runoff is generated, designed flow paths such as vegetated swales (with as long a flow path as possible) can encourage infiltration and improve water quality by trapping sediments and attached pollutants.
- **Impervious Surface Reduction** – Reducing impervious area increases opportunities for stormwater to infiltrate. Techniques to lower impervious surface area include reducing roadway widths, using alternate road layouts that reduce the linear feet of roadway, and using permeable pavements for parking areas and sidewalks. Directing runoff from impervious areas onto landscaped and vegetated areas can reduce the amount of effective impervious surface.

Several counties in the Puget Sound region have done pilot studies using LID techniques and have had notable success. A study by and for Pierce County (CH2M Hill, 2001) concluded that LID techniques are successful at reducing impervious area, reducing peak flows, and enhancing base flows in streams.

Pierce County is revising its stormwater manual and development regulations to include LID practices. The new WA State Ecology Manual also provides some incentives for using LID strategies whenever practicable.

LID practices should be implemented in the parts of the Basin zoned for higher-density land uses, particularly the upper plateau areas. Use of LID "Best Management Practices" (BMP) in high-density areas will help to mitigate for increased stormwater runoff that will be generated by future development, prevent localized flooding, and reduce water quality impacts.

In addition to more effectively managing stormwater, LID strategies can have other environmental and community livability benefits. Infiltrating stormwater on-site helps to recharge local groundwater supplies.

LID road designs result in narrower streets that frequently reduce traffic speeds, increasing public safety and promoting walking and bicycling as alternative transportation methods.

Subdivisions and commercial areas can be designed to promote interaction between neighbors and to incorporate open space and recreational areas. Clustered housing designs can preserve large tracts of natural areas (forests, wetlands, etc.) that can be used for wildlife habitat or for passive recreation. Each strategy has the additional effect of a more attractive, greener development, which can increase marketability and property values.

Finally, LID can provide tools for cost-effective retrofitting of stormwater facilities, which has proven to be an expensive concern to many communities in the past. See PRG-23-01 in Section 9.3.

9.2.2 Fish Protection of Habitat From Adverse Effects of Urban Stormwater Runoff

Forested riparian corridors enhance habitat and protect water quality. Wider riparian areas perform best, although even a narrow undisturbed strip of vegetation provides more protection than none at all. Several programs fund riparian zone protection such as the "Conservation Reserve Enhancement Program" of the Natural Resource Conservation Service (NRCS). Under the NRCS program, the landowner can be paid annually for 150 percent (150%) of the income-generating potential of the riparian area set aside. This can be applied to either livestock or crop production.

The Salmon Recovery Funding Board (SRFB) administers grants to fund habitat protection and restoration projects that have a certainty of success and produce benefits for fish. Local and state governments, private landowners, conservation districts, Native American tribes, non-profit organizations, and special purpose districts are eligible to receive funding through the SRFB.

From 1999 to July 2004, $133 million in grants were approved in Washington state to fund habitat protection and restoration projects across the state. Combined with local matching funds, a total of $202.8 million was allocated for 715 individual projects. The SRFB accepts project lists from designated local lead entities (including Pierce County) established under the Salmon Recovery Act (RCW 77. 85 or ESHB 2496). A panel of scientists reviews and rates the projects for benefit to salmon and certainty of project success. The SRFB seeks to fund projects that are both scientifically sound and locally supported. This could be an additional source of funding for proposed stream habitat restoration projects (See PRG-23-04, PRG-23- 05, PRG-23-06, PRG-23-07, and PRG-23-11 in Section 9.3).

9.2.3 Conservation of Flood Hazard Areas

One of the best ways to protect stream resources and to provide floodwater storage is to acquire property along the stream corridor and preserve or restore its floodplain. Acquisition compensates property owners for not developing in an area that a local government has decided to protect due to its broad public benefit as floodplain. In some cases, purchase of development rights is an alternative. However, the cost of development rights rivals the cost of fee simple purchase. Where federal grant funds are used, only fee simple acquisition of property is authorized.

Undisturbed stream corridors are the primary choice for preservation. Value also exists in acquiring disturbed property and restoring the channel and its floodplain.

Pierce County, primarily through federal grants from the Federal Emergency Management Agency (FEMA), has acquired a number of properties in the Puyallup River and Carbon River floodplains. Other property acquisitions have occurred as part of implementing the preference stated in the 1991 Plan for non-structural solutions to flooding and storm drainage concerns and preservation of wetlands and floodplain for a passive form of floodwater storage. Property acquisitions are frequently made as land becomes available. Some opportunities for acquiring land in floodplain corridors in the Mid-Puyallup Basin are described below.

Mouth of Horsehaven

A half-mile of stream corridor crosses a single parcel of property at the mouth of Horsehaven Creek, extending from the mouth to 168th Street East. This riparian corridor is well-vegetated and in good condition. Sediment loads from upstream have impaired stream channel function here, but could be restored (See CIP-23-HH1-AC01 in Section 9.3 for the full recommendation).

Middle Horsehaven

A dairy farm formerly occupied property along Horsehaven Creek between 150th Avenue East and 188th Street East. A roughly 0.3 mile section of the stream crosses the property. Aerial photographs show that this section of stream has no vegetation that shades the stream. The stream corridor on this property is a good candidate for restoration, including revegetation. (See CIP-23-HH4-AC02 in Section 9.3 for the full recommendation.)

Mouth of Ball Creek

A quarter-mile of the lower reach of Ball Creek crosses property that is available for purchase. Aerial photographs show that the vegetation along the riparian corridor of this reach is sparse and absent in places. A field assessment of the stream was not possible because the property owner did not grant access. The creek will need to be restored and riparian areas planted.

Restoration of this creek will include removing the riprap from the mouth of the creek as it creates a partial fish barrier (See CIP-23-BC2-AC01 in Section 9.3 for the full recommendation).

9.2.4 Public Education and Public Involvement

An on-going watershed education program can help residents to learn about the consequences of certain actions, can give them ways of doing things differently, and help them to change their habits to protect the creeks and their associated watersheds. This is one of the most effective ways of providing for future floodplain preservation, surface water quality improvement and protection of fish habitat. Educational activities can be developed for schools in the Basin as well as for the general public. Specific activities can be targeted to both youth and adult audiences, and can be related to existing community programs wherever possible.

A comprehensive public education program can effectively involve Basin residents in the Watershed and in CIP's or individual actions that can contribute to restoring and protecting the Basin tributaries' natural resources. A public education program should be focused on specific principles and recommendations of the Basin Plan. Examples of public education activities and tools include:

- Interpretive programs and basin tours to explain the basin's natural processes and residents' responsibility to help protect natural resources.
- Brochures, newsletters and fact sheets on specific elements of the Basin Plan.
- Posters, signage, and displays at community events on water quality, flood control, and fish habitat issues.
- Citizen involvement projects such as trash removal near the creek, storm drain stenciling, riparian planting, and water monitoring activities.

In addition to making more effective use of limited funds, citizen participation in restoration projects is one of the most effective methods for educating residents on important basin issues. Joint cooperation and funding of existing groups' publication efforts (Puyallup Tribes and the Pierce Conservation District) is another effective use of funds and efforts devoted to public education (See PRG-23-06 in Section 9.3 for full recommendation).

9.2.5 Flood Hazard Management

Stormwater Regulations

The Washington State Department of Ecology issued its new manual for Western Washington in 2001, which updated the 1992 Puget Sound Stormwater Management Manual. The requirements for detention and for water quality treatment from higher-density land uses were strengthened and the list of BMP's was broadened. The Ecology manual is aimed at urbanizing areas and commercial and industrial developments. Individual jurisdictions will be required to adopt stormwater regulations that are functionally equivalent to those of the new Ecology manual within the next few years. The County's current Stormwater Management and Site Development Manual, Title 17A, is the technical equivalent of the 1992 Ecology manual (See PRG-23-02 in Section 9.3 for the associated recommendation).

Ponded Water

Many flooding problems in the Basin result from ponded water after heavy rains. The topography across the upland areas of the Basin is flat to gently rolling with several closed depressions. Certain areas within the Basin do not have a surface connection to a stream, and rainfall runoff flows to the lowest point where the water ponds and slowly infiltrates. Although ponded water locations and depths have not been not well documented, maximum depths are typically three feet or less. Roads, homes, or other property located within these depressions can be adversely affected until the ponded water subsides.

County development regulations require that proposals for major developments assess the effects of the development on downstream drainage conditions. For the Mid-Puyallup Basin, this downstream assessment should review whether the project will be affected by, or drain to, a depression. If this is the case, the hydrologic analysis provided by the project proponent should demonstrate that the project will not be affected by on-site ponding nor contribute substantially to an off-site ponding problem. In addition to site-specific ponding information provided by the County, information regarding past ponding incidents can be sought from the local residents.

Where properties or existing roadways experience frequent ponding, bioretention can be used to provide a convenient local place for water to collect and infiltrate. Disclosure statements can be required for the sale of existing properties that are known to have areas of ponding (See PRG-23-01, PRG-23-03, PRG-23-06, and PRG-23-10 in Section 9.3 for recommendations).

Future Conditions

Some parts of the Basin are expected to undergo rapid development over the next twenty years. Specific subbasins that could double in impervious area include FC-2, FC-3, BL-3, BL-4, HH-1, HH-3, HH-6, D-2, D-3, D-4, D-8, D-9, D-14, and D-17. These areas are primarily on the residential plateaus above the valley. Hydrologic modeling of future conditions in Horsehaven

Creek shows that stream flooding could increase by as much as 100 percent in the Lorenz tributary that receives runoff from the developing plateau if stormwater mitigation is not achieved. Other creeks such as Ball Creek and Fennel Creek flows will increase by 5 to 50 percent without future runoff mitigation. These areas may also provide prime opportunities for Low Impact Development pilot programs (See PRG-23-01, PRG-23-02, PRG-23-03, and PRG-23-04 in Section 9.3 for full recommendations).

Further study of the hydrologic interaction between the plateaus and the valley bottom will help to guide mitigation efforts. Subsurface water from the plateau feeds multiple springs that emerge from the hillside and serve as a water supply for residences and small farms on the valley floor. The impact that development is likely to have on these springs and the groundwater on the valley floor is recommended for further study as described in section 9.3.3, ST-4.

9.2.6 Water Quality Management

In the Mid-Puyallup Basin, the two water quality parameters that most consistently exceed state standards are water temperature and bacteria (fecal coliform). In addition, fine sediment settling to the channel bottom is a common cause of fish habitat degradation.

The measures to reduce water temperatures and fecal coliform counts are similar to those identified for stream and riparian habitat improvement.

Restricting livestock access to streams in the Basin will greatly reduce the degree of stream bank and channel instability caused by this practice. This, in turn, will reduce stream sedimentation and allow higher quality gravel substrate to reestablish in stream bottoms. Bacterial contamination of streams due to animal sources will also decline.

Riparian vegetation is a key element that can reduce the incidence of higher stream temperatures. Trees, particularly conifers, are needed along many sections of the streams to provide shade and moderate temperature during warm, sunny days. Another factor that moderates stream temperature in some locations is groundwater inflow, particularly in tributaries that flow from the plateau down onto the valley floor.

An additional benefit of riparian vegetation is the water quality improvement that is expected to occur. Runoff from adjacent activities such as residences, animal grazing, crops, barnyards, and animal confinement areas is slowed and filtered as it passes through the vegetation and surface soils of riparian areas. This allows for more effective removal of sediment, organic matter, and nutrients than is the case where such activities occur immediately adjacent to the stream.

Long-term data on flow and water quality of Mid-Puyallup Basin tributaries is needed to document trends. Long-term data is also essential to document improvements that accrue as a result of implementing the programmatic recommendations and CIP's of the Basin Plan (See PRG-23-03, PRG-23-05, PRG-23-07, ST-1, and ST-2 in Section 9.3 for recommendations).

9.2.7 Riparian Corridor Management

Perhaps the single most important and practical measure that can be implemented to enhance salmon habitat in the long-term, is riparian native species tree planting. With high temperatures, lack of large woody debris (LWD), and extensive reed canary grass problems, riparian planting

programs should play a major role in the Mid-Puyallup Basin. The most effective long-term way to prevent spreading of reed canary grass is by shading it to inhibit growth. Conifers are considered the best for shading, as hardwoods allow early spring and late fall growth to occur unhindered. Another option is to use willows to crowd out reed canary grass with their root mass. It is possible to establish willows with a maintenance program. Strategic tree planting can be used to ultimately reshape and widen floodplains. Trees, both conifer and hardwoods, will ultimately contribute LWD to the channel, but this is a long-term process. The benefits of shade and reed canary grass control will come much sooner.

Public information can contribute significantly to the maintenance of riparian corridors by helping citizens understand what constitutes a healthy riparian corridor and how property owners and general public are benefited with its protection. Property owners adjacent to streams can participate in stream improvements on their own land. Agencies such as the Conservation District have existing education and incentive programs to assist homeowners with stream enhancement (See PRG-23-04 and PRG-23-05 in Section 9.3 for the recommendations).

9.2.8 In-stream Habitat Improvement

Several fish habitat elements need improvement in the Mid-Puyallup Basin's tributaries. The two most important in-stream elements are channel morphology and large woody debris (LWD). Extensive changes to channel morphology tend to be expensive and difficult. They also, require cooperation from, and coordination with property owners.

Placing LWD in-stream would create pool habitat for fish, but would need to be placed carefully to prevent local flooding. One reason there is so little in-stream LWD is because it has historically been removed from channels to prevent flooding. Fish barriers would need to be removed downstream of any restored sites for in-channel improvements to be beneficial to anadromous fish. In-stream habitat restoration is most practical when implemented along with other measures, such as riparian enhancement, in a comprehensive restoration project.

Established older stands of alder do not provide the same quality of salmon habitat function that conifers do. Conifer LWD is generally larger and lasts much longer in water than does hardwood LWD. Selection of conifer species must be based on site conditions and geographic setting. The typically wet conditions next to streams is generally best suited for cedars, hemlock, and Sitka spruce. Cedars provide the highest quality LWD, but are also the slowest growing conifers of those mentioned. Conifers can be interplanted in alder and maple stands. Cedars are especially shade tolerant. Species selection should take the local ecosystem and historic character of the area into account.

A potential limitation to the success of an in-stream habitat restoration program on private land is the right of landowners to cut down the plantings at a later date when they become commercially harvestable, in 40+ years. However, agreements with landowners can be put in place to preserve the trees and other riparian plants.

The Mid-Puyallup Basin offers multiple opportunities for restoring in-stream habitat. Each tributary that flows into the Puyallup River provides refuge for young salmonid fingerlings, where they can feed and grow. Removing barriers to fish passage and restoring the lower reaches of Puyallup tributaries can increase usable habitat and enhance the survival of fish (See PRG-23-05 in Section 9.3 for the programmatic recommendation concerning restoration and enhancement of stream corridors).

9.2.9 Livestock and Riparian Interactions

Much erosion and stream bank damage in the Mid-Puyallup Basin comes from areas where livestock have had direct access to the creek. Most cattle operations are small hobby farms with herds of only 10 to 20 animals on average.

Livestock enclosures limit the spatial extent to which animals are allowed contact with stream channels and allows riparian corridors to become established or remain intact. If access of livestock is limited to narrow sections of stream, perhaps 30-feet wide, and the banks are graded back and hardened, the sacrificial areas can protect hundreds of yards of habitat elsewhere.

The use of nose pumps or electric pumps can completely eliminate the need for livestock to come in direct contact with the stream (See PRG-23-04, PRG-23-05, and PRG-23-06 in Section 9.3 for recommendations concerning livestock and riparian areas).

9.2.10 Filling Information Gaps

A lack of information about several aspects of the Mid-Puyallup Basin limited the Basin Characterization and identification of alternatives. Several studies could provide needed information and help facilitate Basin implementation. The recommended studies are described in Section 9.3.3.

Fine sediment is a major problem in the tributaries that flow across the valley bottom. The Basin Plan assumes that this material has entered creeks at places where livestock have access and farm runoff discharges. However, an investigation of sediment sources in the Basin would be useful to determine the best sediment management options.

It is currently unknown whether or not groundwater along the valley bottom is being affected by the septic systems in this area. A monitoring study is recommended to investigate this issue.

Some uncertainty remains about the precise location of the Basin's western and northern boundaries in the vicinity of subbasin HH-6. Surface water runoff in the southwest portion of the Basin flows to Horsehaven Creek and the Puyallup River and so has been included within the Mid-Puyallup Basin. However, groundwater in this area flows toward and contributes to Clover Creek. A study can help determine an appropriate boundary between these two basins given the complex hydrology. Along the north Basin boundary, a portion of Wapato Creek has been diverted into the Puyallup River. The drainage area for this segment of Wapato Creek is hydrologically now part of the Mid-Puyallup Basin and the Basin boundary in this area should be updated to reflect this change.

During hydrologic modeling for this Basin Plan, it became apparent that groundwater input plays a significant roll in the base flow found in both Ball and Horsehaven creeks. Field data characterizing groundwater was not available at the time modeling was done.

To better understand the hydrology of streams along the Mid-Puyallup valley floor, a study of groundwater interactions is needed (See ST-1 through ST-5 in Section 9.3 for study recommendations).

9.2.11 Continuing Stakeholder Involvement

Broad, multi-stakeholder groups are usually instrumental in implementing basin plans. Representatives of environmental interest groups, tribes, businesses, development interests, farmers, property owners and residents provide valuable review and support of specific implementation activities.

These groups can also be instrumental in carrying out an effective public education campaign (See PRG-23-06 in Section 9.3 for the public involvement recommendation).

Mid-Puyallup Basin Recommendations

The section presents the specific recommendations for the problems described in Chapter 6, Chapter 7, and Chapter 8. The considerations summarized in Section 9.2. These recommendations address flooding, water quality, and related fish habitat problems within the Mid-Puyallup Basin and are presented in this order:

1) CIP recommendations

2) Programmatic recommendations

3) Additional Studies recommendations

Figure 9-1 shows the general locations of the CIP projects. More detailed maps can be found in the appendices. CIP's are grouped by tributary basin and those associated with channel improvements are ordered by starting at the mouth and moving upstream. Several projects relate to one another. These links are discussed at the end of each tributary section as needed.

9.2.12 Project Identification Codes

The CIP and programmatic recommendations are labeled with project codes that were developed to be universal for all of the County's basin plans. These project identification codes are a linked series of codes that describe the type of project, for example. CIP-23-BC2-RST01. The breakdown of this identification number is as follows:

Project Category	Basin No.	Subbasin	Project Type	Project Order Number
CIP	23	BC2	RST	01
PRG	23			01

Project Category: Is either PRG (Programmatic) or CIP (Capital Improvement Project).

Basin No.: This is a County designated basin number for identifying subbasins within Pierce County. The basin number for Mid-Puyallup is 23. A measure with County-wide applicability is 00.

Subbasin: The reach or subbasin identified within the Basin Plan.

Project Type: Is the general category that best fits the project's activities.

Project Types:

AC	Acquisition	IP	Infiltration Pond
C	Culvert	RST	Restoration
DP	Detention Pond	BRG	Bridge
RF	Road Flooding	PRG	Programmatic
ST	Study	RP	Regional Pond
WL	Wetland	ENF	Enforcement
EDU	Education	RP	Retention Pond
RD	Raised Road	WQ	Water Quality

9.2.13 Capital Improvement Projects

The recommended CIP's are described below. Further description of the problems that are being addressed by these CIP's can be found in Chapter 6. Sketches of each CIP conceptual solution are provided in Appendix J along with the cost estimate worksheets.

Alderton Creek

CIP-23-A1-RF01 **"PIONEER WAY CONVEYANCE IMPROVEMENTS"**
(Pioneer Way between 142nd Avenue Court East and the railroad)
Cost: $53,000 Score: 132 Priority: Low

Problem: Stormwater collects at the side of the road along Pioneer Way from 142nd Avenue Court East to the Burlington Northern Santa Fe railroad crossing, but does not go over the roadway. Runoff pools in low spots creating hazards for pedestrians. Infiltration of this water is slow, but does occur. There are no roadside ditches to collect the runoff.

Solution: Construct bioretention swales along the north side of Pioneer Way to contain and infiltrate runoff. Include an overflow route for high flows that is directed east down Pioneer Way and connects to the existing drainage path on the east side of the railroad tracks. This will require 12-inch culverts under driveways and under the railroad bed perched at the overflow level of the swales. Estimated cost for this project includes the material cost of culverts, excavation of the swales, and soil preparation to encourage infiltration.

Benefits: This CIP addresses issue A1-RF01 discussed in Chapter 6. This project will provide a controlled containment for road runoff along the north side of Pioneer Way reducing the hazard to pedestrians that may enter the roadway while trying to avoid ponded water. The suggested solution uses LID techniques to maintain the benefit of existing low spots that hold water and serve as depressional storage.

Van Ogles Creek

CIP-23-VO1-RST01 "VAN OGLES CREEK RESTORATION"
(From the mouth to 92nd Street East)

Segment 16/8//1: $472,400

Segment 16/8//2: Phase 1 = $315,000; Phase 2 = $315,000

Segment 16/8//3: Phase 1 = $315,000; Phase 2 = $315,000

Segment 16/8//4: Phase 1 = $315,000; Phase 2 = $314,600

Cost: $2,362,000 Score: 262 Priority: Medium

Problem: Van Ogles Creek is degraded along its entire length. The first 0.3 mile of stream still retains a partially vegetated riparian corridor but has several invasive species including reed canary grass growing along the banks. The remainder of the stream has been degraded because of historic land use and stormwater conveyance practices with fine sediment built up in the channel bed, low frequency of pools, very little LWD, hardened banks, and very low channel complexity.

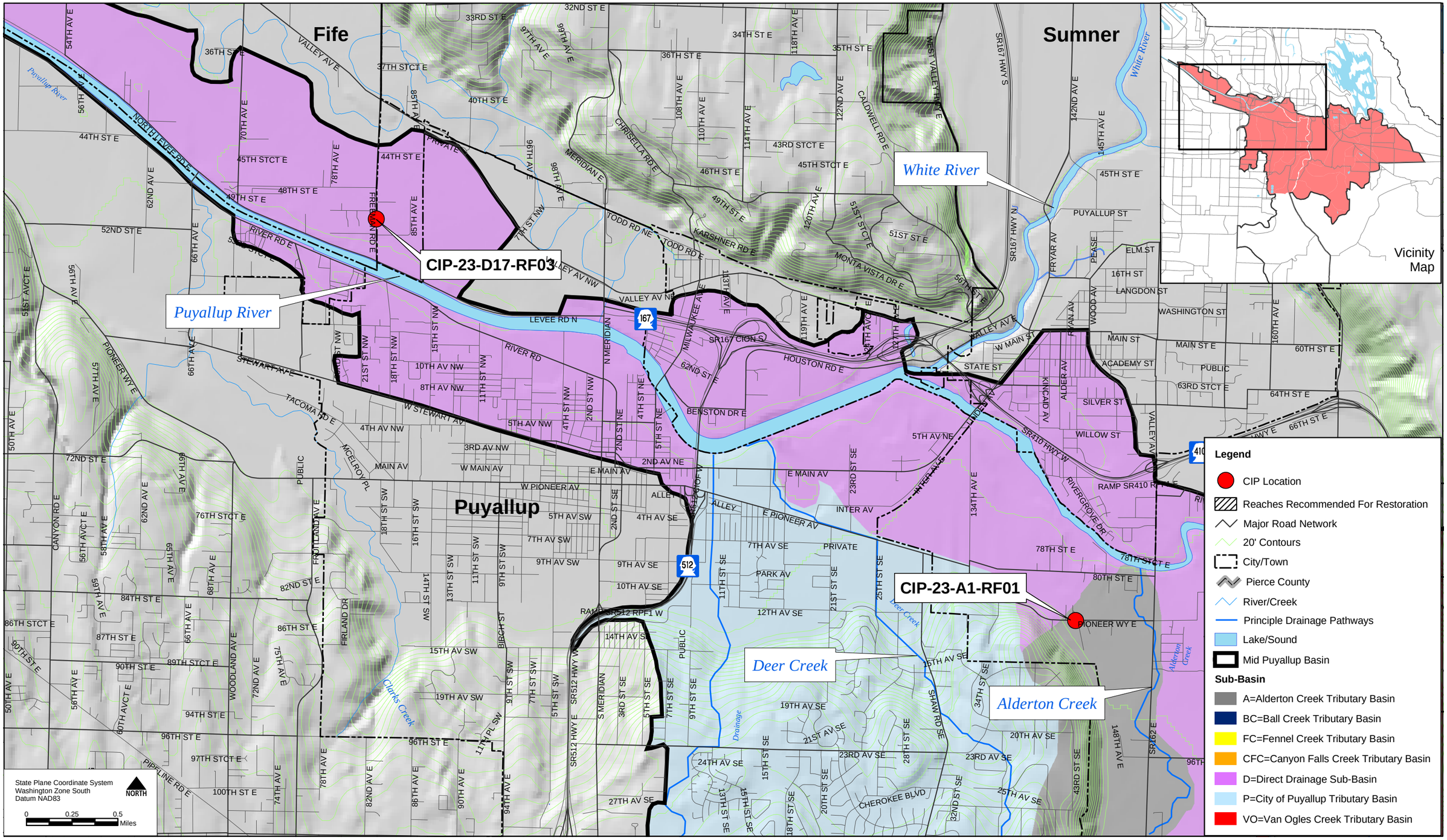
Solution: Restore the length of Van Ogles Creek from the mouth to the culvert at Riverside Drive (0.3 river mile). This reach is on County property with a partial existing vegetated riparian area. The riparian area should be fully restored and channel complexity should be enhanced with the introduction of LWD and other channel stabilizing features.

The remaining length of the creek (1.2 river miles) is on private property and should be restored in cooperation with landowners through public education and assistance programs up to the culvert at 92nd Street East. Estimated cost for this project is based on a linear foot general cost for all construction costs including temporary stream diversion, stabilizing the streambed, and replanting riparian area.

Restoration of the full 1.5 river miles of this creek will be broken down by the segments of the creek defined during the stream assessment (*Figure 4-11*) and divided into phases. The phases of restoration imply shorter restoration reaches within each segment.

Benefits: This CIP addresses habitat issues in Van Ogles Creek as discussed in Chapter 8. Restoring the lower reach of Van Ogles Creek will provide improved rearing and spawning habitat for coho, chum, and cutthroat. Other species may also return to use the creek depending on the success of the creek's restoration. Restoring the creek will also reduce summer water temperatures.

PATH: G:\Gis_Projects\Mid_Puyallup\Project\Fig-9-1A-CIP-Upper.mxd
DATE: 1.07.04



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This MAP is based on information from numerous sources and the accuracy of which is not guaranteed by Pierce County and its consultants. Pierce County and its consultants are not responsible and shall not be liable to the user for damages of any kind arising from the data or information shown on this map.

Figure 9-1A: CIP Locations

Mid-Puyallup Basin Plan

PIERCE COUNTY entranco Momentum

PATH: G:\Gis_Projects\Mid_Puyallup\Project\Fig-9-1B-CIP-Upper.mxd
DATE: 03.03.04

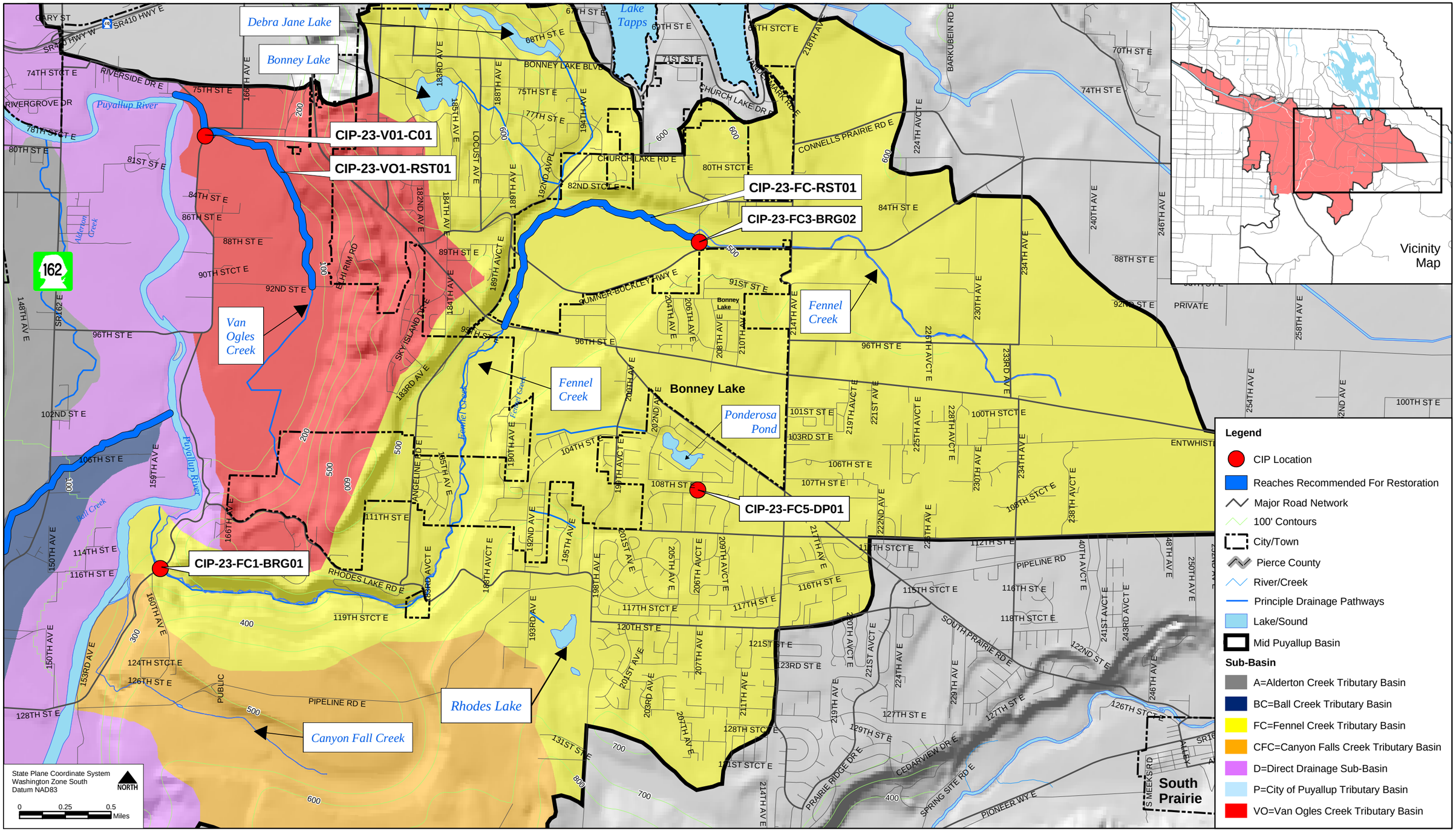

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Figure 9-1B: CIP Locations

Mid-Puyallup Basin Plan

PIERCE COUNTY entranco Momentum

PATH: G:\Gis_Projects\Mid_Puyallup\Project\Fig-9-1C-CIP-Upper.mxd
DATE: 1.07.04

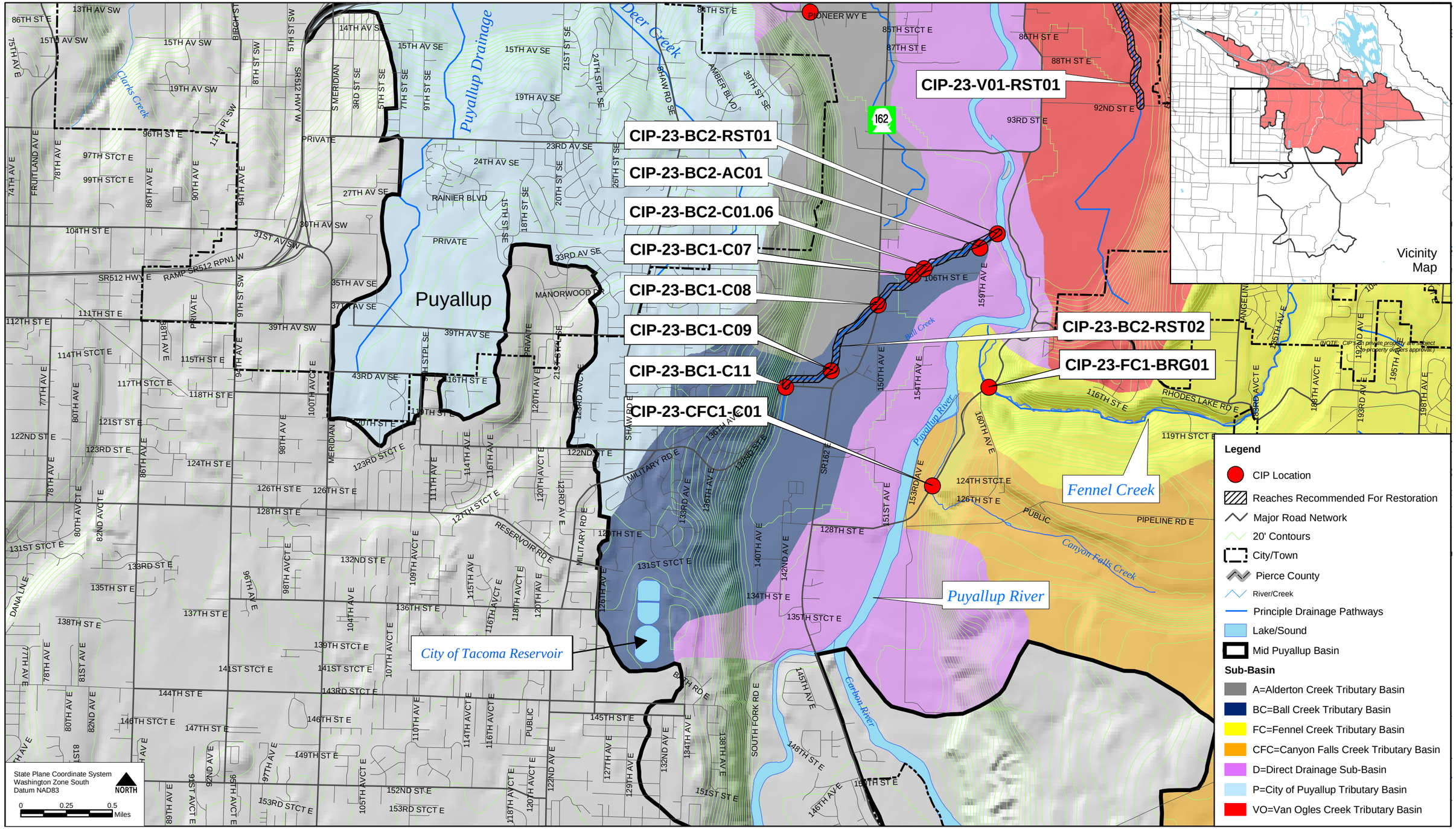

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Figure 9-1C: CIP Locations

Mid-Puyallup Basin Plan

PIERCE COUNTY entranco Momentum

PATH: G:\Gis_Projects\Mid_Puyallup\Project\Fig-9-1D-CIP-Lower.mxd
DATE: 03.03.04

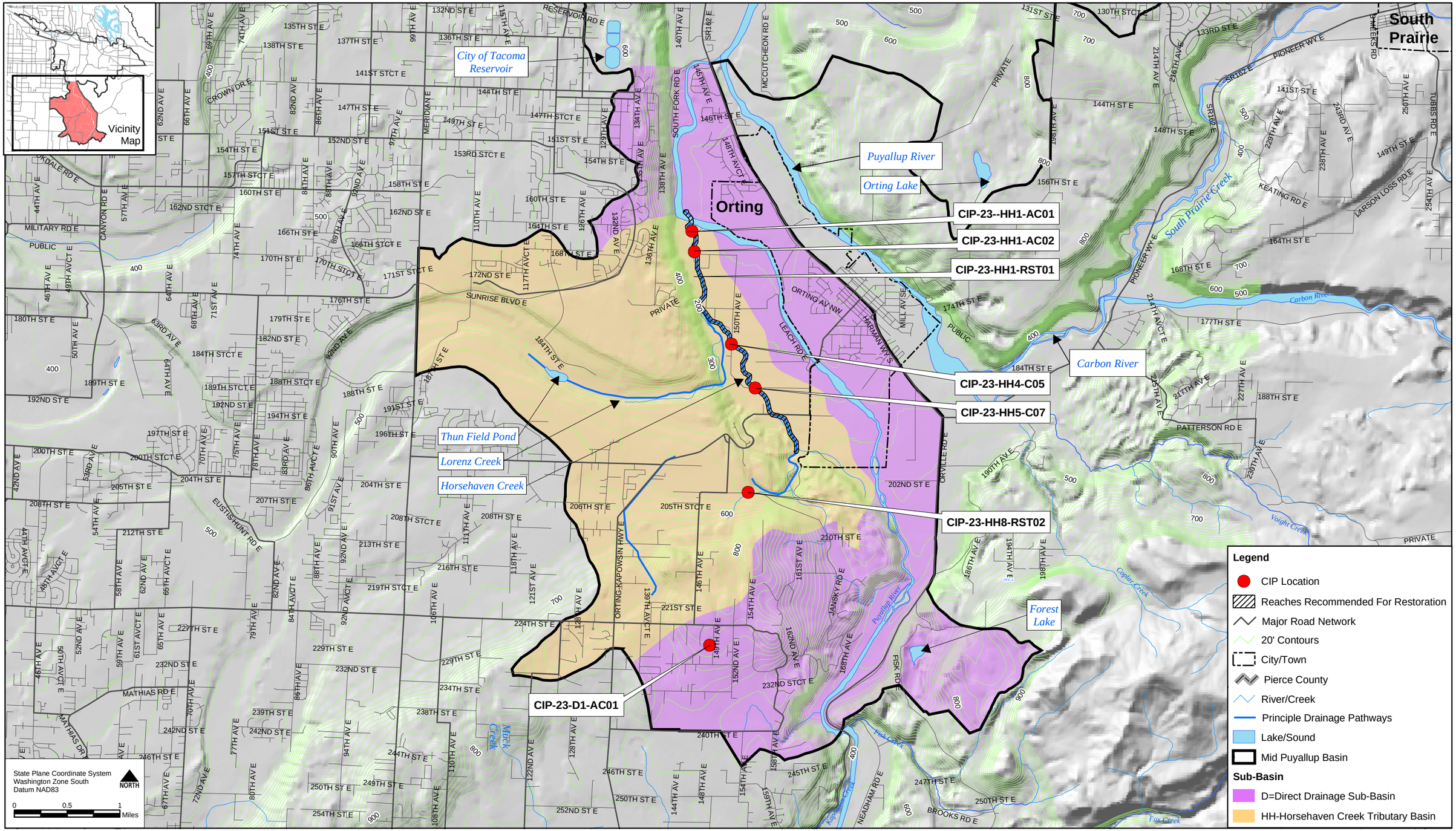

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Figure 9-1D: CIP Locations

Mid-Puyallup Basin Plan

PIERCE COUNTY

entranco Momentum

CIP-23-VO1-C01 **"RIVERSIDE DRIVE EAST CULVERT REPLACEMENT"**
(Riverside Drive south of 78th Street East)
Cost: $148,000 Score: 75 Priority: Low

Problem: The culvert under Riverside Drive East is a 48-inch round precast concrete pipe and is listed in the Conservation District culvert inventory as a fish barrier. The slope of the existing culvert is 1.5 percent (1.5%) overall with a slope break caused by the sectional pipe segments coming apart. This blockage is only a partial barrier because residents have reported fish further upstream.

Solution: Replace the existing culvert with a box culvert that is 12-feet wide by 8-feet high and 50-feet long. The culvert should be countersunk by 3-feet, filled with streambed gravel, and aligned with the natural channel gradient. Estimated cost for this project includes the material cost of the culvert, streambed gravel to fill the culvert, and riparian restoration in the construction area.

Benefits: This CIP addresses the fish blockage at culvert VO1-C01 as discussed in Chapter 8. Replacing this culvert will improve fish access to upstream reaches of Van Ogles Creek. Approximately 1,100 feet of stream channel will become available to fish before the next confirmed barrier is encountered.

Ball Creek

CIP-23-BC2-RST01 **"MOUTH OF BALL CREEK FISH PASSAGE"**
(At the confluence of Ball Creek with the Puyallup River)
Cost: $131,000 Score: 198 Priority: Medium

Problem: At the mouth of Ball Creek, there is a cascading drop to the Puyallup River made up of large boulders and riprap that presents a fish barrier. Some fish have been seen within the creek both by property owners and during field assessments indicating that the mouth is only partially blocked.

Solution: Restored the mouth of Ball Creek to allow for fish passage. The boulders should be removed and, if necessary, the stream regraded to prevent the drop in gradient at the mouth from becoming a nick-point that migrates upstream. An alternative regarding the stream is to construct log weirs along a shorter reach to form cascading pools. The creek design must be consistent with WDFW's Integrated Stream bank Protection Guidelines (2003). The property at the mouth of the creek may need to be acquired for this project to be done (see Section 8.3.2).

Benefits: This project will allow fish access to Ball Creek thereby providing off-channel rearing habitat for smolts from the Puyallup River. There is some potential for spawning habitat in this stream as well, if the stream is restored (see project CIP-23-BC2-RST02).

CIP-23-BC2-AC01 "MOUTH OF BALL CREEK PROPERTY ACQUISITION"
(End of 106th Street East)
Cost: $264,000 Score: 220 Priority: Medium

Problem: Roughly 1,300 feet of stream channel crosses a property at the mouth of Ball Creek. Access to the property was not possible, so little is known about the condition of the creek. Degradation of the creek in this area is highly likely because upstream conditions indicate that fine sediment may be accumulating in the channel and aerial photographs indicate a very thin patchy riparian corridor. Three culverts are on the property; little is known of their construction or whether they present blockages to fish.

Solution: Purchase the 20-acre property for restoring and preserving Ball Creek. The estimated cost is based on rural land value for 20 acres.

Benefits: Purchasing this property will allow the County to restore and preserve the creek in this area for rearing and potential spawning by coho salmon. This will also allow easy access for restoration at the mouth of the creek (see CIP-23-BC2-RST01) and allow fish access to reaches further upstream.

CIP-23-BC2-RST02 "BALL CREEK RESTORATION"
(From the mouth to Old Military Road)

Segment 16/10//1: Phase 1=$415,000; Phase 2=$415,000; Phase 3=$417,000

Segment 16/10//2: Phase 1=$415,000; Phase 2=$415,000; Phase 3=$417,000

Cost: $2,494,000 Score: 272 Priority: Medium

Problem: Ball Creek is degraded in many areas because of historic land use and stormwater conveyance practices. Degradation of the stream includes sparse or absent vegetation along the riparian corridor, fine sediment accumulation in the channel bed, low frequency of pools, very little LWD, hardened banks, and very low channel complexity.

Solution: Restore the length of Ball Creek and the associated riparian corridor that extends from the mouth of the creek to the culvert at Old Military Road. This is approximately 1.6 river miles of the creek. Estimated cost for this project is based on a linear foot general cost for all construction costs including temporary stream diversion, stabilizing the streambed, and replanting the riparian area.

Restoration of the full 1.6 river miles of this creek will be broken down by the segments of the creek defined during the stream assessment (*Figure 4-11*) and divided into phases. The phases of restoration imply shorter restoration reaches within each segment.

Benefits: Restoring Ball Creek will provide improved rearing and spawning habitat for coho salmon. Other species may also return to use the creek depending on the success of the creek's restoration. Restoring the creek will also reduce summer water temperatures.

CIP-23-BC2-C01–C06 "BALL CREEK FISH BARRIER CULVERT REPLACEMENTS"
(Ball Creek downstream from 106th Street East)
Cost: $39,000 Score: 234 Priority: Medium

Problem: There are six culverts on private property between the mouth of Ball Creek and 106th Street East. Four of these are barriers are partial barriers to fish and need to be replaced to provide fish access up to and beyond 106th Street East. The replacement of the culvert at 106th Street (CIP-23-BC1-C07) is associated with this CIP because of fish passage. For the replacement of culvert BC1-C07 to be most beneficial, culverts BC2-C01 through BC2-C06 must all be fish passable.

Solution: Replace the culverts as follows (presented from downstream to upstream):

- Replace C01, C02, and C03 each with a 48-inch CMP. These culverts are on the property discussed in CIP-23-BC2-AC01 and could be removed under project CIP-23-BC2-RST02 versus being replaced under this project.
- C04 was found to be passable to fish. Notes in the Conservation District inventory, however, suggest that some of the pipe sections are separating. In addition, Ball Creek modeling shows that this culvert floods at the 50-year event. If the property owner wishes to replace this culvert, a 12-foot by 5-foot box culvert, 16-feet long, and countersunk 3-feet is recommended.
- Replace C05 with a footbridge for pedestrian access.
- C06 is listed as a fish passable culvert. Ball Creek modeling shows that this culvert floods at the 25-year event. If the property owner wishes to replace this culvert, a 12-foot by 5-foot box culvert, 11-feet long, and countersunk 2-feet is recommended.

Estimated cost for this project includes the material cost of the culverts, streambed gravel to fill the culverts, and riparian restoration in the construction areas.

Benefits: This CIP addresses two of the flooding culverts identified from modeling Ball Creek as discussed in Chapter 6. Replacing these culverts will allow fish passage up to 106th Street East opening half a mile of stream habitat.

CIP-23-BC1-C07 "106TH STREET EAST CULVERT REPLACEMENT"
(106th Street East of SR 162 East)
Cost: $106,000 Score: 332 Priority: High

Problem: Roadway flooding occurs at the 36-inch precast concrete culvert under 106th Street East on Ball Creek. Hydraulic modeling indicates that the culvert's capacity is exceeded at the 25-year event. Fine sediment deposits at the upstream end of the culvert further reduces culvert capacity and fish passage. Erosion is also occurring at a bend in the stream just upstream from the culvert. This erosion is cutting into private property on the right bank side of the creek. The Conservation District has tagged this culvert as a fish barrier.

Solution: Replace the existing culvert with a 12-foot by 5-foot box culvert, 31-feet long, countersunk, and filled with 2-feet of streambed gravel. Using a box culvert will allow the road elevation to remain consistent and still provide the needed width for fish passage.

Restore and restructure the eroded bank upstream of the culvert. The mean channel width should be maintained through this reach to reduce the amount of sediment that accumulates in this area. The bank on the outside of the bend should be reinforced with a combination of rock and large wood with flow deflectors to further protect the bank from high velocity flows. Estimated cost

for this project includes the material cost of the culvert, streambed gravel to fill the culvert, and riparian restoration in the construction area and the upstream area.

Benefits: This CIP addresses issue BC1-C07 discussed in Chapter 6. Replacing this culvert will eliminate flooding across 106th Street East and stop the bank erosion of the upstream reach. This project will also allow fish passage beyond this point opening about 0.3 additional miles of accessible stream channel.

CIP-23-BC1-C08 **"PIONEER WAY CULVERT REPLACEMENT"**
(Pioneer Way north of 109th Street East)
Cost: $142,000 Score: 142 Priority: Medium

Problem: The culvert under Pioneer Way consists of two pipes: a 1.5-foot corrugated metal pipe (CMP), 58-feet long; and a 2-foot cast-in-place concrete (CPC) pipe, 59-feet long. On the downstream end, both pipes are 1.5-foot precast concrete pipes. This indicates that there is likely a slope break somewhere along this culvert. The culvert is considered a fish barrier for this reason and because both pipes have a slope of more than 1 percent (1%).

Solution: Replace the culvert with a 12-foot by 5-foot box culvert, 60-feet long, that is counter sunk 2-feet along the gradient of the stream. Estimated cost for this project includes the material cost of the culvert, streambed gravel to fill the culvert, and riparian restoration in the construction area.

Benefits: Replacing this culvert will open about 0.5 mile of stream to fish before the next barrier is encountered.

CIP-23-BC1-C09 **"RAILROAD CULVERT REPLACEMENT"**
(Access road and railroad north of Military Road)
Cost: $96,000 Score: 132 Priority: Medium

Problem: This culvert (comprised of two pipes) sits under the railroad on the west side of Pioneer Way and a dirt road that parallels the railroad. The twin, 2-foot CMPs are 38-feet long and are impassable to fish because the slope exceeds one percent (1%). In addition, computer modeling shows that the culverts flood at the 10-year event.

Solution: Replace the twin culverts with a 12-foot by 5-foot box culvert, 38-feet long, and countersunk 2-feet and filled with streambed gravel to the natural bed level. Estimated cost for this project includes the material cost of the culvert, streambed gravel to fill the culvert, and riparian restoration in the construction area.

Benefits: This CIP addresses one of the flooding culverts identified from modeling Ball Creek as discussed in Chapter 6. Replacing this culvert will prevent flooding of the railroad and access road adjacent to the railroad and open an additional 0.4 mile of creek habitat.

CIP-23-BC1-C11 **"MILITARY ROAD FISH PASSAGE"**
(Military Road west of SR 162)
Cost: $44,000 Score: 120 Priority: Low

Problem: This culvert was found to exceed the velocity threshold of 4-feet per second (fps) (as listed in WAC 220-110-070 for adult trout and other salmonids) at high flows. Therefore this culvert is a partial fish barrier.

Solution: Replace the culvert with a 10-foot CMP arch culvert that is 63-feet long. The slope of the culvert should follow the gradient of the streambed if possible. Estimated cost for this project includes the material cost of the culvert, streambed gravel to fill the culvert, and riparian restoration in the construction area.

Benefits: Replacing this culvert will allow fish access to upstream reaches. The creek beyond this culvert begins to resemble a farmland drainage ditch with less habitat value than some of the downstream areas.

Associations Between CIP's (Links)

Several of the recommended CIP's in the Ball Creek Tributary Basin are dependent on one another for their full benefits to be realized. Most associations between CIP's relate to fish passage issues because of the continuity required for fish to have access to upper reaches.

The largest group of associated CIP's are: CIP-23-BC2-RST01, CIP-23-BC2-AC01, CIP-23-BC2-RSTO2, CIP-23-BC2-C01–06, and CIP-23-BC1-C07. These projects as a whole will open fish passage to the lower reach of Ball Creek and restore this area of the creek for viable fish use. Removing the blockage from the mouth of Ball Creek (CIP-23-BC2-RST01) must be done if the fish passage improvements of CIP-23-BC2-C01–06 and CIP-23-BC1-C07 are to be useful.

Similarly, the habitat in this stream needs to be improved (CIP-23-BC2-RST02) if fish access to the stream is opened. Acquiring the property at the mouth of the creek (CIP-23-BC2-AC01) is the best way to ensure continued protection of the habitat conditions of the creek. If this property cannot be acquired, however, restoration of the stream is still possible with support from the landowners. These projects should all be completed with similar timing.

Fish passage projects upstream from 106th Street East (CIP-23-BC1-C08 and CIP-23-BC1-C11) should be built after the projects in the lower reaches are finished.

Fennel Creek

CIP-23-FC1-BRG01 "MCCUTCHEON ROAD BRIDGE REPLACEMENT"
(McCutcheon Road at Fennel Creek crossing)
Cost: $345,000 Score: 197 Priority: Low

Problem: Fennel Creek floods McCutcheon Road during the 10-year event according to output from a HEC-RAS model developed for Federal Emergency Management Agency (FEMA) floodplain mapping. McCutcheon Road runs along the slope break between the steep valley wall and the flat valley bottom. This crossing at Fennel Creek is a small concrete bridge.

Solution: Raise the road surface elevation 2-feet to provide the height needed to raise the low chord of the bridge 2-feet. Install additional culverts under the roadway on either side of the bridge to achieve capacity required for high flows. Either a series of six circular, 30-inch, CMP's, or two 2-feet by 10-feet box culverts can be installed adjacent to the bridge depending on available space. Estimated cost for this project includes the material cost of road construction, bridge replacement, and riparian restoration in the construction area.

Benefits: This CIP addresses issue FC1-BRG01 discussed in Chapter 6. This project will prevent flooding across McCutcheon Road eliminating the need for closing this road, which is the only north-south route across the valley on the east side of the Puyallup River.

CIP-23-FC3-BRG02 "KELLY LAKE ROAD BRIDGE REPLACEMENT"
(Kelly Lake Road at Fennel Creek crossing)
Cost: $289,000 Score: 80 Priority: Low

Problem: Fennel Creek floods over the roadway at less than a 10-year event according to the HEC-RAS model developed by others for generating FEMA maps of this creek. Kelly Lake Road (206th Avenue East) crosses Fennel Creek near river mile 5.3.

Solution: Raise the road surface 2-feet and set one of the bridge abutments back 8-feet from its current location to expand the bridge opening. This will provide sufficient capacity under the bridge for passing a 100-year event. Estimated cost for this project includes the material cost of road construction, bridge replacement, and riparian restoration in the construction area.

Benefits: This CIP addresses issue FC3-BRG02 discussed in Chapter 6. This project will prevent flooding across Kelly Lake Road eliminating the need for closing this road during high-flow events.

CIP-23-FC1-RST01 "FENNEL CREEK RESTORATION"
(Fennel Creek from Sumner-Buckley Hwy to 214th Avenue East)

Segment 16/11//11: Phase 1 = $419,000; Phase 2 = $415,000

Segment 16/11//12: Phase 1 = $415,000; Phase 2 = $415,000

Segment 16/11//13: Phase 1 = $415,000; Phase 2 = $415,000

Cost: $2,494,000 Score: 294 Priority: Medium

Problem: Fennel Creek is degraded primarily on the upper plateau area because of historic land use and stormwater conveyance practices. Degradation of the stream in local areas includes sparse or absent vegetation along riparian corridors, low frequency of pools, very little LWD, hardened banks, and very low channel complexity. Most of the riparian area south of the Sumner-Buckley Hwy is still intact and the quality of in-stream habitat remains relatively high in this downstream area.

Solution: Restore the 1.6-mile section of Fennel Creek that extends from the Sumner-Buckley Hwy upstream to the culvert at 214th Avenue East along with the associated riparian corridor. Estimated cost for this project is based on a linear foot general cost for all construction costs including temporary stream diversion, stabilizing the streambed, and replanting the riparian area.

Restoration of the full 1.6 miles of this creek will be broken down by the segments of the creek defined during the stream assessment (*Figure 4-11*) and divided into phases. The phases of restoration imply shorter restoration reaches within each segment.

Benefits: Restoring the upper reaches of Fennel Creek will reduce summer stream temperatures and improve habitat for resident trout.

CIP-23-FC5-DP01 "FIR RIDGE INFILTRATION POND"
(108th Street Court East and 206th Avenue Court East)
Cost: $205,000 Score: 274 Priority: Medium

Problem: The stormwater pond serving the Fir Ridge development (formerly Wembley Park) is an infiltration facility with a history of overtopping. The pond was enlarged in the early 1990s but overtopped again during the major flood in the winter of 1996–97. The pond sits at a relative low point with no defined or constructed outlet for overflow. One home adjacent to the pond was purchased and removed by Pierce County because of frequent flooding.

The Ponderosa neighborhood is north of Fir Ridge and surrounds Ponderosa Pond, which is in a closed depression that overtops to the northwest. To reduce flooding, neighborhood infrastructure was improved in 2002 by constructing two stormwater ponds and improving roads.

Water from the outlet of Ponderosa Pond passes through an 18-inch pipe and is released into a wetland at the end of 104th Street East. From here, flow runs west through wetlands, crosses 200th Avenue Court East in an 18-inch culvert, and enters an infiltration pond adjacent to the Brookwater development. The surface flow path ends here with water migrating to Fennel Creek as subsurface flow.

Solution: Route overflow from Fir Ridge Pond to Ponderosa Pond. An estimated 99,910 cubic feet of water at a peak discharge of 4.72 cubic feet per second (cfs) will be directed to Ponderosa Pond during a 100-year 24-hour event. An 18-inch pipe set one-foot below the berm elevation of the Fir Ridge Pond will be needed for this conveyance.

To avoid increasing the surface water elevation of Ponderosa Pond, the outlet control structures need to be modified, the flow path that conveys water to the infiltration pond needs to be expanded, and the infiltration pond itself needs to be enlarged by at most 3,700 cubic yards to receive this additional volume.

A low-flow outlet feature from the Fir Ridge Pond to Ponderosa Pond may be useful to maintain greater storage capacity in the Fir Ridge Pond in anticipation of recurrent storms. This approach may improve the effectiveness of the Fir Ridge Pond and reduce the peak volume of the flow routed to Ponderosa Pond.

Estimated cost for this project includes the material cost of storm pipe (and riser) and installation, land acquisition for expanding the infiltration pond, and cost of construction for the pond expansion.

Benefits: This CIP addresses issue FC5-DP01 discussed in Chapter 6. This project will eliminate flooding of properties in the Fir Ridge and Ponderosa neighborhoods. Past practices of removing overflow with trucks would no longer be necessary.

Horsehaven Creek

CIP-23-HH1-AC01 "MOUTH OF HORSEHAVEN CREEK PROPERTY ACQUISITION"
(From 168th Street East to the mouth)
Cost: $264,000 Score: 300 Priority: Medium

Problem: Off-channel spawning and rearing habitat has diminished greatly in the Puget Sound region and in the Puyallup River in particular. The lower reaches of Horsehaven Creek have relatively good habitat with an intact forested riparian corridor. The only degradation at this location is from fine sediment that has built up in the channel bed in response to land use practices upstream.

Solution: Acquire the riparian corridor that begins at the mouth of Horsehaven Creek and extends to 168th Street East containing approximately 2,500 feet of stream channel. Some channel restoration is recommended to remove the fine sediment from the creek. This restoration is included in CIP-23-HH1-RST01. Restoration will also consist of removing the existing levee between the stream and the Puyallup River to allow natural channel migration to occur. It may be necessary to construct a setback levee at the upstream end of this property. The estimated cost is based on rural land value.

Benefits: Acquiring and preserving this property will provide off-channel habitat for salmon smolts from the Puyallup River. Preserving this forested stream corridor will also help maintain summer stream temperatures.

CIP-23-HH1-AC02 "HORSEHAVEN RIPARIAN PROPERTY ACQUISITION"
(South of 168th Street East)
Cost: $79,200 Score: 297 Priority: Medium

Problem: Riparian zones are more easily preserved when publicly owned. The lower reaches of Horsehaven Creek in particular are valuable habitat because the riparian vegetation is still intact with few development influences.

Solution: Acquire approximately 5 acres of riparian property that is just downstream from the culvert at 168th Street East. This parcel is adjacent to the property discussed in CIP-23-HH1-AC01 and will extend the unbroken riparian corridor up to 168th Street East. The estimated cost is based on rural land value.

Benefits: This acquisition will increase the acreage of County owned land along the riparian corridor at the mouth of Horsehaven Creek. This riparian area provides prime spawning and rearing habitat for coho and chum salmon as well as resident trout. This riparian area also provides shade that protects water temperature.

CIP-23-HH1-RST01 "HORSEHAVEN CREEK RESTORATION"
(From the mouth to 162nd Avenue East)

Segment 16/20//1:	**Phase 1=$467,000; Phase 2=$467,000; Phase 3=$467,000; Phase 4=$467,000; Phase 5=$470,000**
Segment 16/20//2:	**Phase 1=$390,000; Phase 2=$390,000; Phase 3=$390,000; Phase 4=$390,000**
Segment 16/20//9:	**Phase 1=$190,000**
Segment 16/20//10:	**Phase 1=$190,000**
Segment 16/20//11:	**Phase 1=$190,000**
Segment 16/20//12:	**Phase 1=$208,000**

Cost: $4,676,000 Score: 289 Priority: Medium

Problem: Horsehaven Creek is degraded in many areas because of historic land use and stormwater conveyance practices. Degradation of the stream includes sparse or absent vegetation along riparian corridors, fine sediment accumulation in the channel bed, low frequency of pools, very little LWD, hardened banks, and very low channel complexity.

Solution: Restore the length of Horsehaven Creek and the associated riparian corridor that extends from the mouth of the creek to the culvert at 162nd Avenue East (approximately 3 river miles). In the lower reaches, from the mouth to upstream of 168th Street East, the primary restoration effort is to remove built up fine sediment from the streambed and reduce the upstream sediment loading. In the upstream sections, restoration should include restoring riparian corridors as well as improving in-stream conditions. Estimated cost for this project is based on a linear foot general cost for all construction costs including temporary stream diversion, stabilizing the streambed, and replanting the riparian area.

Restoration of the full 3 river miles of this creek will be broken down by the segments of the creek defined during the stream assessment (*Figure 4-11*) and divided into phases. The phases of restoration imply shorter restoration reaches within each segment.

Benefits: Restoring Horsehaven Creek will provide improved rearing and spawning habitat for coho and chum salmon. Other species may also return to use the creek depending on the success of the restoration. This project will also reduce summer water temperatures.

CIP-23-HH4-C05 "150TH AVENUE CULVERT REPLACEMENT"
(150th Avenue East north of 183rd Street Court East)
Cost: $151,000 Score: 206 Priority: Medium

Problem: Flooding occurs at the 150th Avenue East crossing at a 50-year event as shown by computer modeling. Twin 3-foot precast concrete culverts pass flows under this road. A property owner has placed boards across the upstream end of these culverts to form a landscaped pond in the front yard. During high flows, the boards are removed to prevent flooding. These boards are a partial barrier to fish passage. Although the flooding here is infrequent, combined with the fish passage issue, it places a greater need on replacing this culvert.

Solution: Replace the culverts with a single, six-foot circular culvert that is fitted with baffles to provide low-flow restriction for maintaining the upstream pond while also allowing fish passage (see *Figure 6-1* in Chapter 6 for an example of this culvert type). The roadway elevation may need to be raised locally as much as one foot to accommodate a culvert of this size.

Benefits: This CIP addresses issue HH4-C05 discussed in Chapter 6. This project will eliminate road flooding at this location and improve fish passage. The special design of this culvert is also intended to maintain water levels for property owners that have used the stream to integrate water features into their landscaping.

CIP-23-HH5-C07 "188TH STREET EAST CULVERT REPLACEMENT"
(188th Street East west of Orting-Kapowsin Highway)
Cost: $87,000 Score: 302 Priority: Medium

Problem: The 36-inch precast concrete culvert under 188th Street East on Horsehaven Creek floods over the roadway during storms less than the 10-year event. This road runs across the valley bottom and is very flat at the point where it crosses Horsehaven Creek.

Solution: Replace the existing culvert with a 12-foot by 5-foot culvert, 34-feet long, countersunk to 2-feet to allow for fish passage. Estimated cost for this project includes the material cost of the culvert, streambed gravel to fill the culvert, and riparian restoration in the construction area.

Benefits: This CIP addresses issue HH5-C07 discussed in Chapter 6. This project will eliminate flooding over 188th Street East. The new culvert will also be an improvement to fish passage because the streambed will be continuous throughout.

CIP-23-HH8-RST02 "JANSKY ROAD CHANNEL STABILIZATION"
(Jansky Road E east of 150th Avenue East)
Cost: $99,000 Score: 331 Priority: High

Problem: Severe erosion is occurring on Horsehaven Creek just upstream of twin, 24-inch driveway culverts where the creek flows along the north side of the road. There are no anadromous fish this high in the Watershed, but erosion sends sediment to downstream spawning reaches.

Solution: Stabilize the channel upstream of the existing twin, 24-inch driveway culverts to prevent further erosion. Install a rock sill to hold sediment where the gradient begins to drop. Below the rock sill, install one or two log drops to anchor the gradient. Plant the banks with willows and fence it off from livestock to maintain channel stability. Estimated cost for this project includes the material cost of gabions and log weirs, fencing, and riparian restoration in the construction area.

Benefits: This CIP addresses issue HH8-RST02 discussed in Chapter 6. This project will prevent further erosion in this place along side Jansky Road, which will both protect the road from undercutting and reduce sediment input to the downstream reaches of Horsehaven Creek.

Associations between CIP's (Links)

Two CIP's (CIP-23-HH1-AC01 and CIP-23-HH1-RST01) are associated with one another in the Horsehaven tributary basin. The property recommended for acquisition at the mouth of the creek will be beneficial to maintaining this riparian corridor. However, restoration of the channel itself is necessary to fully recover the habitat at this site.

The other CIP's in the Horsehaven area can be built independently of each other. However, all projects related to the stream channel should be constructed starting with ones downstream and working in an upstream direction.

Direct Discharge Subbasins

CIP-23-D1-AC01 **"FLOODED PROPERTY ACQUISITION"**
(149th Avenue off of 244th Street East)
Cost: $197,000 Score: 72 Priority: Low

Problem: Flooding occurs on two lots along 149th Avenue East from a drainage way that passes water under 224th Street East. This is in an area of closed depressions with no surface water routes to carry water out of the area. The outfall from the culvert under the roadway originally discharged into a wooded area. This area is now developed and stormwater collects on some of the residential properties.

Solution: Acquire the two properties that are flooding. Remove these two homes and allow flood waters to infiltrate on site. Estimated cost for this project is based on rural land cost.

Benefits: This CIP addresses issue D1-AC01 discussed in Chapter 6. Acquiring these properties will provide an infiltration area for excess stormwater thereby preventing further flooding in this neighborhood.

CIP-23-D17-RF03 **"FREEMAN ROAD CONVEYANCE IMPROVEMENTS"**
(Freeman Road and 50th Street East)
Cost: $86,000 Score: 62 Priority: Low

Problem: Between 45th Street East and 52nd Street East, flooding occurs along Freeman Road because the roadside has no clearly defined flow path and water ponds in this area. The roadway itself does not flood, but runoff from the road contributes to water ponding on adjacent private properties. Several of the properties are lower than the roadway by as much as 2-feet or 3-feet. There is a wetland at the southern end of Freeman Road.

Solution: Construct biofiltration swales that can hold and infiltrate roadway runoff from minor events. If future storms create ponded water that becomes a roadway hazard, 12-inch culverts can be installed under driveways with inverts set near the top elevation of the biofiltration swale to carry high flows south to the wetland at the corner of Freeman Road and 52nd Street East. Estimated cost for this project includes the material cost of culverts, excavation of the swales, and soil preparation to encourage infiltration.

Benefits: This CIP addresses issue D17-RF03 discussed in Chapter 6 and will reduce standing water from road runoff. The recommended solution uses LID techniques to retain the benefits of depressional storage that currently exist.

9.2.14 Programmatic Measures

This Basin Plan recommends a variety of technical and social programs that will help the County achieve its water resources related goals. Most of these programs apply countywide. Costs for implementing them in the Mid-Puyallup Basin have been calculated based on a 10.2 percent (10.2%) share of the countywide costs. These programs are listed below:

PRG-23-01 **"LID PILOT STUDY" (Along valley bottom and other infiltration limited areas)**
Cost Assumption: Includes 0.5 FTE per year for two years for a pilot project within the Basin
Cost: $100,000 Score: 346 Priority: High

Problem: Increasing levels of impervious area in watersheds impacts stream hydrology. Traditional methods of mitigating for these impacts have had limited success. Designing developments with minimum impervious area and increased infiltration helps to maintain natural hydrologic characteristics in urbanizing areas.

Solution: Conduct a pilot study for the effectiveness of LID techniques in places with high groundwater. The central portion of the Mid-Puyallup Basin is the flat Puyallup River Valley that has shallow groundwater throughout. Infiltration in this area may not be an efficient means of controlling stormwater runoff. Some LID techniques such as reducing EIA and using soil amendments may still be beneficial, however. A pilot project should be conducted to determine what LID techniques are most useful in this unique area.

Benefits: Demonstrating that LID techniques are effective in the Mid-Puyallup Basin will increase confidence in both developers and permitting agencies that these techniques are beneficial. Widespread use of LID will decrease the hydrologic impacts from urban growth.

PRG-00-02 **"UPDATE STORMWATER MANAGEMENT STANDARDS" (countywide)**
Cost Assumption: Includes 0.25 FTE as one-time, one-year cost. Prorated for the Mid-Puyallup Basin's share of the countywide cost (10.2 %)
Cost: $3000 Score: 380 Priority: High

Problem: The Washington State Department of Ecology increased the standards for stormwater mitigation with the publication of their 2001 Stormwater Management Manual. This new manual sets the level of compliance for all municipalities operating under an NPDES permit such as Pierce County. Pierce County's previous stormwater management manual must be brought into compliance with Ecology's standards.

Solution: Update the current Pierce County stormwater manual based on the stormwater management standards presented in Ecology's manual issued in 2001. Ecology provided local jurisdictions, including Pierce County, with updated guidance on stormwater management standards by issuing their 2001 manual for western Washington. Adoption of either the Ecology manual, or an equivalent manual, is required for all municipalities currently covered under an NPDES permit. Guidance for management of both water quantity and water quality is covered by the Ecology manual.

Benefits: Adopting the stormwater standards set forth by Ecology will increase the level of required stormwater mitigation and thereby help counteract urbanization impacts in Pierce County.

PRG-00-03 **"INSPECTION INCREASES FOR STORMWATER COMPLIANCE REQUIREMENTS AND NPDES PERMIT" (countywide)**
Cost Assumption: Includes 6.0 FTEs per year countywide. Life-cycle cost prorated for the Mid-Puyallup Basin's share of the countywide cost (10.2 %)
Cost: $612,000 Score: 398 Priority: High

Problem: Existing stormwater facilities require maintenance for proper functioning. Neglected ponds fill with sediment over time, which reduces their holding capacity. In addition, standards for stormwater compliance for NPDES permits have recently (2001) become more stringent. Regular field inspections are the most reliable way to ensure compliance with stormwater standards and maintenance requirements.

Solution: Increase the number of inspections related to public and private stormwater facilities to ensure compliance with current regulations including the County's Municipal NPDES permit. Both existing and new stormwater facilities will be inspected to confirm that regular maintenance is occurring and that maintenance standards and agreements are being met. When a violation is identified, inspectors will offer education and technical assistance; enforcement actions will be taken when necessary.

Benefits: Increasing the number of inspectors will ensure that stormwater facilities in Pierce County are being properly maintained and that they meet current requirements for stormwater facilities. This will in turn help reduce hydrologic impacts on streams and fish habitat.

PRG-00-04 **"DEVELOP LAND ACQUISITION PROGRAM" (countywide)**
Cost Assumption: Includes 0.5 FTE for one year to develop the inventory and establish the policies and procedures for acquisition and management; also, a 0.25 FTE per year for nine years to pursue acquisitions and oversee property management. Prorated Mid-Puyallup share of the countywide cost (10.2 %)
Cost: $27,000 Score: 389 Priority: High

Problem: Many riparian corridors traverse private property. Because of this, many riparian areas have had vegetation removed, cattle have been allowed to enter streams, woody debris has been removed from streams, along with numerous other minor but cumulative impacts. Because these areas belong to individual property owners, it is very difficult, if not impossible, to restore them to a condition that protects fish habitat. Even if a property owner maintains the riparian corridor, there is no guarantee that the next owner will do the same.

Solution: Develop a system for acquiring and managing properties for habitat protection. The program will have the following elements:

- **Standards for Property Acquisition:** Pierce County Water Programs will develop criteria for determining which properties or types of properties will be acquired. Property acquisition will be generally for the purposes of reducing flood hazards, preserving floodplain storage, protecting water quality, and protecting critical habitat features.
- **Acquisition:** Pierce County Water Programs will pursue acquisition of properties through direct purchase, obtaining easements, or by other legal means depending on the preference of the property owner. The agency will also track riparian and wetland parcels as they come on the market, review the current or potential habitat value of parcels, and negotiate with sellers.

- **Inventory Development:** Develop and maintain an inventory of desired properties. This will facilitate tracking properties as they become available. Properties identified through the planning process will help initiate the inventory.
- **Consultation with other Stakeholders:** Develop standards and mechanisms for coordination with other agencies and groups that have a stake in property acquisitions.
- **Management:** Develop a program for managing acquired properties. The program will address issues such as access, prevention of vandalism and illegal dumping, restoration, maintenance, and liability. Pierce County may consider working with private or non-governmental agencies on mapping certain parcels where appropriate.

Benefits: Riparian corridors that are County owned can be restored and preserved in perpetuity.

PRG-00-05 **"RESTORATION AND ENHANCEMENT PROGRAM" (countywide)**
Cost Assumption: Includes 1 FTE to establish and run the program (costs estimated for a 10-year period); prorated for the Mid-Puyallup Basin's share of the countywide cost (10.2 %)
Cost: $102,000 Score: 325 Priority: Medium

Problem: It is the County's intention to restore, preserve, and protect riparian corridors and wetland areas. Although efforts to do this are on-going, there is no central coordination in place that can track restoration efforts, maintain a database of riparian properties for potential acquisition, and maintain restored sites and preservation properties.

Solution: Develop and implement projects to restore and enhance riparian and wetland areas and improve ecosystem functions. Participation of property owners will be necessary to obtain easements or purchase land directly. The primary function of the program will be to manage the restoration sites contained in this Basin Plan. Activities will 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. It is recommended that the County form partnerships with volunteer groups and other organizations such as the Conservation District, Pierce Stream Team, and the Puyallup Tribes to work cooperatively on enhancement projects.

Benefits: This program will provide the means to centralize the County's efforts to restore and protect streams and wetlands. It will also improve the County's ability to work cooperatively with other groups including the Conservation District, Pierce Stream Team, and the Puyallup Tribes as well as work with individual property owners.

PRG-00-06 **"EDUCATION, OUTREACH, AND TECHNICAL ASSISTANCE PROGRAM" (countywide)**
Cost Assumption: Includes the cost of 1 FTE to establish and run the program for a 10-year period; prorated for the Mid-Puyallup Basin's share of the countywide cost (10.2 %)
Cost: $102,000 Score: 397 Priority: High

Problem: Many property owners lack the technical knowledge to help them provide stewardship for riparian and wetland areas on their property. Because of this, degradation to streams and wetlands is common on private property.

Solution: Develop a comprehensive education, outreach, and technical assistance program for the benefit of the general public. Such a program should include the following elements:

- **Public Awareness:** Develop mechanisms to inform the public about educational opportunities; departmental activities; available information such as flood plans, groundwater information, and mapping; targeted sites for restoration; and Basin Plan activities as they develop.

- **Educational Topics:** Develop classes, workshops, and seminars to educate the public. Topics should include aspects of land stewardship such as proper maintenance of riparian corridors and the use of native plant landscaping, sources of common pollutants such as the use of fertilizers and pesticides and how they can be reduced, the importance of maintaining in-stream flows, and BMPs for small farm management. Generally, increasing public awareness of BMP's that they can implement to reduce water quality, flooding, and habitat impacts in their basin will be the focus of each educational effort.

- **Target Audiences:** Include basin residents in audiences, but also target specific stakeholders such as floodplain residents, business owners, real estate professionals, or homebuyers. Coordinate with other education providers such as schools and non-governmental organizations.

- **Methods:** Distribute information via a variety of techniques such as information posted 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. Specific methods will be based on the information to be distributed and the target audience.

- **Technical/Financial Assistance:** Provide assistance to those residents who are motivated to take direct action toward improving basin conditions. This may include supporting volunteer monitoring programs; providing volunteer opportunities to replant and maintain riparian corridors; offering technical and financial assistance to residents who live in a floodplain, riparian zone, or wetland areas; and coordinating with other agencies that provide technical support such as the Conservation District. Additional incentives might come in the form of free native plants, discounts at local stores, free workshops, tax breaks, or other methods.

- **Coordination:** Coordination with other agencies, groups, and jurisdictions will improve the effectiveness of distributing information and assistance. Other groups may include the Puyallup Tribes, the Conservation District, and the Washington State Department of Fish and Wildlife WDFW).

Benefits: Public education provides property owners with the information they need to help maintain riparian areas and wetlands on their property. This in turn increases the preservation of aquatic habitat throughout the County. In addition, it provides residents with a sense of participation in a positive community benefit.

PRG-00-07 **"MONITORING PROGRAM" (countywide)**
Cost Assumption: Assumes total of 3.75 FTEs countywide plus a $91,000 life-cycle cost over 10 years; prorated for the Mid-Puyallup Basin's share of the countywide cost (10.2 %)
Cost: $474,000 Score: 265 Priority: Medium

Problem: Information is needed both about current conditions and trends to preserve and protect aquatic habitat in Pierce County. Current information in the areas of water quality and quantity, BMP performance and biological health are only available from previous studies or other agencies and organizations that have collected data.

Solution: Develop and implement a monitoring program that will include these aspects (*Figure 9-2* shows recommended monitoring sites):

- **Water Quantity:** The water quantity element will set up and maintain gauge stations to monitor both base and flood flows on selected Mid-Puyallup Basin tributaries. Groundwater depths will be recorded in areas where septic systems may interact with groundwater and in pothole areas where infiltration is poor and flooding is frequent.

- **CIP Performance:** Several sites in the Mid-Puyallup Basin were identified in Chapter 6 as places that should be inspected during peak events to ensure that corrective measures have been effective. These sites include:

  ✓ Stormwater ponds along Angeline Road that serve Sky Island

  ✓ Conveyance improvement at 96th Street East & 234th Avenue East

  ✓ Fennel Creek culvert under the Old Sumner-Buckley Highway

- **Water Quality:** Water quality monitoring should be initiated in streams that have been recommended for restoration in this Basin Plan to document the water quality benefits of restoration. Most of the Mid-Puyallup Basin streams have been affected by agriculture, development, or both.

  Therefore water quality parameters to monitor include:

  ✓ temperature
  ✓ fecal coliforms
  ✓ nutrients
  ✓ turbidity
  ✓ suspended solids
  ✓ metals
  ✓ total petroleum hydrocarbons

  Some special cases of recommended water quality monitoring are testing groundwater for fecal coliforms in places where septic systems are used over high groundwater, and testing for contaminants in Lorenz Creek (a Horsehaven tributary). Water quality monitoring should be coordinated with other agencies and groups such as the Puyallup Tribes who are also collecting data within this Basin.

- **Biological Health:** Currently, Pierce County is participating in macroinvertebrate sampling which follows the protocols established for the Benthic Index of Biological Integrity (BIBI). This sampling program should continue unless a more effective protocol or methodology is identified to assess biological health.

- **Habitat:** Habitat should be assessed by arranging to have selected streams surveyed at least once every five years. The Tri-County Urban Issues assessment methodology will be used to maintain consistency with surveys performed to characterize the original basin plans. Pierce County will compare the results of the surveys to identify any trends and to analyze the effectiveness of regulations, education programs, and incentives for protecting riparian habitat.

- **Dissemination/Mapping:** Information collected under this monitoring program will be evaluated and shared with other appropriate agencies. When feasible, data will be recorded in GIS systems and mapped. Pierce County will have a strategy for posting updated information on the internet.

- **Adaptive Management:** As the monitoring program generates data, that information will be shared and used to assess the effectiveness of policies, programs, and procedures. Every three to five years, Pierce County will perform an in-depth analysis of available data and publish a report on the overall health of the basin and on the effectiveness of applicable programs.

- **Training:** Competent personnel are needed to generate reliable data. Pierce County will 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.

Benefits: Collecting periodic data will provide the County with a means of feedback for their efforts to restore and preserve aquatic habitat. These data can be used to assess the effectiveness of programs and help detect and determine problem areas that may arise in the future.

PRG-00-08 **"BMP MAINTENANCE MANUAL" (countywide)**
Cost Assumption: Includes a one-time cost for 0.5 FTE plus $75,000 for a consultant contract to develop a BMP manual and an additional 0.1 FTE annually to support on-going training sessions and updates; life-cycle cost over 10 years, prorated for the Mid-Puyallup Basin's share of the countywide cost (10.2 %)
Cost: $21,000 **Score: 427** **Priority: High**

Problem: Pierce County has a variety of surface water maintenance needs including stormwater BMPs, dikes and levees, and river sediment to name a few. Currently, there is no single source of uniform standards for these maintenance activities.

Solution: Develop a maintenance manual containing BMP's for Pierce County's stormwater management facilities. The manual will address pond, river, and levee maintenance activities. The maintenance manual will be patterned after the Tri-County transportation facilities approach and will involve practices and techniques to protect water quality and habitat while preserving the flood control functions of the facilities. The manual will provide standard operating procedures for work crews. It will also be designed to achieve compliance with Pierce County's NPDES permit. Distribution of the manual will be accompanied by training sessions on its purpose and use.

Benefits: A BMP maintenance manual will provide standards for Pierce County crews who maintain stormwater ponds, levees, and rivers.

PRG-00-09 **"INVASIVE SPECIES MANAGEMENT PROGRAM" (countywide)**
Cost Assumption: Includes one-time cost for 0.5 FTE and $7,500 for a consultant to develop the BMP document, complete the inventory and data layer, and 0.1 FTE annually for on-going volunteer organization and implementation; life-cycle cost over 10 years then prorated for the Mid-Puyallup Basin's share of the countywide cost (10.2 %)
Cost: $21,000 Score: 437 Priority: High

Problem: Non-native invasive species of plant and animals are species that are brought into an area where they have never existed before. Because they are foreign to the new location, there are frequently no competing species to keep their growth in balance. Uncontrolled growth of new species can out compete native species thereby reducing the abundance of native species.

Examples of non-native invasive species in the Mid-Puyallup Basin include Himalayan blackberry (*Rubus discolor*), reed canarygrass (*Phalaris arundinacea)*, and Japanese knotweed (*Polygonum cuspidatum*).

Solution: Develop a program for addressing invasive species impacts to surface water and County surface water management facilities. A general inventory of invasive plant problems in Pierce County will be conducted and entered into Pierce County's GIS database. A BMP manual will be developed to offer guidance in identifying problematic species, information on their preferred conditions, and options for controlling each problem species.

The invasive species management program will use an Integrated Pest Management approach. This approach will include a range of management tools and approaches, depending on species, extent, water body and beneficial use sensitivity, and other site factors. These tools will include low-impact hand removal, mechanical removal, preventive measures, and use of herbicides as appropriate.

Water Programs 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 completing 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. Water Programs will survey their facilities and properties to identify the presence of invasive species and the extent to which they are affecting the facility.

This information will be incorporated into division work plans. Implementation of this recommendation could also include organizing and orchestrating volunteer groups and working with other groups and agencies to conduct invasive species control such as hand or mechanical harvesting, native species plantings, and other techniques.

Benefits: Controlling invasive species will help protect native species of both terrestrial and aquatic plant and animal life.

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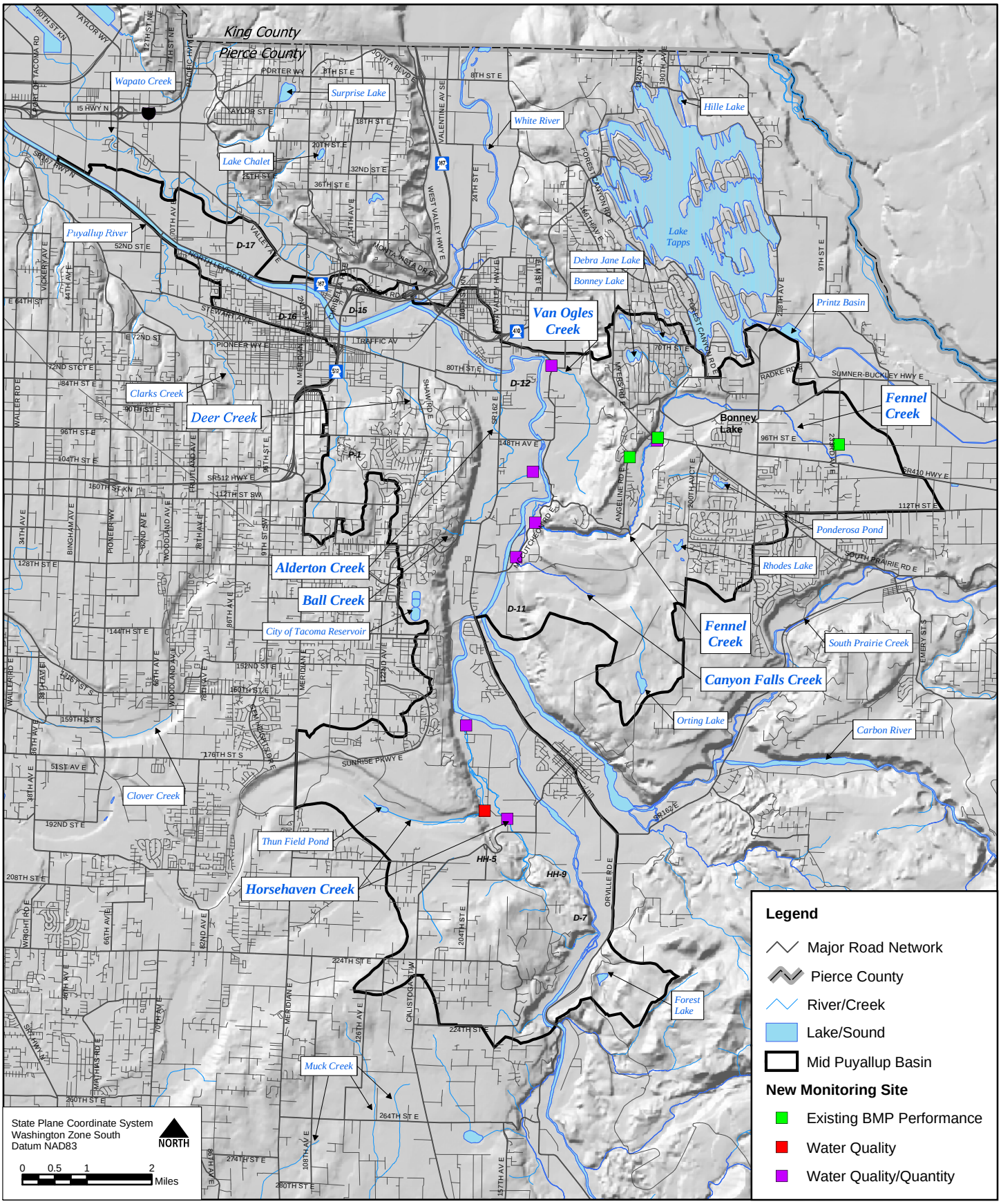

This MAP is for general planning purposes only, and is subject to updates and changes. Any user should check with Pierce County prior to use to be sure that the data is correct. Because of the scale of this map, any user should not rely on it for the exact definition of any boundary or division line shown on said map.

This MAP is based on information from numerous sources and the accuracy of which is not guaranteed by Pierce County and its consultants. Pierce County and its consultants is not responsible and shall not be liable to the user for damages of any kind arising from the data or information shown on this map.

Figure 9-2: Monitoring Sites

Mid-Puyallup Basin Plan

PIERCE COUNTY

entranco Momentum

PRG-00-10 **"FLOOD DISCLOSURE STATEMENTS IN PROPERTY TITLES" (countywide)**
Cost Assumptions: Includes 0.25 FTE per year countywide over a 10-year life-cycle cost; prorated for the Mid-Puyallup Basin's share of the countywide cost (10.2 %)
Cost: $25,500 Score: 85 Priority: Low

Problem: Cases have occurred in which home buyers have purchased property within designated flooding areas without full disclosure. Some measure of protection for buyers is provided through RCW 64.06.020 (1994), a state law that requires sellers of real property to disclose to buyers if a property is within a designated floodplain or designated flood hazard zone. Disclosure is based on the seller's actual knowledge of the flood hazard when the disclosure form is completed. Response options for floodplain disclosure are "yes," "no," and "don't know," with no further explanation or documentation required. Because the basis for this disclosure is the seller's knowledge of flood hazard rather than a determination based on scientific and historical evidence, this disclosure has limited effectiveness in informing potential buyers about flood hazard risk.

Solution: Require that a disclosure statement of flood hazard designation be placed on the titles of buildings located in significant flood hazard areas.

Benefits: Increasing the identification of flood hazards for all real property will increase the current state requirements for hazard disclosure and will reduce the incidence of "don't know" disclosure statements by sellers. This will increase awareness of flood hazard potential among floodplain residents and could increase the number of residents covered by flood insurance.

PRG-00-11 **"ENHANCED COOPERATIVE ARRANGEMENTS WITH CITIES AND OTHER JURISDICTIONS"**
Cost Assumption: 1.0 FTE per year countywide over a 10-year period life-cycle cost; prorated for the Mid-Puyallup Basin's share of the countywide cost (10.2%) plus additional at SWAB direction to increase commitment to Mid Puyallup Basin to 0.5 FTE
Cost: $150,000 Score: 315 Priority: Medium

Problem: Pierce County has an established and generally mature countywide surface water management program. Basin planning is an effective strategy to identify and evaluate problems, analyze and select solutions, and monitor their effectiveness and inform and educate citizens. However, there are limitations that hinder the programs' ability and effectiveness of reducing floods impacts and improving and preserving water quality and aquatic habitat. In general, the principal limitation is that Water Programs is the surface water management utility for only the **unincorporated areas** of Pierce County. Its services for the main begin and end at the incorporate limits of cities.

While the Programs' principle statutory drivers are the same as for incorporated areas of Pierce County (i.e., federal Clean Water Act, in particular Sections 402, 404, 303d, and 319, federal Endangered Species Act, and federal National Flood Insurance Program), each jurisdiction manages, or is developing its own approach. Additionally, the Puyallup/Carbon River levee system provides protection against flood damage for citizens throughout the watershed, (citizens from both incorporated and unincorporated areas) but is maintained by Water Programs. Finally, effective in 2005, cities in the Basin will come under the state's municipal stormwater NPDES

permit requirements, conditions unincorporated Pierce County has been under since 1995, administered by Water Programs.

In general, a disconnect can be illustrated through the Basin Plan by comparing (1) a watershed draining totally unincorporated areas of the basin and (2) a watershed draining unincorporated and incorporated areas.

Horsehaven Creek and Fennel Creek are two watersheds within the Mid-Puyallup Basin Plan. Surface water from the west fork of Horsehaven Creek flows east of the South Hill area and meets the South Fork on the floodplain to flow into the Puyallup River all within an unincorporated area. *Figure 5-1b* in the plan displays the watershed. Pages 5-7, 5-12, and 5-16, identify the problem areas. *Figure 9-1d* identifies the capital improvement projects. Their implementation will bring surface water improvements to this watershed and residents will benefit.

Fennel Creek (*Figure 4-3a*) flows westerly beginning in an unincorporated area, through the incorporated Bonney Lake and reenters an unincorporated area to finally discharge to the Puyallup River. Problem areas are identified (pages 5-4, 5-5, 5-12). Capital improvement projects are identified *(Figure 9-1b*), but not so in the incorporated areas. Success of the plan within fennel creek watershed rests on the extraordinary ability of the water program staff to bridge this gap and without an interlocal agreement, it is unlikely to occur.

Cities within this basin planning area stated an interest in sharing information in Phase I and in collaboration during Phase II. However, there is no formal process in place to ensure and perpetuate that collaboration.

In considering this situation, the Pierce County Storm Drainage and Surface Water Management Advisory Board, comprised of residents of each of Pierce County's seven Council Districts, and including members of unincorporated and incorporated Pierce County, acknowledged the need for increasing coordination of efforts for flood control, water quality and aquatic habitat protection and rehabilitation in the Mid-Puyallup Basin. It also acknowledges that this arrangement can be beneficial in other basins of the County.

Solution: The SWAB recommends that Pierce County Water Programs create more cooperative arrangements for surface water management services with cities and other jurisdictions within the Mid-Puyallup Basin and countywide. These can be formal or informal and have the objective of reducing flooding, protecting water quality and protecting aquatic habitat through various mechanisms, such as interlocal agreements.

Benefits: This approach will foster cooperation between County and cities to help address various watershed management issues. It will enable a deliberative and informed discussion of costs and benefits and will provide an opportunity to, at a minimum, improve collaboration. If implemented, the results could be enhanced and more efficient surface water management for the County.

9.2.15 Additional Studies Recommended

ST-1 **"IDENTIFY SEDIMENT SOURCES" (Van Ogles, Ball, & Horsehaven Creeks)**
Cost Assumption: 0.5 FTE for one year
Cost: $50,000

Problem: The Mid-Puyallup Basin tributaries that flow across the valley bottom and through agricultural areas have abundant fine sediment built up within their channels. This sediment clogs or completely covers spawning gravel in these creeks. Suspected sources of these fine sediments are agricultural runoff, livestock within the channel, and eroding banks from peak flow scour but exact locations are unknown. Removing the fine sediment from the streambed will only provide short-term improvement unless sediment input is reduced.

Solution: Identify sediment sources on Ball and Horsehaven creeks. These creeks flow across the flat valley bottom of the Puyallup River and carry an abundance of fine sediment. The recommended study will identify fine sediment sources in these two creeks and suggest ways to reduce input volumes to improve the long-term success of stream restoration efforts.

Benefits: Identifying and locating sediment sources will provide the information needed to reduce sediment input.

ST-2 **"SEPTICS OVER HIGH GROUNDWATER" (along the valley floor)**
Cost Assumption: 0.25 FTE for 2 years
Cost: $60,000

Problem: On-site sewer systems are used extensively in the valley portion of the Mid-Puyallup Basin. Citizens in the Mid-Puyallup Basin have complained that flooding has caused several on-site sewer systems to fail. In order to develop alternative solutions, the conditions associated with each reported site must be understood.

Solution: Investigate the extent to which on-site sewer system failures in the valley of the Mid-Puyallup Basin are related to surface water flooding, including groundwater flooding. Identify how extensive the problem is and alternative solutions.

Benefits: Document the extent to which surface water flooding is causing on-site sewer system failures. The information can be used to identify reasonable alternatives.

ST-3 **"BASIN BOUNDARY ADJUSTMENT" (Boundary adjacent to Clover Creek)**
Cost Assumption: 0.25 FTE for 1 year; $15,000 for additional survey work
Cost: $40,000

Problem: Two places along the Mid-Puyallup Basin boundary may need adjustment and should be carefully investigated. One place is along the northern basin boundary to the west of the White River confluence where the upstream reaches of Wapato Creek have been diverted into the Puyallup River. The location of the diversion is fixed and known. The basin boundary around the area draining to the diversion is illustrated in *Figure 9-3*.

The second place is along the western edge of the Basin near Graham. In the area along the southwest side of the Mid-Puyallup Basin, surface runoff flows toward the Puyallup River because of the topography. Groundwater in this area, however, flows toward Clover Creek to the

north and Muck Creek to the south. The existing Basin boundary was delineated based on topography and may not be accurate when subsurface flows are considered.

Solution: An investigation should be conducted to determine the hydrologic basin boundary between the Mid-Puyallup River, Clover Creek, and Muck Creek basins.

Benefits: Having accurate basin boundaries allows for more accurate assessment of basin needs.

ST-4 **"GROUNDWATER INTERACTION EVALUATION" (Creeks Valley Bottom)**
Cost Assumption: 0.25 FTE for one year; four new 6-inch monitoring wells at $10,000 each; $15,000 for additional survey work; $25,000 for sub-surface technology; $20,000 for public and environmental process; and $80,000 for consulting services
Cost: $205,000

Problem: During hydrologic modeling for this Basin Plan, it became apparent that groundwater input plays a significant role in the base flow found in both Ball and Horsehaven creeks. Field data characterizing these inputs were unavailable at the time modeling was done.

Solution: To better understand the hydrology of streams along the Mid-Puyallup valley floor, a study of groundwater interactions should be made.

Benefits: Study will provide a better understanding of the hydrology of the streams that flow across the Mid-Puyallup valley bottom. This in turn will allow for more accurate flow predictions and help to prevent flooding, maintain water quality, and assess fish habitat.

ST-5 **"WETLAND ACQUISITION SITES" (countywide)**
Cost Assumption: 0.1 FTE for two years; $50,000 for professional services
Cost: $60,000

Problem: Wetlands provide habitat, flood storage, and stream flow attenuation, in addition to other functions they serve within the ecosystem. Records of exact wetland boundary locations are limited within Pierce County.

Solution: Inventory and evaluate wetlands in Pierce County that should be candidates for acquisition and preservation.

Benefits: The protection and restoration of selected wetlands will benefit the Mid-Puyallup Basin by retaining hydraulic functions and preserving aquatic habitat.

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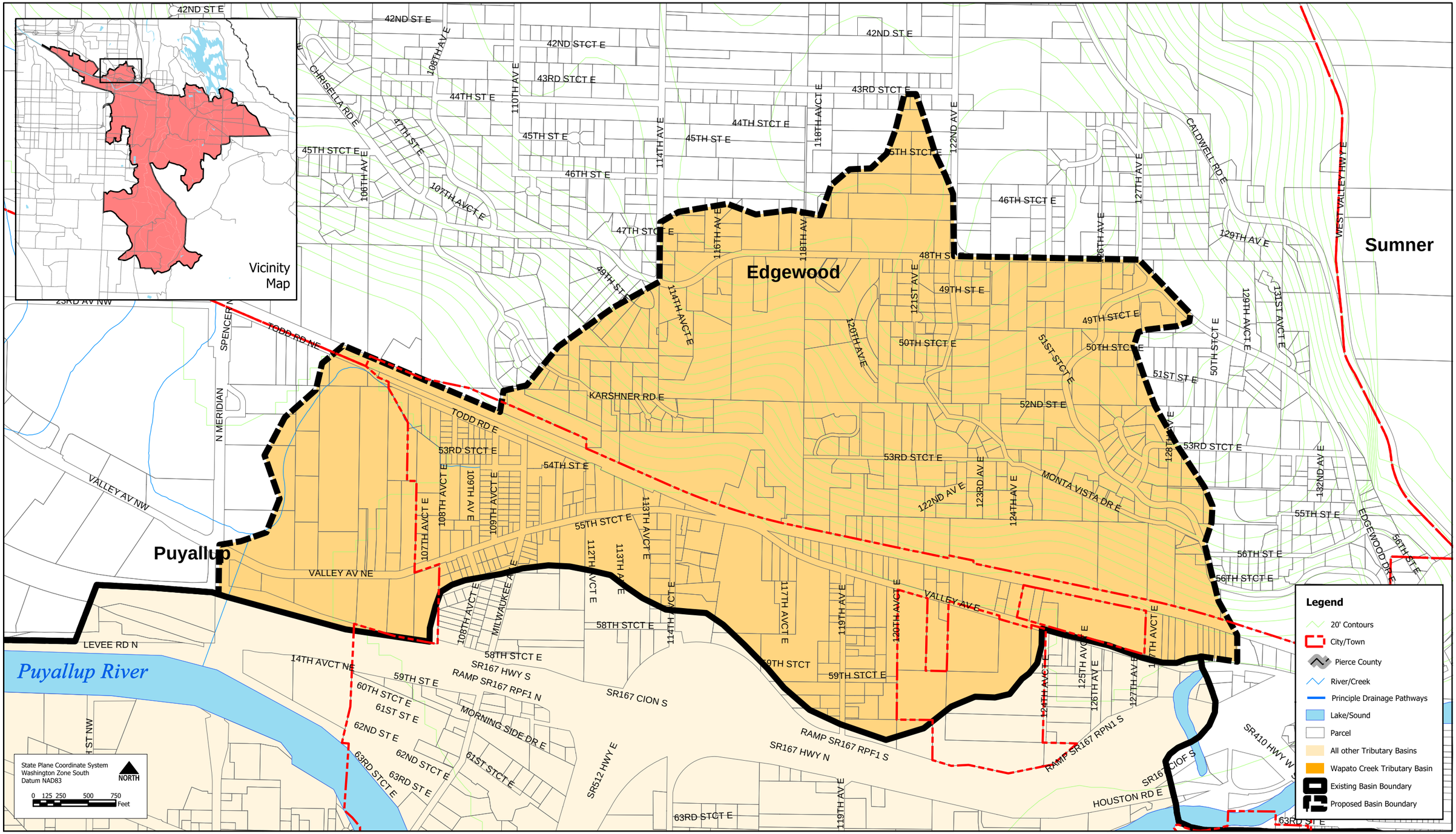

This MAP is for general planning purposes only, and is subject to updates and changes. Any user should check with Entranco prior to use to be sure that the data is correct. Because of the scale of this map, any user should not rely on it for the exact definition of any boundary or division line shown on said map.

This MAP is based on information from numerous sources and the accuracy of which is not guaranteed by Entranco. Entranco is not responsible and shall not be liable to the user for damages of any kind arising from the data or information shown on this map.

Figure 9-3: Wapato Tributary Basin

Mid-Puyallup Basin Plan

PIERCE COUNTY

entranco Momentum

10. ENVIRONMENTAL IMPACT STATEMENT

FINAL

SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

for the

Proposed MID-PUYALLUP BASIN PLAN

Prepared in compliance with the State Environmental Policy Act and Title 18D Pierce County Code

August 9, 2005

PIERCE COUNTY PUBLIC WORKS AND UTILITIES
Water Programs Division

9850 64th Street West, University Place, WA 98467-1078

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10.1 FACT SHEET

Title of Proposed Action	**Mid-Puyallup Basin Plan**
Description of Proposed Action	Pierce County Public Works and Utilities, Water Programs Division proposes to update the 1991 Pierce County Storm Drainage and Surface Water Management Plan (1991 Plan) by adopting and appending the proposed Mid-Puyallup Basin Plan to the 1991 Plan. Since its adoption, the 1991 Plan has served as a guide for the identification, design, and construction of storm drainage and surface water management facilities, and for the design and implementation of nonstructural/programmatic activities in unincorporated Pierce County. The Proposed Mid-Puyallup Basin Plan recommends a set of capital improvement projects and programmatic measures to solve flooding, water quality, habitat, and other storm drainage problems within the Mid-Puyallup Basin. The No-Action Alternative would continue to select capital projects for construction from the 1991 Plan recommendations and in response to urgent problems. The 1991 Plan contains no capital projects for the Mid-Puyallup Basin. This Final SEIS adds information to the 1991 *Draft* and *Final Environmental Impact Statements* for the *Pierce County Storm Drainage and Surface Water Management Plan* pertaining to the Mid-Puyallup Basin.
Location of Proposal	Unincorporated areas draining to streams that discharge to the middle section of the Puyallup River, from River Mile (RM)-7 to RM-26.5. The Mid-Puyallup Basin lies in Puyallup-White River Water Resource Inventory Area (WRIA) 10.
Proponent	Pierce County Public Works and Utilities, Water Programs Division
Proponent Contact	Al Zehni, P.E. Public Works and Utilities, Water Programs Division 9850 64th Street West University Place, WA 98467-1078 (253) 798-4662
Lead Agency	Pierce County Planning and Land Services

Lead Agency Contact	Adonais Clark, Senior Planner Environmental Designee Pierce County Planning and Land Services 2401 S. 35th Street Tacoma, WA 98409-7490 (253) 798-7165
Estimated Adoption Date	Fall of 2005 after public hearings before the Pierce County Council
List of Permits & Approvals Required	Approval of an ordinance of the Pierce County Council adopting the Proposed Basin Plan. Approval of annual amendments to the Capital Facilities Element of the Comprehensive Plan for Pierce County Washington that include projects from the Proposed Mid-Puyallup Basin Plan. Approval of annual budgets containing projects from the Proposed Mid-Puyallup Basin Plan. Permits for work in and adjacent to water (e.g., Hydraulic Project Approvals, Shoreline Permits, Section 404 Permits, others) will be required for capital projects prior to construction.
Authors & Principal Contributors	Al Zehni, P.E.; Janine Redmond, Marsha Huebner, Entranco, Inc.
Date of DSEIS Issuance	June 17, 2005
Written Comments Due Date	July 18, 2005
Date of FSEIS Issuance	August 9, 2005
Public Meetings & Hearings	Pierce County Storm Drainage & Surface Water Management Advisory Board; March 22, 2005 Planning Commission Hearing, Pierce County Public Services Building, 2401 South 35th Street,Tacoma; May 24, 2005 Informational Meeting on Draft Basin Plan and Draft SEIS, Orting Multi-Purpose Center; May 31, 2005 Informational Meeting on Draft Basin Plan and Draft SEIS, Sumner City Hall, June 7, 2005
Subsequent Environmental Review	Project-specific environmental review will be performed for construction projects and programmatic actions prior to construction and implementation respectively.

Locations of FEIS on "1991 Plan"

Pierce County Public Works & Utilities, Environmental Services Building, 9850 64th Street West, University Place, WA 98467-1078, (253) 798-2725; and at Pierce County Planning and Land Services Department, located at 2401 S. 35th St., Tacoma, WA, 98409, (253) 798-7210.

Locations of Proposed Mid-Puyallup Basin Plan and Final SEIS

View on the internet at:
www.piercecountywa.org/midpuy

Printedcopies are available at the following libraries:

- Orting Branch, Pierce County Library System; 202 Washington Avenue North, Orting, WA 98360
- Bonney Lake Branch, Pierce County Library System; 18501 90th Street East, Bonney Lake, WA 98390
- Sumner Branch, Pierce County Library System; 1116 Fryar Avenue, Sumner, WA 98390
- City Puyallup Public Library; 324 South Meridian, Puyallup, WA 98371
- South Hill Branch, Pierce County Library System; 15420 Meridian East, Puyallup, WA 98375

Cost of Printed FSEIS

The FSEIS may be purchased for the cost of printing at:

Pierce County Public Works and Utilities
Environmental Services Building
9850 64th St. West, University Place WA, (253)798-2725, or

Pierce County Planning and Land Services,
2401 S. 35th St., Tacoma, WA,
(253)798-7210

10.2 SUMMARY OF FSEIS

Pierce County Public Works and Utilities, Water Programs Division, proposes to adopt and implement the Mid-Puyallup Basin Plan (Basin Plan). If adopted, the Basin Plan will amend the Pierce County Storm Drainage and Surface Water Management Plan (1991 Plan).

The State Environmental Policy Act (SEPA), Chapter 43.21C RCW, requires that an Environmental Impact Statement (EIS) be prepared for proposed actions that could result in probable significant adverse environmental impacts. An EIS was prepared for the original 1991 Plan to describe potential adverse environmental impacts of alternatives being considered at the time. The EIS compared a No-Action Alternative against the measures identified in the 1991 Plan.

This Final SEIS (FSEIS) has been prepared to take into account significant new information that has been developed about the study area, new laws enacted, new policies adopted, and the terms of the County's Stormwater National Pollution Discharge Elimination System Permit. It describes the effect of the No-Action Alternative and the Proposed Mid Puyallup Basin Plan on existing law and policy to describe how capital improvement projects and changes in County programs resulting from implementation of the Mid-Puyallup Basin Plan would result in "probable significant adverse environmental impacts". The FSEIS also takes into account "significant new information" that has been developed and changes in law that have been enacted over the past 12 years (WAC 197-11-405(4)). The FSEIS compares implementation of the Mid-Puyallup Basin Plan with the No-Action Alternative. The No-Action Alternative would continue implementation of the 1991 Plan.

This Basin Plan is one of 10 basin plans that Pierce County Water Programs is preparing to update the 1991 Plan. The 1991 Plan was adopted to provide a comprehensive approach to solving flooding and erosion problems in unincorporated Pierce County, as a condition for ongoing eligibility in the Flood Control Assistance Account Program (FCAAP), and to establish the basis for a self-sustaining Storm Drainage and Surface Water Management Utility. It evaluated 26 drainage basins in the non-federal lands of unincorporated Pierce County, set out policy objectives, and identified stormwater and surface water management facilities and other measures to reduce flooding and erosion. The basins were evaluated at different levels, depending upon whether they were considered to be urban or rural. Eight urban and urbanizing areas were studied in more detail. Mid-Puyallup was studied as part of the greater rural area of Pierce County. Therefore, no detailed characterization was undertaken and no basin-specific recommendations were made for the Mid-Puyallup Basin in the 1991 Plan.

Since the original 1991 Plan was adopted, surface water management has increased in complexity. In the early 1990s, the State Growth Management Act (GMA) directed the County to establish and protect "Critical Areas," such as wetlands, aquifer recharge areas, and steep slopes. It directed the County to give special consideration to conservation measures necessary to preserve or enhance anadromous fisheries. The GMA required development and adoption of an internally consistent comprehensive plan and mandated that budgets and other policy documents

of the county be consistent with the comprehensive plan The Comprehensive Plan for Pierce County, Washington was adopted in November 1994.

A growing emphasis has been placed on counties protecting water quality, streams, wetlands, and other critical areas affected by stormwater runoff and the way it is managed. In the mid-1990s, jurisdictions with populations over 100,000, including Pierce County, were required to create stormwater management programs under the federal Clean Water Act's (CWA) "National Pollutant Discharge Elimination System (NPDES) Program." In the late 1990s, the federal government listed chinook salmon, bull trout, and other fish species found in Pierce County waters under the Endangered Species Act (ESA). Any adverse impact to a listed species is considered to be significant.

This Basin Plan evaluates current conditions and problems and prioritizes recommended projects given the changed background of environmental requirements and adopted County policy. It addresses changes in policies and programs needed to meet requirements of the CWA , ESA, and GMA.

The purpose of the Mid-Puyallup Basin Plan is to create a basin-specific, but comprehensive approach to reducing flood hazards and erosion, improving fish and wildlife habitat within the storm drainage system, and improving water quality of stormwater. The Basin Plan provides a focused analysis of flooding, drainage, and water quality issues within the Basin, not undertaken for the Mid-Puyallup Basin in the 1991 Plan. The Basin Plan also addresses fish habitat mandates as they apply to managing storm drainage and surface water runoff that did not exist when the 1991 Plan was adopted.

Citizens within the Basin contributed to the Basin Plan at public meetings and by completing questionaires. Their concerns regarding water quality and quantity in the Mid-Puyallup Basin are addressed within the Plan. Their suggestions for ways of solving problems were considered as alternative solutions were developed.

The Basin Plan refers solutions for some of the drainage problems identified in the Basin other agencies. For example, the Plan refers culverts on private property to Pierce Conservation District. Flooding problems whose resolution lies in road maintenance are referred to the Pierce County Roads Division.

The Basin Plan proposes 23 projects to reduce flooding and drainage problems within the Basin, including projects to improve water quality and fish habitat to meet legal mandates. Some projects would become part of the Water Programs Division CIP. Others may be completed as part of the facilities maintenance program and in conjunction with other agencies. The list of CIPs includes:

- Eight (8) culvert replacement projects to alleviate flooding or remove barriers to fish passage
- Two (2) bridge conveyance improvements that involve elevating the roadway
- One (1) stormwater pond improvement

- Two (2) local drainage improvements
- Four (4) property acquisitions for flood protection and habitat preservation
- Six (6) stream and riparian corridor restoration projects

In addition, the Basin Plan presents recommendations for programmatic measures and "Best Management Practices." A long-term monitoring plan is recommended to measure the effectiveness of basin management actions and allow for adaptive management to meet changing conditions. Five studies for problems that could not be resolved within the scope of the planning effort are also recommended.

Table 10-1, Comparison of Impacts, compares the adverse environmental impacts that are likely to occur if the Proposed Mid-Puyallup Basin Plan is adopted (Proposed Action) to the adverse environmental effects of not adopting the Basin Plan (the No-Action Alternative).

Table 10-1
Comparison of Impacts

Alternative	Impacts	Probable Significant Adverse Environmental Impact?
Water Resources		
Proposed Action	• Temporary reduction in water quality associated with culvert replacement projects during construction. • Net improvement in flooding and drainage conditions. • Potential for temporary water quality impacts during removal of fish migration barriers or stream restoration projects. • Projects and actions would improve water quality.	No
No-Action Alternative	• Temporary reductions in water quality associated with culvert replacement projects during construction. • Many flooding problems would continue to occur. • Development impacts could increase flood flows and flooding. • Water quality violations of stream temperature, nutrient, and pathogen standards would likely continue.	Potential

Fishery Resources		
Proposed Action	• Potential for short-term increase in stream sediment during construction of culvert replacements and stream restoration projects. • County stream restoration and enhancement projects and programs would improve salmon habitat. • Livestock access to streams would be reduced, decreasing habitat impacts. • Removal of fish barriers would expand accessible salmon habitat.	No
No-Action Alternative	• Potential for short-term increase in stream sediment during construction of culvert replacements and stream restoration projects. • Others would carry out the majority of habitat improvements. • Problems with habitat degradation and low channel flows are expected to worsen. • Long-term impacts to stream banks and habitat due to livestock access are expected to continue. • Fish habitat would continue to be degraded due to loss of riparian vegetation from development and grazing livestock.	Potential
Vegetation		
Proposed Action	• Stream banks would be revegetated to improve habitat, reduce water temperature, and improve water quality. • Temporary impacts to vegetation may occur during construction. • Improvements to riparian buffers would increase riparian area and vegetation.	No
No-Action Alternative	• Vegetation would continue to be affected in developing areas with no coordinated plan for protection. • No improvements to existing conditions.	No

Wildlife		
Proposed Action	• During construction, wildlife may be temporarily displaced. • Habitat acquisition and enhancement would aid wildlife.	No
No-Action Alternative	• During construction, wildlife may be temporarily displaced. • No improvement to existing habitat programs.	No
Land and Shoreline Use		
Proposed Action	• Development would be directed away from floodplains and valuable habitat resources toward areas with fewer constraints. • Basin Plan would guide and/or support land use plans that reduce impacts to water resources. • The Basin Plan is proactive in reducing development related impacts	No
No-Action Alternative	• Riparian corridors would continue to diminish. • Development impacts to water resources would continue, the 1991 Plan emphasizes CIP development, and does not provide support for land use decisions. • The existing program is reactive to development related impacts.	Potential
Aesthetic, Historical and Cultural Resources		
Proposed Action	• Temporary aesthetic impacts associated with tree/vegetation removal would occur during construction of infiltration ponds, detention facilities, and other projects. • Revegetation of stream corridors would increase "green" areas within the basin.	No
No-Action Alternative	• Temporary aesthetic impacts associated with tree/vegetation removal would occur during construction of infiltration ponds, detention facilities, and other projects.	No

Public Services and Utilities		
Proposed Action	• During construction, roads/lanes could be closed temporarily, creating potential delays for emergency vehicles. • Upgrades of under capacity culverts would reduce road closures due to flooding. • Projects and programs would improve public safety and reduce the need for some public services.	No
No-Action Alternative	• During construction, roads/lanes could be closed temporarily, creating potential delays for emergency vehicles. • Limited upgrades of several under capacity culverts would reduce, somewhat, road closures due to flooding. • Public safety and the need for some public services would be minimally improved.	Potential
Soils		
Proposed Action	• Temporary disturbance of local soils would occur during construction of CIPs. • Erosion potential within the Basin would be reduced.	No
No-Action Alternative	• Temporary disturbance of local soils would occur during construction of drainage facilities. • Soil erosion to streams would likely continue, diminishing habitat.	Potential

10.3 ALTERNATIVES, INCLUDING THE PROPOSED ACTION

10.3.1 Introduction and Background

The proposed Mid-Puyallup Basin Plan applies to areas in unincorporated Pierce County that drain directly to the middle section of the Puyallup River and that drain to the tributary streams that flow into the middle section of the main river channel.

The Mid-Puyallup Basin is in a period of steady and rapid growth. This once rural and agricultural basin is becoming residential suburbs, particularly on the plateau areas above the Puyallup River Valley. The Mid-Puyallup Basin Plan is intended to address current problems as well as anticipate and prevent future problems due to growth and changing environmental regulations.

This section describes two alternatives being considered to achieve the long-term goals of the Pierce County Storm Drainage and Surface Water Management Plan (1991 Plan). The alternatives evaluated consist of the Proposed Action, adoption of the proposed Mid-Puyallup Basin (Basin Plan) and the No-Action Alternative, continued use of the 1991 Plan.

This section also provides background on the original 1991 Plan as it pertains to the Mid-Puyallup Basin.

The Pierce County Storm Drainage and Surface Water Management Plan

The Pierce County Council established the County's Surface Water Management Utility in March 1988 by Ordinance 87-205. In 1991, the County adopted the original Storm Drainage and Surface Water Management Plan (1991 Plan). The 1991 Plan was intended to provide a comprehensive program for surface water management operations, funded by service charges.

The Storm Drainage and Surface Water Management Utility was established pursuant to Chapters 36.89 and 39.34 RCW (authorizes surface water management fees, and provides for cooperation between local agencies, respectively). It was also prepared to satisfy Washington State Department of Ecology (Ecology) requirements for a Comprehensive Flood Control Management Plan (WAC 173-145) and to fulfill the requirements for participation in State and federal grant programs.

The 1991 Plan addressed all 26 drainage basins in Pierce County to varying degrees. Urban areas were studied in more detail than rural basins. Eight basins were studied in detail: Gig Harbor, Hylebos Creek, Clear/Clarks Creek, Clover/Steilacoom Creek, Chambers Bay, Tacoma West/Browns-Dash Point, Muck Creek, and American Lake. The remaining basins were studied collectively. The Mid-Puyallup Basin was included in the collective study as a rural area.

The 1991 Plan recommends both structural and nonstructural means to accomplish its goals and objectives. Nonstructural methods provide, "The strategy to modify susceptibility to flood damage and disruption" consisting of "actions to avoid dangerous, uneconomic, undesirable, or unwise use of the floodplain" (FEMA, May 1989). Nonstructural recommendations tend to be broad and county-wide rather than basin or area specific.

The 1991 plan focused primarily on projects aimed at addressing flooding problems existing at that time. Specific flooding projects were recommended in the 1991 Plan, Volume 2 - Capital Improvement Program (CIP). However, no projects were recommended for the Mid-Puyallup Basin. Emphasis at the time was flooding of the Puyallup, Carbon and White Rivers. A flood control management plan for these rivers was developed in the same time frame.

The long-term goals were to last the life of the program. These goals are shown in *Table 10-2*:

Table 10-2
Long-Term Goals of the 1991 Plan

Goal	Description	Objectives
1. Prevent Loss of Life, the Creation of Public Health or Safety Problems, and the Loss or Damage of Public and Private Property.	Prevent the loss of life or property due to flooding events.	Nonstructural measures should be preferred over structural measures. Protection of existing facilities and structures should take preference over the protection of undeveloped lands. Land use and related regulations and zoning should reflect the natural constraints of the streams, floodplains, meander zones, and riparian habitat zones. Together, this plan, program, and codes should present consistent goals and objectives.
2. Establish and Adopt a Systematic and Comprehensive Approach	The need for emergency measures should be reduced or prevented through planning, and the use of structural and nonstructural measures.	Continue the role of the Citizens Advisory Committee or similar body in an advisory role to the Utility. The body should represent the entire County and citizens with a variety of reasons for their interest in surface water management. Strategies for surface water management should balance engineering, economic, environmental, and social factors in relationship to stated comprehensive planning goals and objectives. Public understanding of the various capabilities and limitations associated with stormwater management should be improved through a variety of educational efforts. The goals and objectives of the Master Plan should be evaluated at regular intervals (i.e., every 5 years) to maintain consistency with other related programs affecting the environment.
3. Minimize Expenditure of Public Funds	The need for emergency measures should be reduced or prevented through planning, and the use of structural and nonstructural measures.	A stable, adequate, and publicly acceptable long-term source of financing should be established and maintained for the Utility and the comprehensive management program.
4. Maintain the Varied Uses of the Existing Natural Drainage System Within the County	Stormwater management in Pierce County should occur in the context of the varied uses associated with the natural drainage systems within the County. These include agricultural, commercial, industrial and residential, fish and wildlife habitat, water supply, open space, and recreation.	Stormwater management measures should preserve, to the fullest extent possible, opportunities for other uses. Structural flood control measures should preserve or enhance existing flow characteristics for fisheries and other uses of the riparian zone. Flood control activities should not result in a net loss of, or damage to fish and wildlife resources, but wherever possible, develop or improve the diversity of habitat.

Table 10-2 (Continued) Long-Term Goals of the 1991 Plan		
Goal	**Description**	**Objectives**
	Preserve to the fullest extent possible, the scenic, and ecological qualities of the natural drainage system in harmony with those uses deemed essential to life of its citizens, and wherever possible, enhance the in-stream and riparian uses of the streams, wetlands, and lakes of Pierce County.	Changes in land use should try to restore the land's natural character to the natural state whenever possible.
5. Prevent the degradation of the quality of both surface water and the water entering the region's aquifers.	Urbanization normally leads to degradation in the quality of stormwater runoff. This can become a problem both for the wildlife that depends on the stream system and the local populace.	The use of the natural drainage system is preferred over the use of pipelines or enclosed detention systems. The preservation of natural wetlands, floodplains, and streams is to be actively pursued. The County will apply for a NPDES permit and will strive to comply with requirements for preserving water quality. All stormwater runoff from impervious surfaces should be treated before it is allowed to enter the natural drainage system, infiltrate into the ground, or enter Puget Sound.
6. Coordinate with Public and Private Sectors	Stormwater management measures should be compatible with the various public and private sectors affected.	Planning and design/construction of stormwater management measure should include the opportunity to identify acceptable stormwater management measures. The Citizens Advisory Committee should provide input on existing or pending regulations that are incompatible with the goals of the Master Plan. Efforts should be made to work with the cities towards standardizing regulations that impact stormwater management.

Use of 1991 Plan As Principal Focus of CIP Has Evolved

The 1991 Plan has been used as a basis for CIP proposals since its adoption. This foundation has been, augmented from time to time by (1) recommendations for projects to address flooding due to population growth and land development and not problems in 1991, and (2) a 1997 rate structure study. Projects are selected every year and adopted by the County Council as part of the annual amendments to the Capital Facilities Element of the County Comprehensive Plan.

Although many projects still come from the 1991 Plan, others have been developed based on more recent information, regulatory requirements, and experience.

Since the 1991 Plan, cities such as Bonney Lake, Puyallup, Sumner, Orting and Fife have annexed adjoining areas and much development has occurred in the cities and in unincorporated Pierce County. Flooding problems occurred during the 1996 and 1997 storm events that demanded prompt attention. So while the 1991 Plan did not identify capital projects for the Mid-Puyallup Basin, several storm drainage projects have been constructed

10.3.2 ALTERNATIVES

Proposed Action: Mid-Puyallup Basin Plan

The proposed action is to adopt and implement the proposed Mid-Puyallup Basin Plan for surface water management of the Mid-Puyallup Basin. The Basin Plan documents the existing condition of the Basin's water resources and the physiographic and land use characteristics that bear on flooding and storm drainage conditions. It identifies water resource problems and issues and recommends a set of actions and construction projects to improve conditions. The Basin Plan recommends 23 capital projects, 12 programmatic activities and five studies designed to remedy existing problems and to prevent future water resource problems. Plan goals are translated into a comprehensive list of basin needs and action recommendations with projects, programs, and policies to address the flooding, water quality, and riparian habitat problems identified in the Basin Plan. Projects in the Basin Plan would append and update the 1991 Plan, which identified no CIPs for this basin. Programmatic recommendations in the Basin Plan would augment the nonstructural recommendations contained in the 1991 Plan. The Basin Plan would provide guidance for Pierce County's future CIPs, capital expenditures, water resource protection policies, and public education programs in the Mid-Puyallup Basin. Refer to Chapter 9 of the Basin Plan for maps and details of the proposal.

The Mid-Puyallup Basin Plan provides strategic water resource management direction within the Basin by assessing problems, providing structural and nonstructural solutions, and recommending monitoring and evaluation programs. Also, the Basin Plan enables cross-basin water resources management coordination by applying standard protocols and evaluation criteria used in the other basin plans.

The Mid-Puyallup Basin Plan has been developed in accordance with the framework document "Guidance for Basin Planning" prepared by Pierce County Water Programs (2000). The guidance document lists prescribed tasks to prepare a basin plan and gives directions for completing the tasks.

The Mid-Puyallup Basin Plan recommends the following CIPs to address identified water resource management issues:

- Eight culvert replacement projects for flooding or fish passage
- Two bridge conveyance improvements that include elevating the roadway
- One stormwater pond improvement
- Two local drainage improvements
- Six stream and riparian corridor restorations
- Four property acquisitions for flood protection and habitat preservation

Several recommended CIPs involving fish passage and habitat improvements are related. The Basin Plan discusses these links and the importance of constructing related projects within a similar time frame.

Future land use for the Basin is designated primarily as low-density rural and residential use. Low impact development (LID) techniques are recommended for new developments in the area and on-site infiltration of stormwater is encouraged. Programmatic recommendations in the Basin Plan include:

- Implementing LID techniques and a basin-specific pilot study
- Updating County regulations, including the stormwater management standards and BMP maintenance manual
- Increasing inspections for compliance with stormwater requirements and the County's Stormwater NPDES Permit
- Developing a program to restore and preserve floodplains and fish and wildlife habitat along storm drainage/surface water channels
- Establishing a public outreach and education programs
- Developing a monitoring program to measure and track stormwater runoff volumes, water quality, and biological health of streams.

Each project and programmatic action in the Basin Plan is rated and assigned a priority using standardized criteria. The prioritization involves assigning points related to the accomplishment of basin plan goals and objectives. See the appendix of the Basin Plan for the rating sheets. Main categories that reflect basin plan objectives include:

- Flood reduction (level and frequency)
- Water quality improvement (source reduction)

- Natural resource improvement (restoration and protection)
- Recreational and multiple use opportunities
- Aesthetics

No Action

The "No-Action Alternative" means that the Mid-Puyallup Basin Plan is not adopted and the current ad-hoc method of solving flooding, water quality and riparian habitat problems continues. Under the "No-Action Alternative," stormwater facilities would continue to be managed using the 1991 Plan, which does not consider needs within the drainage basins tributary to the middle section of the Puyallup River. The 1991 Plan does not recommend any CIPs for the Mid-Puyallup Basin. Therefore, the Water Programs Division of the Pierce County Public Works and Utilities Department would continue to address water resources issues on an "as needed" basis.

Several nonstructural measures identified in the 1991 Plan would continue to influence water resource activities in the Mid-Puyallup Basin. These measures include:

- Economic incentives for resource protection
- Floodplain/wetland protection
- Floodproof existing structures
- Relocation of existing structures out of the floodplain
- Public education related to water resource issues
- Property owner purchase of flood insurance
- Land use management techniques, including floodplain zoning ordinances, building codes, clearing and grading ordinances, subdivision ordinances, stormwater management ordinances, and stream corridor density regulation

Comparison of Alternatives

Table 10-3 summarizes major characteristics of the proposed Mid-Puyallup Basin Plan and the No-Action Alternative.

Table 10-3
Comparison of Alternatives' Features
(X means the feature is present in the alternative)

Feature	Basin Plan	No Action
Flooding solutions	X	
Water quality solutions	X	
Habitat solutions	X	
Annual capital facilities element	X	
Comprehensive, strategic	X	
Focus on specific projects	X	
Focus on basin problems	X	
Countywide programmatic or nonstructural solutions	X	X
Basin-specific programmatic or nonstructural solutions	X	
Recommendations prioritized within basin[1]	X	
Recommendations prioritized county-wide		X

[1] Although prioritizing county-wide does not occur in the basin plan, rating protocols allow projects to be ranked with projects in other basins county-wide

10.4 AFFECTED ENVIRONMENT, SIGNIFICANT IMPACTS, AND MITIGATION MEASURES

This section describes existing environmental conditions for the elements of the natural and built environment that could be affected by adopting the Mid-Puyallup Basin Plan or the "No-Action Alternative." For each affected environment subject area, the significant impacts that are expected to occur and the proposed mitigation measures are discussed.

10.4.1 Water Resources

Affected Environment

The Mid-Puyallup Basin is a subsection of the Puyallup River Watershed that contributes to the Puyallup River between river miles (RM) 4 and 26.5. The Basin covers 57.6 square miles just south of Lake Tapps in the central portion of Pierce County. From north to south, the Basin is roughly 13 miles long, with widths varying from up to 13 miles at the widest point to four miles at its narrowest.

The Basin topography is characterized by a wide, flat valley bottom bisected by the meandering Puyallup River and abrupt valley walls on either side. The valley walls climb an average of 500-feet before leveling to hilly terraces with closed depressions on either side. Hydrology of the Basin differs between the valley floor and the surrounding plateaus.

The primary surface water resources in the Mid-Puyallup Basin (excluding the Puyallup River itself) are the drainage tributaries that convey runoff to the Puyallup River. The six largest tributaries are Alderton Creek, Van Ogles Creek, Ball Creek, Fennel Creek, Canyon Falls Creek, and Horsehaven Creek. In addition to these tributaries, direct discharge areas send runoff to the Puyallup River without discharging to a stream. The Basin Plan focuses on the six tributaries described below.

Alderton Creek drains the north-central part of the Basin along the valley floor on the west side of the Puyallup River. The origin of Alderton Creek is on the valley floor near the intersection of 102nd Street East and State Route 162 (SR-162). From here, the stream flows north to join the Puyallup River just west of the corner of 80th Street East and SR-162 at about Puyallup RM 12.2 about 1.8 miles from its origin. This is the most severely degraded of the six primary tributaries. Most of the creek is conveyed in buried pipes with only a few sections flowing through open channels. The creek's primary function in its current state is to provide a drainage route for urban runoff.

Van Ogles Creek drains the north-central portion of the Basin along the valley floor on the east side of the Puyallup River. Van Ogles Creek originates on the valley floor south of 92nd Street East. It flows north along the base of the bluff west of Bonney Lake before looping west to Riverside Park where it passes under Riverside Drive. It turns north at this juncture, but swings west again within a moderately confined channel (steep bank on its east and north sides) to its confluence with the Puyallup River. Stream length is given as 2.15 miles in the Washington State Department of Fisheries Catalog of Washington Streams and Salmon Utilization (Williams et al. 1975), but is 1.9 miles based on combining the Washington State Department of Natural Resources (DNR) and Washington State Department of Fish and Wildlife (WDFW) hydrolayer segment lengths. Stream substrate is primarily fine sediment and organic matter.

Ball Creek drains a central area of the Basin that extends to the plateau above the west valley wall. Ball Creek is valley floor tributary originating south of Old Military Road at the base of the bluff that forms the Puyallup Valley west wall. This stream flows diagonally northeast across the valley floor, crosses SR-162 and 106th Street East, and continues to its confluence with the Puyallup River. Stream length given in the Catalog of Washington Streams and Salmon Utilization (Williams et al. 1975) is 1.35 miles, but combining the segment lengths listed in the Salmon and Steelhead Habitat Inventory Assessment Program (SSHIAP) gives a length of 1.7 miles. The source of Ball Creek appears to be a system of springs and seeps coming down off the west valley wall at a point approximately 0.75 mile south of the mapped channel origin, which gives an actual stream length closer to 2.4 or 2.5 miles. This is close to the location where the City of Tacoma aqueduct crosses the valley floor. From that point northward, the channel appears to be perennial and large enough to be fish-bearing.

Fennel Creek is the largest tributary in the Basin. This creek drains the northeast corner of the Basin with the majority of the subbasin on the east plateau. Fennel Creek originates in a wetland near the north side of SR-410, east of its intersection with 233rd Street East. The stream generally flows west toward the City of Bonney Lake then turns south and flows through an old Vashon-age melt water drainage channel that was filled by a lobe of the Osceola mud flow (Crandell 1963) to Victor Falls, RM 2. The course then shifts to the west through a steep canyon to the Puyallup River valley floor at McCutcheon Road, RM 0.4. There the stream flattens and turns north to flow across the valley floor to its confluence with the Puyallup River. Victor Falls is a natural fish barrier that restricts anadromous fish from the plateau. Stream length is given as 7.95 miles and drainage area as 6.58 square miles in the Catalog of Washington Streams and Salmon Utilization (Williams et al. 1975). Wintertime base flow near the mouth of Fennel Creek ranges from 15 to 20 cubic feet per second (cfs), whereas base flow in the upper reach near the Sumner-Buckley Highway is closer to 10 cfs.

Canyon Falls Creek drains a forested area of the east plateau just south of the Fennel Creek Basin. Canyon Falls Creek begins in wetlands in a geological depression approximately 0.5 mile south of Victor Falls on Fennel Creek. AES and Beak (1997) reported a series of wetlands extending downstream around a “fish hook bend” to the west as far as RM 1.8 where the first flowing surface water begins. From there, the stream flows just north of west to the Troutlodge Hatchery at about RM 1.0 where the hatchery water intake (water right for 15 cfs) dries the channel. Return water from the hatchery reenters the stream at RM 0.86. The stream then drops through a steep ravine (gradient 17 to 18 percent) to McCutcheon Road, RM 0.55, where the

gradient flattens and the stream turns north to join the Puyallup River. Stream length is listed as 1.71 miles and the drainage area as 3.0 square miles in the Catalog of Washington Streams and Salmon Utilization (Williams et al. 1975); however, the proposed Cascadia Employment Based Planned Community EIS (Huckell-Weinman 1998) recorded the total drainage area as 3.8 square miles.

Horsehaven Creek is the second largest creek in the Mid-Puyallup Basin and drains most of the southern lobe of the Basin near Orting. The headwaters of the creek are on the west plateau in a residential area. The majority of the channelized stream flows along the valley bottom through mostly agricultural land. The main stem of Horsehaven Creek begins at a small 1- to 1.4-acre pond southwest of the Orting Soldiers Home. It drains west and then north through a steep gully with an impassable cascade and emerges on the valley floor near the Soldiers Home where it is joined by two tributaries. At this point, the stream becomes a valley tributary, flowing northwest along the base of the bluff for approximately two miles to its confluence with the Lorenz Creek tributary. Lorenz Creek itself originates at an approximately 10-acre pond, then flows west down a steep ravine with an impassable cascade to the valley floor. There it turns north to join the main channel. The main channel then continues north-northwest to join the Puyallup River at Puyallup RM 20.2

The Horsehaven main stem stream length is given as 3.3 miles with the Lorenz Tributary stream length given as 1.4 miles in the Catalog of Washington Streams and Salmon Utilization (Williams et al. 1975). Winter base flows along the main stem are typically on the order of three cfs.

Most of the land adjacent to the main stem of the Puyallup River drains directly to the main stem of the river through either multiple small channels or subsurface flow. Anecdotal accounts from local citizens indicate that drainage tiles were installed in many of these areas around 1950 to improve drainage for farming.

As development has progressed, drainage from the contributing areas in each tributary basin has been modified into a network of pipes, ditches, culverts, and detention facilities. Generally, in the upland residential areas, drainage ditches direct surface water runoff along roadways to nearby streams. Newer developments pipe water from catch basins to detention facilities before discharging to roadside channels or pipelines and then to streams.

Flooding

Generally, most drainage concerns and issues within the Mid-Puyallup Basin are development-related and involve flooding issues. Problems described in the Basin Plan were identified based on drainage complaints, questionnaire surveys received from residents, and specific problems known to County staff. Development was the problem most frequently mentioned by citizens in the Mid-Puyallup Basin. Comment included concerns that development was happening too fast and without consideration for the future, thereby causing deforestation, erosion, and the loss of aquifer recharge areas due to the increase in impervious surface area.

Flooding occurs both from flooding along the Mid-Puyallup Basin tributaries and in residential areas within the upland contributing basins. Flooding also occurs along the main stem of the

Puyallup River that is not directly related to flows from the Mid-Puyallup Basin tributaries. Main stem flooding, however, is not being directly addressed in this Basin Plan. Problems identified as sources of frequent flooding typically are related to inadequately sized conveyance in upland areas, including culverts, ditches, and stormwater ponds. The lack of a formal storm drain system was called out in several surveys. Sediment deposited in some tributaries was also blamed for recent flooding in some places.

The most significant problems are found within the tributary basin areas of Ball Creek, Fennel Creek, and Horsehaven Creek. Ball Creek has several minor flooding problems in the neighborhoods comprising its headwaters and one culvert on the downstream reach that will likely need to be replaced. Fennel Creek has a variety of flooding problems throughout the Basin.

Water Quality

Good water quality is important to the beneficial uses of water in the Mid-Puyallup Basin. Impaired water quality can affect fish habitat quality, the health of other aquatic organisms, recreational activities such as fishing and swimming, drinking water quality from local wells and reservoirs, and irrigation of farmland.

A review of water quality studies in the Mid-Puyallup Basin revealed several minor exceedences of the State water quality standards. These studies include samples taken in Alderton Creek, Ball Creek, Fennel Creek, Canyon Falls Creek, and Horsehaven Creek. The only trend of impaired water quality is an apparent association of elevated summer water temperature in channels along the valley bottom where the vegetated riparian cover has been removed. The only other water quality impairment to note was elevated levels of copper found in the upper reaches of Fennel Creek during 1998 to 1999. The copper resulted from chemicals used to treat Debra Jane Lake. Samples taken more recently (2002) show much lower levels of copper at this location.

Based upon reviewing available data, the Mid-Puyallup Basin noted very few water quality problems. At the time of the basin study, no streams were listed on Ecology's 303(d) list for impaired waters of the state, although this may be due in part to limited monitoring data. The primary water quality issues of concern are sediment from erosion and elevated temperatures from lack of stream buffers.

The noted water quality problems are found in five of the six tributary systems of the Mid-Puyallup Basin. Alderton Creek contains large quantities of iron bacteria likely as a result of groundwater contributions. Ball Creek receives erosional sediment from Old Military Road where the road climbs the valley wall above the creek. The creek also passes through farmland and could be affected by local agricultural practices. Fennel Creek has had elevated levels of copper in its upper reaches in the past. Residents near the mouth of Fennel Creek report increased movement of sediment through the channel, though this perception may be an effect of the cessation of dredging within the creek. Canyon Falls Creek currently has no chronic water quality problems though there is public concern for this creek's future because of upstream development in the headwaters and the presence of a commercial fish hatchery. The major impacts to Horsehaven Creek are from the agricultural areas surrounding much of the creek where the riparian corridor has been lost.

Significant Impacts and Proposed Mitigation

Proposed Action

Adopting the Basin Plan would reduce flooding problems in the Mid-Puyallup Basin. The Basin Plan takes specific action in the form of CIP recommendations to replace culverts that currently are too small to pass 100-year flows, expand stormwater facilities that currently have insufficient capacity, and collect runoff and control roadside ponding. The Basin Plan also includes programmatic recommendations that would address flooding by investigating LID techniques, update the existing stormwater management standards, increase compliance with stormwater requirements, acquire frequently flooded properties, and initiate downstream flow control policies in response to upstream development. These recommended CIPs and programs consider future basin growth and are intended to be long-term solutions.

Some privately owned culverts were found to be undersized for the 100-year event during the development of this Basin Plan. In general, public funds cannot be spent to replace privately owned culverts for flooding purposes. The Basin Plan, however, includes general recommendations for replacing private culverts determined to be undersized.

Increasing culvert capacity for either flooding or fish passage allows greater flow to downstream reaches. This increased flow may affect culverts on private property that have not been replaced. The County should be willing to offer technical assistance to property owners that may wish to replace their culverts in the future.

Water quality concerns are addressed in the Basin Plan from a programmatic perspective. Water quality can be protected by using LID stormwater management, updating the current stormwater management standards to comply with NPDES requirements, restoring vegetated stream corridors, monitoring stream water quality, and perhaps most importantly, educating residents about how their actions impact local water quality and what they can do to help protect clean water.

Some temporary water quality impacts may occur during construction to replace culverts. These effects would be mostly from sediment released when soils are disturbed during removal of the existing culverts. Using standard best management practices (BMP) such as compost logs and settling ponds would greatly reduce these impacts. Minor temporary impacts to water quality can also be anticipated during stream restoration activities that involve stabilization of stream banks, wood placement, and any other in-stream work.

No Action

Without the Basin Plan, flooding is expected to become more frequent as growth continues in the Basin. Specific sites with frequent flooding would be addressed by Pierce County on a case-by-case basis. Citizen complaints would continue to be the driving factor for addressing sites rather than the County being proactive in addressing known problems.

Poor water quality resulting from land use influence would continue to be problematic in the Basin tributaries. Without programmatic help from the County to restore stream corridors, current water quality trends of high temperatures and fecal coliform levels are likely to become worse with violations of water quality standards becoming more frequent.

10.4.2 Fishery Resources

Affected Environment

Habitat

Key elements integral to healthy stream habitat include vegetated buffers, clean bed material, a high degree of channel complexity, and stable channel morphology. A vegetated buffer is an area of land adjacent to the creek that has mature trees and shrubs for a distance from the creek of at least one tree height (Kondolf et al. 1996). Vegetated buffers serve several purposes including providing shade to maintain cool water temperatures, reducing bank erosion, providing a source of large woody debris (LWD), and filtering stormwater runoff before it enters the stream. Clean bed gravel is characterized by an absence or low quantity of sand and silt, which can fill the interstitial spaces between larger grains reducing the movement of water through the bed. Clean bed gravel provides spawning habitat for salmonids. Clean gravel also provides habitat for benthic macroinvertebrates that in turn provide food for fish. Channel complexity indicates how much variety there is in a channel's habitat. A channel with high complexity would typically have many pools and riffles, lots of LWD, active gravel bars, side channel refuge areas, riparian wetlands, and meandering flow. These features provide the necessary elements to support life in streams.

Habitat loss typical of agricultural areas includes the removal of riparian vegetation from the stream banks, removal of habitat-forming large woody debris from within the channel, and intrusion of fine sediment into the channel bed from removing streamside vegetation. Urbanization alters stream flow and changes stream channels. With urbanization comes loss of forest cover, encroachment into riparian corridors, and more impervious surfaces. A generally accepted benchmark of urbanization levels used to determine impacts to streams is ten percent effective impervious area (EIA) within a basin. This measure refers to all the surfaces that do not let water seep through and where the runoff from these surfaces is directed into a receiving body such as a stream. Existing conditions in the tributary basins of Mid-Puyallup Basin meet or exceed ten percent EIA with future growth continuing to increase the percentage EIS.

Habitat in the Mid-Puyallup tributary creeks is currently in fair to poor condition. Alderton Creek is in the worst condition with a high level of alteration. It can no longer support fish. Van Ogles, Ball, and Horsehaven creeks flow through agricultural areas along the valley floor for at least part of their length. These streams have less channel alteration than Alderton Creek, but still rank only poor to fair in habitat quality. The remaining two streams, Fennel Creek and Canyon Falls Creek, have good habitat in their headwaters with little channel alteration. Habitat quality is reduced in the middle reaches of these creeks where channels have been altered. The Pierce County Conservation District (Conservation District) inventoried impassable culverts for several County watersheds. In the Mid-Puyallup Basin, out of 81 culverts surveyed, 33 were determined

to be barriers to the passage of migratory fish. Ball Creek had four blocking culverts, the greatest number affecting any of the major Mid-Puyallup Basin tributaries. The first blocking culvert along Ball Creek is about 0.4 mile from the mouth. Horsehaven Creek has two blocking culverts, one is almost one mile from the mouth of the creek and the other is another mile beyond the first. The Lorenz tributary of Horsehaven Creek is accessible to migrating fish. The first problem culvert occurs on the main stem upstream of the confluence with Lorenz Creek and restricts more than two miles of the main fork to fish. The three blocking culverts on Van Ogles Creek are roughly one mile from the mouth of the creek and restrict almost 1.5 miles of stream habitat.

Fish Presence

Alderton Creek is a non-fish bearing stream. Multiple sections of this creek flow underground through pipes with the cumulative piped sections extending over about half the stream's length. The open-channel sections consist of roadside ditches and farm runoff ditches. Anadromous fish are prevented from entering Alderton Creek by 300-feet of piped section at the mouth.

According to field surveys conducted by the Puyallup Tribes, Van Ogles Creek is used by coho salmon, chum salmon, and cutthroat trout. Although this stream is in a degraded condition, these species use the lower reaches for both rearing and spawning.

Ball Creek is used by both coho salmon and cutthroat trout for spawning and rearing. During field surveys, a school of approximately 20 coho salmon parr was observed on the downstream side of the 106th Street East culvert. A property owner near the upper end of the stream observed adult coho spawning in the creek in November 2000. A local WDFW biologist disclosed that adult coho ascended the creek at least as far as the culvert under Military Road. Stream-resident cutthroat trout also were observed during the survey.

On Fennel Creek, anadromous and migratory fish spawn up to Victor Falls at RM 2.0. This includes coho salmon, chinook salmon, winter steelhead, pink salmon (in odd years), and one of the strongest runs of chum salmon in the Puyallup Basin. In the past, resident cutthroat trout were reported in stream segments upstream of Victor Falls, but none were observed during the present fieldwork. Sculpins (qualitatively the most abundant of the fishes), three-spine stickleback, and western brook lamprey were observed during the survey.

Anadromous and migratory fish use Canyon Falls Creek up to McCutcheon Road. These fish include a substantial run of chum salmon and small runs of coho salmon, pink salmon (in odd years), and winter steelhead. A small number of chinook salmon also use the stream; six to ten fish per year have been observed by Puyallup Tribal Fisheries personnel in the last three to four years during spawner surveys. Larval Pacific lamprey and sculpins also have been reported. The principal spawning area for anadromous fish is in a 300-foot reach of stream immediately downstream of McCutcheon Road, although some fish have been seen upstream of the culvert. Other spawning occurs downstream to RM 0.3 where fine sediment completely covers the streambed material. Upstream of a commercial hatchery, there were reliable reports from nearby residents that non-migratory cutthroat trout and rainbow trout (the latter probably are escapees from the hatchery operation) are present in numbers and sizes that attract fishing by local residents.

Horsehaven Creek was stocked annually with hatchery reared coho salmon fry from 1981 through 1996 (C. Baranski, personal communication). The Puyallup Tribe once considered building its own fish hatchery on upper Horsehaven Creek, but decided against the plan because of the ephemeral nature of stream flow in the late summer (R. Ladley, personal communication). Coho and chum salmon use Horsehaven Creek along with resident, and possibly sea-run, cutthroat trout. During the field survey of the upper segments of the Horsehaven main stem, juvenile coho (estimated densities about 30 fish per 100 feet of stream) were observed rearing in pools, as well as resident cutthroat trout (estimated densities of one to five fish per 100-feet of stream).

Significant Impacts and Proposed Mitigation

Proposed Action

The Mid-Puyallup Basin Plan would greatly enhance fish habitat in the Basin. Numerous CIPs are recommended to remove fish barriers from the tributary streams, acquire properties for restoration and preservation, and restore channel habitat. Programmatic approaches would support these projects by raising public awareness about the importance of preserving fish habitat within floodplains and teaching residents how they can contribute to these efforts. Enhancing habitat in the lower reaches of the basin tributaries would also provide higher quality off-channel rearing habitat for fish in the Puyallup River.

Temporary impacts to habitat may occur during the removal of fish passage barriers. Sediment inputs to streams may increase during construction of fish passable culverts as well as during stream restoration activities. Using BMP's established for sediment control and habitat protection during in-stream work would greatly reduce this impact.

No Action

Without the measures recommended in the Basin Plan, improvements to stream habitat would be slow and sporadic. The poor habitat conditions in most of the Mid-Puyallup Basin tributaries may degrade further as growth in the Basin increases. Currently, poor habitat quality is mostly related to agricultural practices. As the population grows, urbanization would increase and introduce additional degradation from altered hydrology. Without a Basin Plan, these issues would be dealt with sporadically as they occur rather than proactively.

10.4.3 Vegetation

Affected Environment

The upland areas of the Mid-Puyallup Basin include coniferous and deciduous forest, pasture lands, and landscaped residential areas. Most of the Basin areas are either developed or used for agriculture. The remaining undisturbed native habitat consists of fragmented areas of forest. These habitat areas are mostly on steep slopes that are not easily developed. The largest areas of intact forest are in the southern end of the Basin to the south and west of the City of Orting.

The Mid-Puyallup Basin contains over 2,800 acres of wetlands along the valley bottom and on upland plateaus. Fennel Creek has the largest network of wetlands, including several large headwater wetlands on the upper plateau where the creek originates. The majority of the wetlands are found along streams, although many small wetlands are scattered throughout the Basin.

Significant Impacts and Proposed Mitigation

Proposed Action

The Mid-Puyallup Basin Plan would increase vegetation in the Basin in two main ways. First, the Plan recommends revegetating riparian areas to provide shade for streams. This vegetation would be a mix of conifers, deciduous trees, and shrubs. Full riparian zones could extend over 200 feet in width along five of the main basin tributaries. Second, the Basin Plan would acquire frequently flooded properties. The properties would be maintained as open space without buildings. Although there is no plan to actively plant these properties, they would likely fill in over time with both shrubs and trees.

In addition, the Basin Plan encourages the use of LID techniques for new development. One aspect of these techniques is to minimize developed area and maximize vegetation retention. LID also uses vegetated areas such as rain-gardens and filter strips to manage stormwater. Widespread use of LID would help reduce the loss of basin vegetation.

The majority of CIPs in the Basin Plan would have little impact on vegetation. Replacing culverts and improving roadside drainage would only disturb local vegetation within the project site. The CIPs that plan to restore riparian corridors would have the greatest impact on vegetation, but would serve to increase vegetation as discussed above.

As growth and development continue in the Mid-Puyallup Basin, vegetated open space would dwindle. The Basin Plan neither supports nor restricts basin growth and therefore would passively see an overall reduction in basin vegetation.

No Action

Vegetation in the Basin is anticipated to diminish with or without the implementation of the Plan. Without the Plan, however, the decline in vegetation is likely to be faster because there would be no mechanisms to restore or preserve vegetated areas along stream corridors. Vegetation would remain undisturbed in areas where development is restricted such as on steep slopes and in wetlands.

10.4.4 Wildlife

Affected Environment

Most of the native wildlife still exists in the Mid-Puyallup Basin, although reduced in abundance except for those species that cannot tolerate or benefit from close association with humans and habitat fragmentation. Typical mammals are bears. Not typical are blacktail deer, coyote, raccoon, red fox, longtail weasel, deer mouse, and shrews. Common birds include several species of flycatchers and wood warblers, black-capped and chestnut-backed chickadees, and red-breasted nuthatches. Song sparrows, fox sparrows, spotted towhees, American robins, and Swainson's thrushes are found in the shrub layer. House sparrows, house finches, European starlings, Brewer's blackbirds, and crows are found in open urban and suburban areas.

Significant Impacts and Proposed Mitigation

Proposed Action

Actions proposed in the Basin Plan are expected to have only minor impacts on local wildlife. Most proposed CIPs are small-scale projects to replace culverts or improve road drainage. Construction of this infrastructure would have limited short-term disturbances. The CIPs that restore riparian areas would have a beneficial impact on wildlife because they would provide wooded habitat for birds and small mammals. The Basin Plan would also enhance protection of wetlands and currently vegetated riparian corridors, which would also benefit wildlife.

No Action

Under the No-Action Alternative, protection of wildlife would continue under existing programs and regulations. Existing programs and regulations that affect Mid-Puyallup wildlife include ESA, GMA, SEPA, and the Pierce County Comprehensive Plan. Even with these regulations in place, wildlife habitat would be reduced as development increases.

On-going riparian restoration projects carried out by both Pierce County Water Programs and the Conservation District would be expected to provide modest improvements to riparian vegetation over time. Without stream enhancement, land acquisition, and other programmatic measures and the CIPs recommended in the Basin Plan, it is expected that overall vegetation conditions may degrade in the Basin, which could reduce wildlife populations and the variety of species living in the Basin over time. Species that tolerate living in proximity to humans would become dominant in the Basin faster.

10.4.5 Land Use

Affected Environment

The Mid-Puyallup Basin has historically been a rural agricultural area. In recent years, urban and suburban growth has expanded into the Basin. In general, agricultural areas exist primarily along the flat valley bottom with residential areas on the upland plateaus. Impervious areas in the Basin currently are more highly concentrated near city centers and on suburban upland plateaus. Most incorporated areas lie in the north portion of the Basin; the only exception is the City of Orting in the south. Some of the fastest growing residential areas are in the Fennel Creek tributary basin and in some sections of the direct drainage areas.

Land use patterns vary among the different tributary basins. Alderton Creek drains open fields and farmlands though the drainage area of this creek is gradually being converted to residential housing. Van Ogles Creek mostly drains agricultural land with some residential housing on the section of the tributary basin that is on the upland plateau. Ball Creek flows through land alternately used for agriculture and residential housing. Fennel Creek drains a mixed-use area of agriculture, rural, suburban, and urban housing, as well as some light industry. The headwaters of Canyon Falls Creek are undeveloped and forested down to a commercial hatchery where flows are routed through the hatchery. Land use downstream of McCutcheon Road appears to be agricultural and sparse residential. The headwaters of Horsehaven Creek are a rural residential area. The valley floor is primarily agricultural. The direct drainage areas vary greatly from agricultural south of Orting to high-density residential sections in the north.

Significant Impacts and Proposed Mitigation

Proposed Action

Implementation of the Basin Plan is not expected to adversely affect land use in the Basin. The Basin Plan recommendations are consistent with or do not interfere with the planning and stormwater management policies from the 1991 Plan and Pierce County Comprehensive Plan. The Basin Plan would also provide benefits such as creating a larger number of “green-belt” areas created as stream corridors become revegetated. Also, the hydrologic impact associated with urban land use would be reduced by the proactive measures of the Basin Plan. No adverse impacts or cumulative adverse impacts to land use are expected as a result of implementing the recommendations in this Basin Plan. The Mid-Puyallup Basin Plan is intended to address current problems as well as anticipate and prevent future drainage problems due to growth.

No Action

Continuing to base drainage improvement decisions on the 1991 Plan or responding to emergencies would not have significant adverse effects on planned land use in the Basin because of the extent of land designated rural. However, the No-Action Alternative would have significant adverse effects on the ability of Water Programs to meet the policies of the County Comprehensive plan and achieve the adopted level of service standard. The 1991 Plan was prepared before the County adopted the current GMA-based comprehensive plan, so any inconsistencies would continue.

10.4.6 Aesthetic, Historic, and Cultural Resources

Affected Environment

The Mid-Puyallup Basin contains several aesthetic and historic resources. The unique topography of the Basin provides scenic views from many parts of the Basin, both from the valley bottom looking up at the surrounding hills and from the top of the valley walls looking out over the river valley. Several small neighborhood parks are in the Basin, some of which are within city jurisdictions and others are County parks. Roughly a dozen places within the Basin are listed as historic sites. These include the McMillin Bridge that crosses the Puyallup River at SR-162, the Woolrey-Koehler hop kiln, several historic homes, churches, and a Native American burial ground.

Significant Impacts and Proposed Mitigation

Proposed Action

Some short-term aesthetic impacts would result from constructing the CIPs recommended in the Mid-Puyallup Basin Plan. However, following construction, these areas would be replanted to restore them to their preconstruction or pre-development condition. The CIPs that call for revegetating riparian corridors would enhance local aesthetics by reestablishing greenbelts along stream corridors, restoring corridors to a more natural condition.

None of the recommended Basin Plan components are expected to adversely affect known cultural or historical resources in the Basin. However, there is potential to encounter historic or cultural resources during construction of CIP's. If any such resources are discovered during construction activities, the County would immediately consult with Office of Archaeology and Historic Preservation (OAHP) in Olympia and other appropriate officials regarding to identify suitable mitigation prior to proceeding with work that could adversely affect the resources.

No Action

The aesthetics of the Mid-Puyallup Basin are changing as the designated urban areas progress from rural agriculture and forestry to residences. The progression is expected to continue regardless of whether the Basin Plan is implemented. However, under the "No-Action Alternative," the reduction of vegetation that enhances the area's aesthetic value would be more pronounced, incising of stream channels would worsen with continued increases in peak flows during storm events

Stormwater improvements would continue under the "No-Action Alternative" with drainage enhancement and culvert replacements constructed as needed. As with the implementation of the Basin Plan, any historic or cultural resources discovered during construction would initiate immediate consultation with OAHP in Olympia and other appropriate officials regarding proper actions.

10.4.7 Public Services and Utilities

Affected Environment

All typical public services are available in the Mid-Puyallup Basin, including fire protection, police protection, surface water management, and schools. Twelve fire districts provide emergency services throughout the Basin. The cities within the Basin each have a police department that services incorporated areas in the Basin. Unincorporated areas are served by the Pierce County Sheriff. Drainage Districts 25 and 26 are entirely within the Basin. The southern portion of Drainage District 21 is also within the Basin. The six school districts in the Basin are Fife, Bethel, White River, Sumner, Puyallup, and Orting. There are no hospitals in the Basin, the nearest is the Good Samaritan Hospital in the Clarks Creek Basin near the boundary with the Mid-Puyallup Basin.

Utilities

The Mid-Puyallup Basin has 34 water purveyors who provide water for drinking, irrigation and other water supply needs. Two solid waste providers, Waste Connection and Pierce County Refuse, also collect solid waste and recycling services in the Basin. The Hidden Valley Landfill in the south end of the Basin was closed in 1998 and no longer receives solid waste. Stormwater from the closed landfill is collected on-site, pretreated and discharged to the Pierce County Wastewater Utility. Pierce County provides sanitary sewer service to the South Hill part of the Basin. Orting, Bonney Lake, Sumner and Puyallup also provide wastewater collection and treatment services. Rural areas are served by on-site sewer systems. Electricity in the Basin is provided by Puget Sound Energy and Tacoma Pubic Utilities. Puget Sound Energy also supplies natural gas to the Basin. Telecommunications such as phone service, cable television, and cable Internet access are provided by Worldcom Network Services, Sprint Communications Co., and Comcast.

Significant Impacts and Proposed Mitigation

Proposed Action

Some of the CIP projects could have short-term impacts upon public safety. Culvert upgrade projects and several local drainage projects could require construction within road rights-of-way. Lanes may be closed and/or traffic detoured for brief periods of time during construction. However, this does not last for more than a few days at a time and notice to local residents is provided before construction starts. Actual adverse effects on transportation and the public safety agencies in the vicinity are addressed in the site specific environmental review that precedes construction permits and construction. Long-term public safety would be enhanced as a result of these projects. Road flooding and closures during the rainy season would be substantially reduced. The elimination of nuisance ponding conditions on roads would also benefit public safety and mobility for all utility providers in the Basin.

The proposed action would have no significant adverse impacts on public services or utilities.

No Action

Under the No-Action Alternative, road flooding would be improved only on an as-needed basis and in response to citizen reports. Road closures from flooding could continue to adversely affect access of emergency services to flooded areas. These are significant adverse impacts.

10.4.8 Soils

Affected Environment

Two soil types generally dominate the Mid-Puyallup Basin: Alderwood-Everett on the plateaus overlooking the Puyallup River Valley and Puyallup-Sultan on the valley floor along the river. Other soils found to a lesser extent include Kapowsin, Buckley, and Harstine. All soils are considered to be till-derived based upon published surficial geologic data.

The Alderwood-Everett association forms in both glacial till and glacial outwash. Alderwood soils are moderately well-drained, whereas Everett soils are somewhat excessively drained. A till layer under Alderwood soils increases the potential for septic failures during periods of heavy rainfall.

The Puyallup-Sultan association along the Puyallup River was formed in alluvium deposited by floodwaters. Puyallup soils are well-drained, whereas Sultan soils are moderately well-drained.

Significant Impacts and Proposed Mitigation

Proposed Action

Many of the CIPs proposed in the Mid-Puyallup Basin Plan would have short-term soil disturbances while under construction. Such CIPs are culvert replacements, detention pond enhancements, conveyance channel improvements, and any other projects that involve constructing a physical structure. Once complete, soils would be reestablished with plantings suited to the location, for example, riparian vegetation adjacent to streams. CIPs that include planting riparian buffers would have long-term benefits for the soils of the Mid-Puyallup Basin by helping to reduce erosion and stream bank damage. In addition, the proposed study to identify sediment sources in Mid-Puyallup Basin tributaries may be a first step in reducing soil loss within the Basin.

The use of LID techniques is encouraged in the Mid-Puyallup Basin Plan. Widespread use of such techniques is likely to have an impact on soil moisture in localized areas of the Basin, because many of these techniques encourage infiltration of stormwater. Increased volumes of water stored in subsurface soils (particularly in upland areas) would help maintain stream base flows as development densities increase.

No Action

Soil erosion in the agricultural areas in the Basin would continue under the No-Action Alternative, however at a fast rate than if the proposed Basin Plan is implemented. Agricultural areas are expected to decrease as residential areas grow. This will bring a shift in soil erosion from that produced by agricultural activities to forms of erosion associated with urban environments, such as much higher peak flow volumes with much greater erosive power.

RESPONSE TO COMMENTS

This section of the FSEIS documents the written comment submitted within the 30-day comment period, from June 17 through July 18, 2005. Copies of the letters are reproduced. Highlighting has been added to call attention to the questions or ideas being conveyed by the commentor. The questions and ideas are sequentially numbered. Correspondence is followed by a written response to each of the questions and comments.

Public Agencies

Comment Letter #1	Washington State Department of Ecology
Comment Letter #2	Washington State Department of Fish and Wildlife

MID-PUYALLUP BASIN PLAN
DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

Comment

Received 6-7-2005
by M. Huebner

A 30-day comment period for the Draft Supplemental Environmental Impact Statement (Draft SEIS) began on May 13, 2005 and will end on June 13, 2005. Comment received by the Environmental Official, Pierce County Planning and Land Services, 2401 South 35th Street, Tacoma, WA, 98409 by 4:30 p.m. on June 13, 2005 will become part of the environmental record. Responses to comment made during the Draft SEIS comment period will be contained in a Final SEIS. Comment is welcome on the Draft SEIS and the Draft Mid-Puyallup Basin Plan.

Name: Bob Duffy Date: June 7 05

Address: Ecology

(360) 407 6239

Comment: The Plan should discuss the relationship of the Plan to regional salmon recovery efforts and salmon recovery funding opportunities.

The link with existing nonpoint plans should be discussed.

Link with PRWC? Cities & Towns? Lots of opportunity!

Response to Comment Letter #1, Washington State Department of Ecology

a. The Draft Mid-Puyallup Basin Plan in Chapter 2 describes in general terms the effects of the Endangered Species Act and recent listings on storm drainage and surface water management in the drainage basin. Chapter 9, Section 9.2.2. mentions the State Salmon Recovery Funding Board (SRFB) grants and notes that the grants could be an additional source of funding for projects improving salmon habitat, especially proposed stream corridor restoration projects.

b. Section 2.10 explains the Nonpoint Rule and states an objective of consistency between the Mid-Puyallup Basin Plan and the Lower Puyallup Watershed Action Plans. Section 2.14 lists documents reviewed for relevant information integrated into the Draft Basin Plan. Included are the Lower Puyallup Watershed Plan, 1993 and the Lower Puyallup Watershed "Phase I" Report from 1992. Information from the Phase I Report was used in the characterization of basin soils and how the basin was formed over time in Chapter 4. The documents were also used to identify several of the problems covered in Chapter 5 and for which solutions are recommended in Chapter 9. Individual projects in Chapter 9 were rated using a form that gives weight to projects that improve water quality and aquatic habitat consistent with recommendations of the Lower Puyallup Watershed Action Plan.

c. Chapter 3 chronicles the involvement of many stakeholders in development of the Basin Plan. Cities and towns provided much information contained in Chapter 4 and staff helped to identify problems to be addressed in the Basin Plan. Although 72% of the Mid-Puyallup Basin is unincorporated, 10% of the basin lies in the City of Bonney Lake and 12% in the City of Puyallup. Collaboration in solving problems in shared basins will be important to preserve and in some cases to restore streams in the basin. The Puyallup River Watershed Council (PRWC) can be a catalyst for increased coordination between local governments and joint projects.

State of Washington
DEPARTMENT OF FISH AND WILDLIFE
Puyallup Field Office: Post Office Box 73249, Puyallup, Washington, 98373 - (253) 848-5113

RECEIVED
JUL 5 2005
WATER PROGRAMS

June 29, 2005

Pierce County Water Programs
ATTENTION: Dan Wrye
9850 64th Street West
University Place, WA 98467

SUBJECT: State Environmental Policy Act Document; Mid-Puyallup Basin Plan, Surface Water Management, Pierce County

Dear Mr. Wrye:

The Washington Department of Fish and Wildlife (WDFW) commends the County's efforts on the development of basin plans and appreciates this opportunity to provide comments on the above referenced document received on May 30, 2005. WDFW is anticipating active participation in the planning and permitting phase of this plan.

The mid-Puyallup Basin Plan is informative and generally accurate to the degree necessary to set priorities in future planning efforts for issues related to surface water management. However, there are some subtleties in the habitat characterization that may need another look.

The overall habitat information on all the mainstem tributary streams is reported as poor to fair. The exception would be Fennel and Canyon Falls which are characterized as fair to good. However, the remaining streams in the plan are certainly viable, highly productive systems as well and provide for continued restoration opportunities and viable fish production as well.

It should also be noted that 2 of the 6 tributaries named (10.0399, 10.0400), were not included in the field assessment section of the characterization study. These streams were historically productive streams that have since been manipulated to a point of grave degradation that should be remedied.

These streams were historically productive coho streams. One of the two, 10.0400, remains a very productive stream for coho and chum. While the other, 10.0399 was only productive prior to being disconnected from the river. These stream courses should be included in the plan to provide for additional fish habitat consideration and surface water management to move water to the river.

All of the streams included in the mid-Puyallup basin plan have historically been highly productive with some exception and continue to function well with the existing fisheries resources in the watershed. Therefore, these streams should be given the same level of protection

Mr. Wrye
June 29, 2005
Page 2

and consideration when planning for future capitol improvements in the watershed such as what is being considered and conceptualized in the mid-Puyallup basin plan.

Thank you for the opportunity to provide these comments. If you have any questions, please contact me at (253) 848-5113

Sincerely,

Travis Nelson
Area Habitat Biologist

TN:tn

cc: Russ Ladley, Puyallup Tribe

Response to Washington Department of Fish and Wildlife

a. The Pre-Field Assessment Report characterizes Stream 0399 on Page 5 and Stream 0400 on Pages 5 and 6. Stream 0399 "no longer exists as an open water channel". Stream 0400 is classified as Type 4 (non-fish bearing) according to the Washington Department of Natural Resources and Department of Fish and Wildlife geographic information system coverage. Given this information, a field assessment of habitat attributes was not undertaken.

b. Comment acknowledged. The Mid-Puyallup Basin Plan concentrates on streams where flooding, water quality, or habitat problems were identified. Lack of documented evidence about the streams and no reported flooding resulted in (setting the streams on the back burner) not evaluating these streams further and focusing on streams with clear preservation and restoration potential. Before strategies and projects could be developed, significant additional study must be completed on Streams 0399 and 0400 for storm drainage and surface water conveyance characteristics, water quality, and historical habitat.

11. REFERENCES

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