

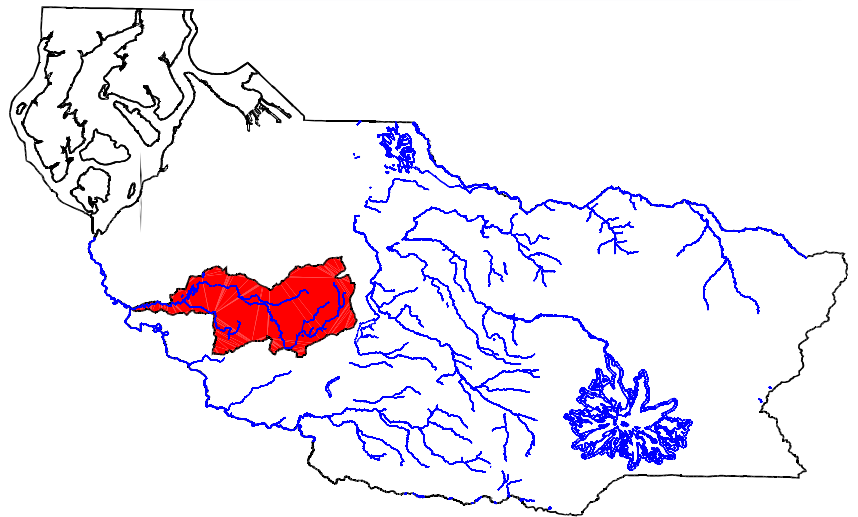
# Muck Creek Basin Plan

## Volume 1 - Basin Plan & SEIS

# MUCK CREEK BASIN PLAN

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As Adopted PCC 2003-62s  
September 2005



**Pierce County**  
Public Works & Utilities  
Water Programs Division

# Muck Creek Basin Plan

## Executive Summary

### ES.1 Introduction and Purpose

The 2003 Muck Creek Basin Plan (Basin Plan) is a comprehensive guide to surface water management in the Muck Creek Basin. The Plan focuses on multiple aspects of surface water management, including water quality, flooding, and habitat issues. This Plan was developed as part of Pierce County's Basin Planning Program to create a more 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) directed surface water management throughout the county for over a decade. As the Plan addressed all basins in the County, only one chapter in the Plan addressed issues in the Muck Creek Basin. The 1991 Plan has been used as a source of information on pertinent studies, plans, and regulatory mechanisms related to water resources in the Muck Creek Basin. Muck Creek Basin is one of 26 basins in Pierce County Figure S-1, "Watersheds of Pierce County."

The purpose of the Muck Creek Basin Plan is to ensure that limited financial and staff resources are applied to the best capital facility projects and programs. To that end, the Basin Plan strategically identifies and evaluates surface water management issues in the Basin and recommends a comprehensive set of projects and programs to reduce flood hazards and drainage problems and improve water quality and habitat throughout the Basin. Actions contained in the Basin Plan are costed-out over a ten-year period and will guide annually updated work plans for capital improvement projects and programmatic measures. ("Programmatic" refers to non-structural actions, such as changes to regulations, policies, programs, or operations.)

The Basin Plan supports (or furthers) Pierce County's:

- Compliance with its federal Clean Water Act National Pollutant 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 protected species;
- Upgrade to a Class 4 Community Rating under the Federal Emergency Management Agency's (FEMA) Community Rating System (CRS);
- Hazard Mitigation Planning, as required by FEMA (as a result of congressional action) to retain eligibility for federal disaster relief funds; and
- Submittal to the Washington Department of Fish and Wildlife (WDFW) for a programmatic approval agreement under RCW 77.55.100, which allows for programmatic approval in lieu of project-by-project permitting.

## ES.2 Goals of the Muck Creek Basin Plan

Specific goals of the Muck Creek Basin Plan are listed below. The full list of goals and objectives can be found in “Appendix O.”

- Goal 1) Reduce flood hazards
- Goal 2) Improve water quality
- Goal 3) Improve fish and wildlife habitat
- Goal 4) Coordinated and responsible use of public resources
- Goal 5) Influence location and methods for new development

## ES.3 Description of Basin

Located in southwest Pierce County, the Muck Creek Basin is the largest tributary in size in the Nisqually River Watershed. The Basin includes Muck Creek and three significant tributaries (Figure S-2): Lacamas Creek, the North Fork of Muck Creek and the South Fork of Muck Creek (also known as South Creek). The Muck Creek Basin is approximately 93 square miles in size with elevations ranging from 140 to 960 feet. The topography of the Basin is generally flat to moderately rolling hill terrain. The only substantial relief in the Basin is the hills along the upper portion of the North Fork of Muck Creek and the canyon formed by the lower stretch of the creek as it flows into the Nisqually River. The creek flows across broad natural prairies with native grasses oaks and through local second-growth coniferous and hardwood-forested riparian habitats. The climate of the Muck Creek Basin is mild. It receives around 40 inches of precipitation annually, almost all as rain.

The majority of the Muck Creek Basin is rural in nature. It is characterized by agricultural, forest, pasture and prairie areas with low-density residential development. The largest population center is the unincorporated Graham area in the northeast portion of the Basin. The only incorporated city in the Basin is the City of Roy. Much of the Basin is a patchwork of small (hobby) farms and ranches, interspersed with larger working cattle ranches and timber lots. Fort Lewis occupies a large percentage of the northwestern portion of the basin. Currently, about 24,000 people reside in the Muck Creek Basin. The population is expected to grow, modestly, to 28,000 by 2020.

Much of the stream channel of the South Fork and the main stem of Muck Creek goes dry during the summer and early fall months. This appears to be a natural condition and is primarily due to the highly infiltrative glacial deposits that cover the middle portion of the Basin. The few long-term groundwater records that exist for the Basin show no declining or increasing trend in groundwater levels. Future water use (Year 2030) in the Basin is projected to represent only about 7 percent of the estimated annual groundwater recharge in the Basin. Water use in the Basin is not anticipated to substantially affect either long-term surface flows or groundwater levels.

Muck Creek supports an important chum salmon run, primarily in the lower and middle reaches of the main stem, below State Route 7. Lesser numbers of steelhead and coho have used the stream, although it has been more than a decade since coho have been seen.

# Watersheds of Pierce County

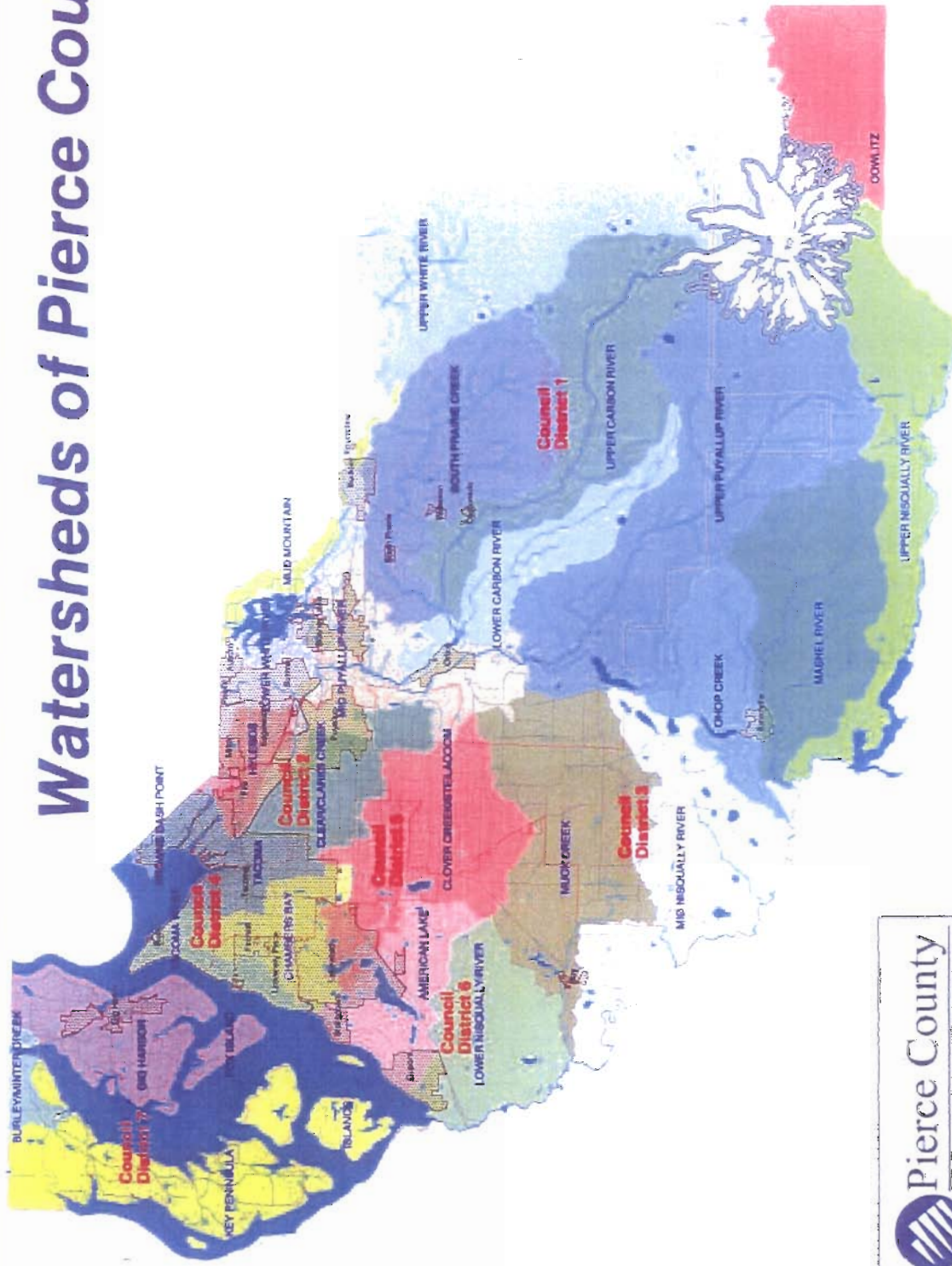
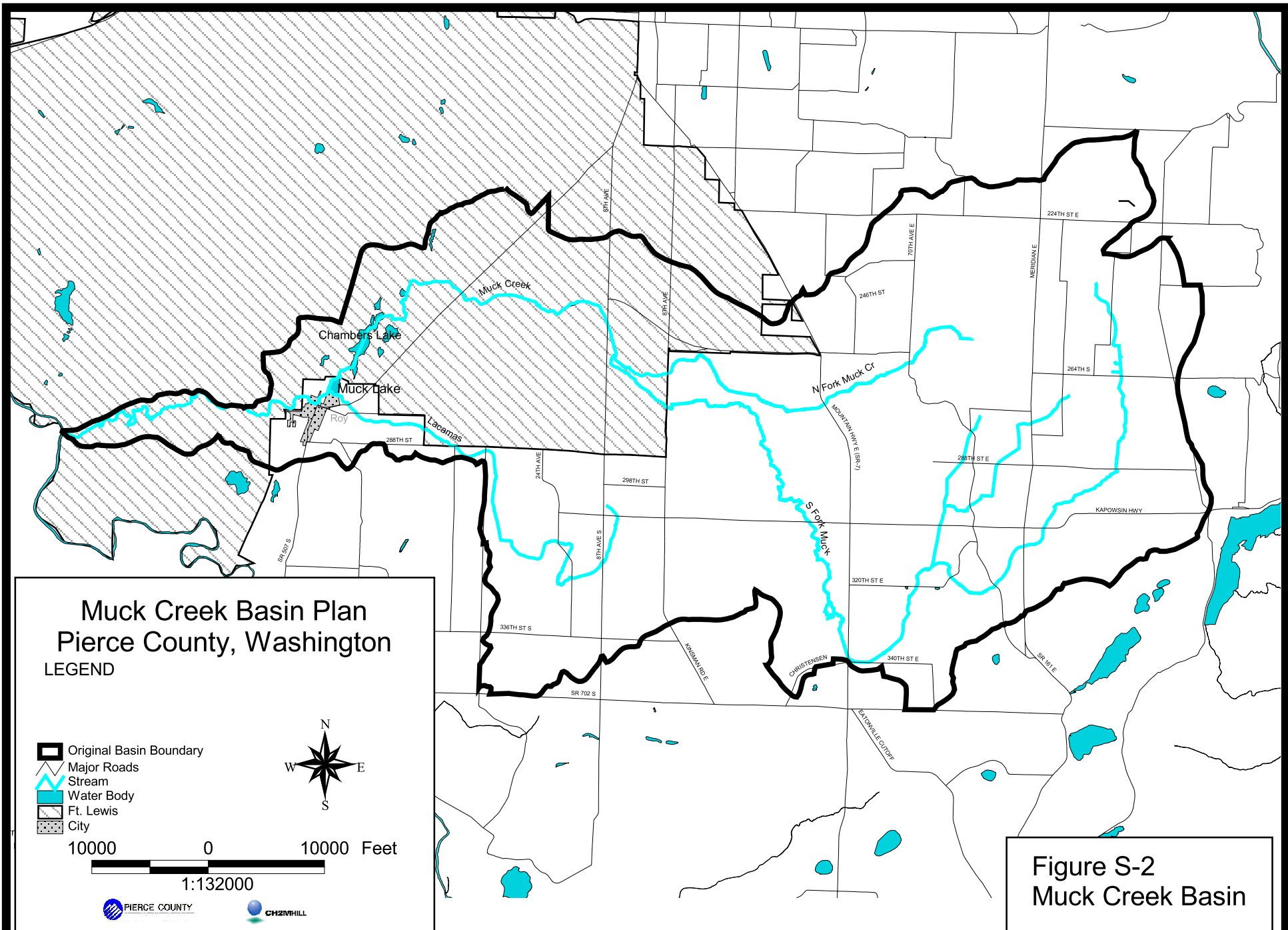








Figure S-1  
Watersheds of  
Pierce County



### Muck Creek Basin Plan Pierce County, Washington

LEGEND

-  Original Basin Boundary
-  Major Roads
-  Stream
-  Water Body
-  Ft. Lewis
-  City

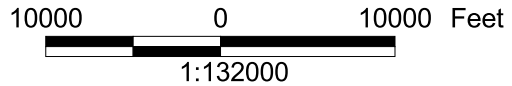


Figure S-2  
Muck Creek Basin

## ES.4 Stakeholder and Public Involvement

Two public meetings were held in February 2000, early in the study, to describe the basin planning process and to solicit information at the beginning of Phase 1. Two additional public meetings were held near the end of Phase 1, in August 2000, to describe the findings and discuss activities for developing the Basin Plan in Phase 2. In addition, presentations were made at several meetings of the Muck Creek Council and the Nisqually River Council and with the Nisqually Indian Tribe. A more detailed description of stakeholder involvement efforts may be found in Chapter 3.

The Draft Basin Plan and the accompanying Draft Supplemental Environmental Impact Statement were made available to the Pierce Conservation District, Muck Creek Council, Nisqually River Council, Nisqually Tribe, Fort Lewis, City of Roy, and other interested or affected parties as determined by Pierce County Water Programs staff for public comment. The Draft Supplemental Environmental Impact Statement was issued on February 12, 2003 and the comment period ended March 14, 2003. A notice announcing the availability of the Draft Basin Plan/DSEIS was distributed to attendees of previous meetings and other interested residents. Two public meetings were held during the DSEIS review period. One public meeting was held in Roy, Monday, March 3, 2003 at the Roy Library. A second public meeting was held at the Graham Library on March 5, 2003. The draft and final plans were also posted on the Pierce County Water Programs website.

Additional public involvement opportunities will occur annually through the Pierce County Planning Commission and County Council actions on the capital facilities plan.

## ES.5 Problems, Proposed Solutions and Prioritization Process

The results from this study indicate that there are no major flood problems in the Basin. However, road flooding does occur and is attributable to undersized culverts and to ponded runoff which collects in local depressions. Some residences are also impacted by ponded runoff which collects in local depressions after heavy rain events. Compared to many other basins in the Puget Sound area, the water quality of the streams in the Muck Creek Basin is relatively good. However, water temperature and bacteria (i.e., coliforms) levels commonly exceed state water quality standards. Past agricultural development in the Basin has channelized many of the stream reaches and removed riparian vegetation. Direct livestock access to streams has severely eroded the stream channels at a number of locations. As a result, less than 15 percent of the stream reaches in the Basin provide good fish habitat for anadromous fish.

Each of the Basin Plan's capital improvement projects and programmatic recommendations were 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.<sup>1</sup>

A scoring summary was prepared for each proposed project and a scoring worksheet for each proposed programmatic measure. These can be found in “Appendix M” of the Basin Plan. Recommended projects and programs were then 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<sup>2</sup>: 25% of total number of recommendations

After this 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.

## ES.6 Recommended Actions

Twenty-one capital improvement projects are recommended in the Basin Plan. These include two regional infiltration basins, a number of culvert upgrades and improvements to several local drainage systems are proposed. In addition potential areas for stream and riparian restoration projects are identified. In addition to improving potential fish habitat, the riparian restoration projects will help to address the water temperature and bacteria water quality problems. It should be noted that maintenance costs were not included in the cost estimates for the capital improvement projects. Pierce County has an existing maintenance program, but may need to evaluate the ongoing cost of supporting that program as projects are completed.

Programmatic recommendations in the Muck Creek Basin Plan are:

- Conduct a Low Impact Development Pilot
- Adopt updated stormwater management standards
- Increase compliance inspections
- Develop and implement a land acquisition program for riparian and wetland habitat protection and flood hazard reduction
- Develop and implement a program to enhance degraded riparian habitat and water quality

<sup>1</sup> Programmatic measures were eligible for additional points in the rating system to implement Pierce County's policy preference for favoring “non-structural measures” over “structural measures.” This policy preference was stated and adopted in the 1991 Plan and again in the County's Comprehensive Plan.

<sup>2</sup> Note: “low priority” does not mean “no benefit” for flood control, water quality protection, or natural resource protection. All of the recommendations in the Basin Plan provide a net benefit to these objectives. “No benefit” proposals were screened out prior to preparation of the Plan. “Low Priority” means that the proposed project or program scored lower than other projects and programs, based on the net environmental benefits that would occur from the project or program as determined by the score sheet criteria. Some projects that are ranked “medium priority” or “low priority” will be considered for implementation prior to other projects to ensure the full benefits of other projects, such as upstream fish habitat improvements are synchronized with downstream barrier removal.

- Develop and implement an education, outreach, and technical assistance program
- Develop and implement a surface water management monitoring program
- Develop and implement a BMP manual for Pierce County Surface Water Utility maintenance activities
- Develop and implement an invasive species management program

Prioritized measures recommended in the Plan over a ten-year period total \$10.5 million. This includes \$9.9 million for capital improvement projects and \$0.63 million for programmatic recommendations (*Table ES-1*). Of the total amount:

- \$3.5 million is for actions identified as “High Priority”;
- \$6.5 million is for actions identified as “Medium Priority”;
- \$0.54 million is for actions identified as “Low Priority”;

Four studies are also recommended in this Plan. Their combined cost is an additional \$0.43 million.

- Evaluate groundwater migration near the Northeast Muck Creek/Clover Creek Basin boundary
- Identification of flooded depression areas
- Detailed flood study along the South Fork upstream of Mountain Highway
- Identification of significant wetland sites

Once this Basin Plan is adopted, these measures will be added to the County-wide surface and stormwater CIP List, joining the CIP requirements of other basins within Pierce County. The common ranking and cost system used to develop these basin-level CIP lists will aid in the overall ranking of each CIP at the County level.

## ES.7 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<sup>3</sup>;
- 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; and
- 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 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; and 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:

- 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.

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<sup>3</sup> 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.

## **Principle Implementer, Financing Strategy and Timing**

Generally, the implementer responsible for the recommendations contained in this report is Pierce County, principally, Pierce County Water Programs either individually or in partnership with other entities. Funding of these recommendations is mainly through Pierce County's surface water management fees collected within the Basin, but may also include general fund, state and federal grants, and other local funds. Currently, this Plan projects full implementation out over a ten year period beginning in 2003. The actual duration of full implementation and the timing of specific projects and programs are determined through annual budget decisions of the County Council concerning the Capital Facilities Plan and operating budget.

**TABLE ES-1**

**Prioritized List of Proposed Projects – Muck Creek Basin 2003**

Priority	Project Name	CIP Number	Score	Est. Cost	Priority Ranking	Total Costs
1	Adopt updated stormwater mgt. standards	PG00-02	380	\$ 1,000	High	
2	Maintenance BMP Manual	PG00-08	427	\$ 7,000	High	
3	Invasive Species Management	PG00-09	420	\$ 7,000	High	
4	Implement riparian land acquisition pgm.	PG00-04	389	\$ 9,000	High	
5	Implement education/tech. assistance pgm.	PG00-06	397	\$ 111,000	High	
6	Increased inspections	PG00-03	398	\$ 204,000	High	
7	Lacamas Creek Habitat Restoration	CIP12LC-STR01	375	\$ 1,444,000	High	
8	North Fork Habitat Restoration	CIP12NF-STR01	380	\$ 1,748,000	High	
Subtotal						\$3,531,000
9	Implement riparian & WQ enhancement pgm.	PG00-05	325	\$ 34,000	Medium	
10	288th St E Culvert Replacement II	CIP12SF-CUL03	165	\$ 41,000	Medium	
11	Meridian E Culvert Replacement	CIP12SF-CUL05	195	\$ 46,000	Medium	
12	Conduct a low impact development pilot	PG12-01	346	\$ 100,000	Medium	
13	Schudy Rd S Culvert Replacement	CIP12LC-CUL01	175	\$ 100,000	Medium	
14	288th St E Culvert Replacement I	CIP12SF-CUL01	180	\$ 128,000	Medium	
15	288th St E Culvert Replacement III	CIP12SF-CUL04	170	\$ 133,000	Medium	
16	Implement surface water monitoring pgm.	PG00-07	244	\$ 158,000	Medium	
17	252nd St E Conveyance Improvements	CIP12NF-CUL03	155	\$ 179,000	Medium	
18	288th St S Infiltration Pond	CIP12MS-INF01	115	\$ 297,000	Medium	
19	336th St S Grade Change	CIP12LC-RD01	150	\$ 303,000	Medium	
20	Highway 507 Culvert Replacement	CIPLC-CUL02	215	\$ 345,000	Medium	
21	South Fork Habitat Restoration	CIP12SF-STR01	365	\$ 608,000	Medium	
22	Patterson Springs Acquisitions	CIP12NF-ACQ01	265	\$ 1,500,000	Medium	
23	Graham Regional Stormwater Facility	CIP12NF-XXX	200	\$ 2,500,000	Medium	
Subtotal						\$6,472,000
24	238th St E Conveyance Improvements	CIP12NF-RD01	45	\$ 2,000	Low	
25	216th St Conveyance Improvements	CIP12NF-CUL01	45	\$ 4,000	Low	
26	Kapowsin Highway Conveyance Improvements	CIP12SF-CUL02	85	\$ 10,000	Low	
27	47th Ave E Conveyance Improvements	CIP12SF-PIP01	60	\$ 34,000	Low	
28	70th Ave E Culvert Improvements	CIP12NF-CUL02	100	\$ 39,000	Low	
29	242nd St E Infiltration Pond	CIP12NF-INF01	85	\$ 136,000	Low	
30	Mountain Highway Conveyance Improvements	CIP12SF-DIV01	95	\$ 319,000	Low	
Subtotal						\$544,000
31	Graham Groundwater Flow	ST12-01		\$ 205,000	Not Prioritized	
32	Identification of Potholes	ST12-02		\$ 90,000	Not Prioritized	
33	South Fork Flood Study	ST12-03		\$ 60,000	Not Prioritized	
34	Wetland Site Identification	ST12-04		\$ 70,000	Not Prioritized	
Subtotal						\$425,000

**Total Estimated Cost of Plan Implementation**

(Cost changes reflect rounding) **\$10,972,000**

# PART 3: Muck Creek Basin Plan

## CHAPTER NINE

### Basin Plan

This Chapter contains the Muck Creek Basin Plan, which is based upon the Basin characteristics described in Part 1 and the problem analysis of Part 2. This Chapter provides:

- A Summary of the Plan;
- Plan Approach to Basin Needs; and
- Specific Recommendations

This Chapter establishes the direction the Water Programs Division will take within this Basin to achieve its goals of flood reduction, habitat improvement, water quality improvement, ensuring responsible use of public resources, and provision of guidance for new development.

## 9.1 Plan Summary

The 2003 Muck Creek Basin Plan is a comprehensive guide to surface water management in the Muck Creek Basin. It focuses on multiple aspects of surface water management, including water quality, flooding, and habitat issues. In summary, the goals of the Muck Creek Basin Plan are:

- Goal 1) Reduce flood hazards
- Goal 2) Improve water quality
- Goal 3) Improve fish and wildlife habitat
- Goal 4) Coordinated and responsible use of public resources
- Goal 5) Influence location and methods for new development

The Plan contains numerous capital facility projects and programmatic actions to address flooding, water quality and stream habitat problems. Several of the measures address multiple issues. For example, culvert replacements can both reduce flood hazards and improve fish passage. The establishment of a riparian buffer may displace animal grazing immediately adjacent to a stream, decreasing nutrients and reducing flood hazards. Implementation of a restoration project also provides an opportunity for public education and outreach.

### 9.1.1 Capital Improvement Projects

There are a total of 21 CIP's proposed in this Plan. Their locations are shown in Figure 9-2. Their distribution by problem type is shown below.<sup>1</sup>

- Road Flooding - 11
- Other Drainage Problems - 8
- Water Quality - 10
- Stream and Riparian Habitat - 9

CIP's involving riparian or wetland revegetation or restoration will require substantial maintenance during the first two to five years after planting. Irrigation may be required for the first year or two to establish some of the tree and brush species. In addition, annual weed removal or suppression will also need to occur at least annually until the plants are well established. This is particularly critical in areas where reed canary grass is being replaced. These additional expenditures are not included in the cost estimates.

### 9.1.2 Programmatic Measures

In addition to the capital construction projects, the Basin Plan recommends nine programmatic measures. They include a combination of programs that would be specific to the Muck Creek Basin and programs that would be undertaken Countywide:

- Conduct a Low Impact Development Pilot
- Adopt Updated Stormwater Management Standards
- Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit
- Develop and Implement a Land Acquisition Program for Riparian and Wetland Habitat and Flood Hazard Reduction
- Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality and Provide Flood Hazard Attenuation
- Develop and Implement an Education, Outreach, and Technical Assistance Program
- Develop and Implement a Surface Water Management Monitoring Program
- Develop and Implement a BMP Manual for Pierce County Surface Water Maintenance Activities
- Develop and Implement an Invasive Species Management Program

The CIP and programmatic measures have been individually ranked according to a common ranking system used by all the basin plans for Pierce County. Each of the potential capital improvement projects and programmatic recommendations were 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

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<sup>1</sup> The number of problems addressed exceeds the number of actual projects because of a single CIP may address multiple problems.

(5%). Each project and program was reviewed and scored using approximately 40 specific criteria. This ranking system is described in “Appendix M.” This appendix also contains a spreadsheet summarizing the scores assigned to each CIP. An individual score sheet is included for each programmatic measure.

Recommended projects and programs were then 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<sup>2</sup>: 25% of total number of recommendations

After this 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 prioritized list of measures is shown in Table 9-1. Prioritized measures recommended in the Plan over a ten year period total \$10.5 million. This includes \$9.12 million for capital improvement projects and \$0.63 million for programmatic recommendations. Of that amount:

- \$3.5 million is for projects identified as “High Priority”
- \$6.5 million is for projects identified as “Medium Priority”
- \$0.5 million is for projects identified as “Low Priority”

### 9.1.3 Information Gaps

In addition to the projects and programmatic recommendations, four basin specific studies are proposed as part of the Basin Plan (numbers 31-34, Table 9-1):

- Evaluate Groundwater Flow between Muck Creek and Clover Creek Basins in the Graham Area
- Identification of Flooded Depression Areas (Potholes)
- Detailed Flood Study along the South Fork of Muck Creek upstream of Mountain Highway

Their combined cost is \$0.28 million. These studies will provide needed information to address Basin issues. The studies were not included in the prioritization process.

The total estimated cost to implement the Basin Plan is \$10.03 million.

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<sup>2</sup> Note: “low priority” does not mean “no benefit” for flood control, water quality protection, or natural resource protection. All of the recommendations in the Basin Plan provide a net benefit to these objectives. “No benefit” proposals were screened out prior to preparation of the Plan. “Low Priority” means that the proposed project or program scored lower than other projects and programs, based on the net environmental benefits that would occur from the project or program as determined by the score sheet criteria. Some projects that are ranked “medium priority” or “low priority” will be considered for implementation prior to other projects to ensure the full benefits of other projects, such as upstream fish habitat improvements are synchronized with downstream barrier removal.

**Table 9-1  
Prioritized List of Proposed Projects – Muck Creek Basin 2003**

	<b>Project Name</b>	<b>CIP Number</b>	<b>Score</b>	<b>Est. Cost</b>	<b>Priority Ranking</b>	<b>Total Costs</b>
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**Total Estimated Cost of Plan Implementation**

**\$10,972,000**

### 9.1.4 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<sup>3</sup>;
- 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; and
- 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 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; and help achieve environmental compliance and long term sustainability. Collectively, these attributes help make Pierce County a liveable 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:

- 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

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<sup>3</sup> 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.



and coordination with other potential implementers and in consideration with available financial and staff resources. The implementation strategy will include performance measurements and provide for periodic evaluation of progress.

### **9.1.5 Pierce County's Basin Plan Objectives**

When the Pierce County Basin Planning Process was established in 2000, several objectives were identified for each basin. The 1991 Storm Drainage and Surface Water Management Plan and this Basin Plan were compared to those objectives.

Table 9-4 summarizes the degree to which the Muck Creek Basin Plan and the 1991 Plan meet the Basin Plan objectives (see "Appendix O").

**TABLE 9-4  
Comparison between Muck Creek Basin Plan and the  
1991 Storm Drainage and Surface Water Plan: Effectiveness in Meeting Objectives**

	<b>Objectives</b> (see Section 1.3)	<b>Muck Creek Basin Plan</b>	<b>1991 Plan</b>
<b>Goal 1 Flooding</b>	Incidents of property loss and repeat damage are reduced.	A	a
	Streams will not be adversely impacted by flood events.	B	c
	Pierce County's standing under FEMA Community Rating System is improved.	A	b
	New development is located outside of flood prone areas.	B	b
<b>Goal 2 Habitat</b>	Number of stream miles available for wild, native fish populations is increased.	A	c
	Population numbers of species listed as endangered or threatened under the Federal Endangered Species Act are maintained or increased.	A	c
	Quality and quantity of available wetland, riparian and upland habitat is improved.	A	c
<b>Goal 3 Water Quality</b>	State Surface Water Quality Standards (WAC 173-201a) are met or exceeded.	A	
	Number of impaired (303d listed) water bodies is reduced.	n/a	n/a
	Pierce County is in compliance with its NPDES permit for stormwater by meeting permit terms and conditions to the maximum extent practicable.	A	c
	Risk of groundwater contamination is reduced.	B	c
	Rates of erosion are reduced.	A	b
<b>Goal 4 Public Resources</b>	Cost of maintaining stormwater facilities are reduced.	B	
	Project value is favorable when measured against costs and benefits.	A	b
	Polls demonstrate that public awareness of flooding, habitat and water quality issues has increased.	B	
	Monitoring and enforcement programs demonstrate an increase in services per dollar spent.	B	c
	Basin Plan implementation also implements elements of other Pierce County plans.	A	
<b>Goal 5 Development</b>	New development in flood prone, riparian or significant habitat areas is prohibited.	B	
	Low Impact Development techniques identified and widely used.	A	c
	Effective BMPs identified and widely used.	A	

- a) Specifically addressed; CIP's and/or measures proposed to achieve the objective.
- b) Generally addressed; few or no Basin-specific measures.
- c) Not addressed.
- n/a) Not applicable.

## 9.2 Plan Approach to Basin Needs

The following describes Plan approaches to the problems identified in Chapters 6-8. These include:

- Stormwater Impact Mitigation through Low Impact Development
- Fish Habitat Protection
- Compliance Assurance
- Land Use Management
- Critical Areas Conservation
- Public Education and Involvement
- Flood Hazard Management
- Water Quality Management
- Reed Canary Grass Management
- Riparian Corridor Management
- Instream Habitat Improvement
- Livestock/Riparian Interactions
- Filling Information Gap
- Stakeholder Involvement

### 9.2.1 Stormwater Impact Mitigation through Low Impact Development

Low Impact Development combines site planning with individual BMP's to preserve natural drainage features and to encourage retention and infiltration of stormwater on the site. Low Impact Development (LID) practices can be effective in substantially reducing the rate and the volume of stormwater runoff from medium and high-density areas. LID emphasizes protection and use of on-site natural features integrated with small-scale (less expensive) stormwater controls to manage stormwater and maintain or restore pre-development watershed hydrologic functions. LID strategies focus on evaporating, transpiring and infiltrating stormwater on site through native soils, vegetation and bioengineering applications, rather than conveying stormwater through the use of large stormwater facilities, pipes, and other costly, traditional drainage systems. LID can reduce development infrastructure and, therefore, development costs in many settings. In addition to reduced infrastructure costs, LID practices have other attractive economic benefits that can increase a development project's marketability. LID stormwater facilities can be easier and less costly to maintain over time, and facility retrofits can be cost-effective. Developers using LID concepts can reduce the size of their stormwater ponds, resulting in more developable land.

The basic strategies to plan and implement Low Impact Development include (Hinman, 2001):

- Assess the site's current and native vegetation cover, wetland areas, soils, streams, ponds, and other critical areas. Establish buffers and delineate protected areas.
- Maximize retention of native vegetation to intercept, evaporate and transpire precipitation.
- Preserve permeable, native soils and restore disturbed soils with compost and other amendments to infiltrate and store stormwater.
- Retain and incorporate topographic site features that promote infiltration and storage of stormwater.

- Direct the location of buildings and roads away from critical areas and soils that can effectively infiltrate stormwater.
- Minimize building footprints, and road widths and lengths to reduce impervious surfaces. Eliminate effective impervious surfaces that flow directly to offsite stormwater pipes.
- Utilize pervious surfaces (e.g. pervious pavement and gravel systems) where possible to promote stormwater infiltration.
- Utilize small, de-centralized bio-retention areas with appropriate vegetation to infiltrate, store and transpire precipitation.
- Reduce the reliance on traditional conveyance and pond technologies to manage stormwater quality and quantity.
- Manage stormwater as close to its origin as possible.

Below is a sample of some potential LID site design applications and BMPs (Wulkan, 2001):

- Developers using LID set aside all sensitive areas and natural drainage, such as streams and wetlands. Portions of a site's trees and other native vegetation is also set aside.
- Specially designed bio-retention areas (or landscaped rain gardens) can capture, filter and infiltrate stormwater.
- Impervious areas can be reduced by designing narrower roads and using permeable pavement for parking lots and driveways. Pervious pavement can help to infiltrate and treat surface water runoff at the site.
- Runoff from remaining impervious surfaces, such as rooftops, can be directed onto vegetated areas with porous soils.
- Rooftop designs can include roof gardens, which further retain and slowly release stormwater.
- Soils compacted during construction are amended with compost or other organic material to restore their capacity to infiltrate runoff and grow healthy plants.

The County has revised its stormwater manual and development regulations to include LID practices. The new Washington Department of Ecology *Stormwater Management Manual for Western Washington* (Washington Department of Ecology 2002) also emphasizes the use of LID strategies wherever practicable.

In addition to more effectively managing stormwater, Low Impact Development strategies can have other environmental and community livability benefits as well. Infiltrating stormwater on site helps to recharge local groundwater supplies. Much of the northeast portion of the Basin, where housing development is occurring, has soils suitable for stormwater infiltration. LID road designs result in narrow streets that 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 recreational use.

LID practices should be implemented in those parts of the Basin that are zoned for higher density future land uses, such as the Rural Activity Center in the vicinity of Meridian and 224th Street East and in the general vicinity of Graham. LID Best Management Practices (BMPs) in these high-density areas could mitigate for increased stormwater runoff that will be generated by future development, prevent localized flooding, reduce stormwater runoff volumes, and reduce water quality impacts. LID practices should be implemented as included in the County's stormwater manual and development regulations, and the new Washington Department of Ecology *Stormwater Management Manual for Western Washington*.

Another benefit of LID is that it can result in more attractive, greener development, which can increase property values. Finally, LID can provide tools for cost-effective retrofitting of stormwater infrastructure, which has proven to be an expensive concern to many communities in the past.

**Conclusion:** The County should develop and implement a pilot program to determine the effectiveness of Low Impact Development techniques within the Muck Creek Basin.

## 9.2.2 Fish Habitat Protection

Riparian buffers afford habitat and protect water quality. While a wider riparian buffer performs better, even a minimal undisturbed buffer strip provides much more protection than none at all. There are several programs to fund riparian zone protection. Funds are available through the Conservation Reserve Enhancement Program (CREP) of the Natural Resource Conservation Service (NRCS). Under this program, the landowner can be compensated for 150 percent of the income-generating potential of the riparian area set aside and paid out annually. This can be applied to livestock or crop production.

The Salmon Recovery Funding Board (SRFB) administers grants to provide funding of habitat protection and restoration projects and 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. In April, 2002, \$36.7 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 \$57.6 million was allocated for 128 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 2496). A panel of scientists review and rate the projects for benefit to salmon and certainty of project success. The Nisqually Indian Tribe is currently the Lead Entity for the SRFB process in the Nisqually River Basin. The SRFB seeks to fund projects that are both scientifically sound and locally supported. This can be a major source of funding for the stream habitat restoration projects carried out in the Basin.

**Conclusion:** The County should develop and implement a program(s) that will facilitate the protection of habitat areas.

## 9.2.3 Compliance Assurance

The protection of stream channels from encroachment can also be addressed by compliance with environmental regulations. The County has Development Regulations intended to protect critical habitat areas (Title 18E, Pierce County Code). As an NPDES municipal stormwater permit holder, the County is required to have a program of legal authority, inspections and

others for water quality protection. Local critical areas rules, NPDES requirements, and other federal and state rules define certain uses and activities that are prohibited within surface waters, stream, and or their buffers. Use and activity regulations prohibit new development and existing landowners from undertaking new activities that could degrade water quality, increase erosion, cause riparian damage, or lead to flooding. Some examples of prohibited activities include: destroying or altering vegetation through clearing, harvesting, cutting, intentional burning, shading, or planting; application of pesticides, fertilizers, and/or other chemicals; constructing, reconstructing, demolishing, or altering the size of any structure; or activities which alter water temperature.

Where livestock or cropping land uses currently occur adjacent to streams, landowners should be encouraged to establish riparian buffers and agricultural BMP's through ongoing County programs, particularly the Conservation District.

Enforcement of development and environmental regulations would greatly reduce extensive stream bank and riparian damage throughout the Basin.

In those limited areas of the Creek (reaches of South Fork) that are subject to the Shoreline Management Use Regulations, new activities within 200 feet of the ordinary high water mark of the creek are subject to review and shoreline permits may be required. The permit review process affords an opportunity for working with the landowner toward mutual benefit.

Most of the development in the Basin preceded current Comprehensive Plan designations and Development Regulation provisions. However, new development must meet the current County stormwater management requirements, required as part of the County's NPDES permit, which require adequate water quality treatment and runoff control and include inspection and maintenance requirements. In addition, there are requirements for strict control of erosion and sedimentation control during construction activities.

An effective compliance assurance program includes tools such as outreach, education, technical assistance, inspections, and formal and informal enforcement. Current (February 2003) state, federal and local regulations exist that provide for water quality, habitat, critical areas and land use protection. A credible, effective program of consistent, fair and equitable compliance assurance actions would improve natural resource and surface water management within the Basin.

**Conclusion:** It is recommended that the County develop and implement programs that will ensure compliance with existing regulations, including public outreach and education.

## 9.2.4 Land Use Management

To ensure protection of Muck Creek and the natural resources within the Basin, development levels should be kept to those currently supported through existing plans and regulations. The existing rural land use designations that have been developed to implement Growth Management in Pierce County recognize that this area is outside the area where urban level densities can be readily sustained. The majority of the Basin is zoned for agricultural or rural residential development at densities of one dwelling unit per 5 or 10 acres, depending on the specific zoning designation. (These are the “base” densities, per Section 18A.35, Pierce County Development Regulations. Increases to up to two units per 5 acres or two and one-half units per 10 acres can be permitted, subject to some restrictions on land usage). Future land uses at these densities will result in relatively low levels of impervious surface development, generally less than 8 percent. Basins with impervious areas of this magnitude generally do not experience serious stream erosion or other negative hydrologic impacts. It is not expected that future development in the Basin will contribute significant amounts of new runoff to the creek, therefore, these densities are appropriate for the long-term development of the Muck Creek Basin. Combining the appropriate development density with the compliance assurance program should result in enhanced protection of Muck Creek resources.

Future densities in the Graham area of the Basin are zoned for Rural Activity Center (commercial) along Meridian and up to two homes per five acres for most of the remaining area. Surface runoff in this area does not reach Muck Creek, but increased stormwater resulting from these densities can pose local drainage problems. Low Impact Development techniques and BMP's, as discussed above, should be implemented in this area to encourage on-site infiltration and prevent localized flooding.

The amount of additional water use needed to support future growth in the Basin is a relatively minor fraction of the potentially available within the Basin. Potential impacts related to increased water use are not likely to adversely affect water resources within the Basin (Section 7.1).

Approximately one-quarter of the Muck Creek Basin lies within Fort Lewis and includes nearly all of the lower portions of the stream system. Activities within Fort Lewis over the years have been a source of concern for area residents who are concerned about the Creek. Future development and training activities at the Fort have the potential for substantial impact upon the stream. Stream crossings by tanks have been blamed for loss of disruption of stream flows and other impacts. The Army has committed to continue using the existing hardened fords for stream crossings to impacts. At this time, no development is scheduled for the eastern portion of the base, within the Muck Creek Basin. As a result, future operations on the Fort Lewis portion of the Basin are expected to have somewhat lower impact in the Basin than current operations (CH2M Hill, 2001).

Development at the rural densities designated by the existing Comprehensive Plan is appropriate for minimizing storm drainage issues and impacts to the streams in the Basin.

**Conclusion:** The County should develop and implement programs that involve cooperative efforts between agencies, and that ensure compliance with applicable land use, environmental and development regulations.

## 9.2.5 Critical Areas Conservation

Potential critical area acquisition must take into account that major portions of Muck Creek typically go dry nearly every year, thereby isolating upstream areas. These include sections upstream and downstream of Roy and several miles on both sides of Highway 507 on Fort Lewis.

On Fort Lewis, Exeter Springs and Johnson Marsh are very important in that they provide stream flow essential for sustaining the chum salmon runs in Muck Creek. Lying within the Fort, these are protected from potential development.

A large percentage of the watershed upstream of Fort Lewis was examined during stream surveys. Very little high quality stream habitat was encountered which would merit possible acquisition and permanent protection. The best habitat found was on the South Fork, two miles upstream of 8<sup>th</sup> Avenue East. This portion of the South Fork lies upstream of the dry stretch of stream located on Fort Lewis. Even though this reach is perennial, the seasonal isolation from perennial waters downstream greatly limits its potential habitat value for anadromous fish.

Patterson Springs is a critical area that is the major source of flow to the upper North Fork and is essential for assuring the perennial flow of this important part of the Muck Creek stream system. Associated with this spring is the large wetland which forms the upper end of the North Fork. This wetland lies north of 252<sup>nd</sup> Street E, parallel to and about one-quarter mile east of 70<sup>th</sup> Avenue East. The Cascade Land Conservancy has acquired nearly 100 acres lying south of 252<sup>nd</sup> Street SE to establish the Morse Wildlife Preserve. The wetland area north of 252<sup>nd</sup> Street SE should also be protected. Although portions of this wetland were once farmed and are in a degraded condition, it does serve an important function in helping to maintain perennial flow to the North Fork. It is recommended that this area be left in an undeveloped state and considered for permanent protection.

There are non-profit organizations that operate within Muck Creek Basin for the conservation of critical lands that have goals compatible with those of the County. For example, the Cascade Land Conservancy recently acquired a 45-acre property adjacent to the 53-acre Morse Wildlife Preserve in Graham. This property includes a portion of Muck Creek and a high-quality forested wetland. The Pierce County Conservation Futures Program provides funding to purchase environmentally important open space areas such as the upper portion of the North Fork.

**Conclusion:** The County should develop and implement programs to acquire and enhance habitat areas.

## 9.2.6 Public Education and Involvement

Individual components and recommendations of this Basin Plan should be incorporated into a comprehensive public education program to inform Basin residents about conditions of the creek and its watershed, any potential capital improvement projects to be completed in the Basin, and individual actions that can contribute to restoration and protection of Muck Creek's natural resources.

An ongoing watershed education program of the County would help to educate watershed citizens about the consequences of their actions and to encourage them to change their habits to protect the creek and its watershed. Educational activities can be developed for schools in the Basin and for the general public. Specific activities will be targeted to both young and adult



audiences, and will be related to existing community programs wherever possible. A focal point in the Basin for citizen involvement in stream and riparian restoration projects is needed and can encourage media attention to watershed activities and events. Organized guided tours of the Muck Creek Basin will help residents to better appreciate the creek and its natural resources. Interpretive programs as part of the tours can explain the natural processes of the Basin and residents' responsibility to help protect the creek.

There are a number of measures that can be undertaken by landowners to mitigate potential impacts from use activities. Some protective measures include the establishment of buffers, fencing livestock and farm animals from wetlands, streams, and their buffers, and building setbacks from buffers. Section 18E.60.050C currently (February, 2003) establishes a stream buffer width of 35 feet for Muck Creek and its tributaries to protect the creek which applies to new uses. During field evaluations, impacts from livestock were observed in many areas of the creek. For existing uses, this requirement could be voluntarily moderated with the allowance for limited stream contact for stock watering purposes. For instance, cattle could be allowed contact with 30 linear feet of stream per property or 30 feet per quarter mile of stream through larger properties. Although such restriction would require considerable fencing or other isolation measures, and may be a stumbling block for compliance by affected landowners, it may be possible to work with agencies such as the Pierce Conservation District.

A comprehensive public education program can be effective in involving Basin residents in the Watershed and in capital improvement projects or individual actions that can contribute to restoration and protection of Muck Creek's natural resources. This public education program would include specific components and recommendations included in this Basin Plan.

Examples of public education activities and tools include:

- Public workshops to introduce the Basin Plan recommendations to Basin residents.
- A Muck Creek Basin newsletter focusing on water quality, fish, habitat, and other watershed issues, community activities, and projects throughout the Basin.
- Creation of a Basin management position to coordinate watershed education activities and citizen involvement in stream and riparian restoration projects, and bring media attention to watershed activities.
- Interpretive programs and Basin tours to explain the natural processes of the Basin and residents' responsibility to help protect the creek.
- Brochures and fact sheets on the 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, and water monitoring activities.

Stream and riparian restoration projects should be organized to maximize the opportunity for Basin residents and other citizens to participate. 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 (Nisqually Tribe, Muck Creek Council, Conservation District) is another effective way of making effective use of funds and efforts devoted to public education.

**Conclusion:** Programs should be developed and implemented to provide public outreach and educational opportunities within the Basin and to maximize public participation.

## 9.2.7 Flood Hazard Management

One purpose of the Basin Plan is to provide information and direction to the County in mitigating flood hazards within the Muck Creek Basin. Pierce County participates in the National Flood Insurance Program administered by the Federal Emergency Management Agency (FEMA). FEMA also offers communities the opportunity through the Community Rating System (CRS) for additional benefits. This program makes subsidized flood insurance available for citizens where their communities take actions to reduce flood hazards. The community rating affects flood insurance rates within the County. Pierce County has one of the lowest cost flood insurance rates available, having been the first county in the nation to achieve a “Class 5” rating, through implementation of programs that reduced flood risks. This Basin Plan includes all the necessary program elements for the County to achieve a “Class 4” or better rating. On a Countywide basis, these measures also include the adoption of more restrictive flood hazard regulations and improved mapping of flood hazard areas.

### Risk Assessment

As mentioned previously, flooding problems have not been a major issue within the Muck Creek Basin. According to the Pierce County Geographic Information System, and current Pierce County Flood Hazard area maps of the Basin of the nearly 43,000 acres within Pierce County’s jurisdictional area of Muck Creek Basin, only 1,689 acres (approximately 4%) are located within an “A” Flood Zone, the area that statistically is anticipated to be flooded once every 100 years. Maps indicate that 2,177 acres (approximately 5%) are located within the “B” Flood Zone, the area that statistically is flooded once every 500 years. (See Figure 9-1.)

Throughout the Basin, only 47 buildings are estimated to be located within the “A” Zone, and 171 buildings are estimated to be within the “B” Zone. The number of structures was determined by selecting those individual parcels within unincorporated Pierce County that were shown as having a flood zone that extended landward from the potential flood source to at least 50% of the depth of the parcel.

The Muck Creek Basin is within the area of Pierce County that is designated as “Rural” under the Comprehensive Plan, the document that guides land use and development activity. The zoning within the Basin is mostly Rural 5 and Rural 10 (See Chapter 5). The base density for new development in these classifications would be 1 unit per 5 acres, and 1 unit per 10 acres, respectively. At these densities, and with the enforcement of County Critical Areas Development Regulations and Flood Hazard Regulations, it is very improbable that major new development could aggravate existing flooding problems.

The Plan supports programmatic measures to develop and implement projects that will serve to reduce flood hazard impacts. These include, but are not limited to: PG00-02, Adopt Updated Stormwater Management Standards; PG00-04, Develop and Implement a Land Acquisition Program for Riparian and Wetland Habitat Protection and Flood Hazard Reduction; PG00-05, Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality and to Provide Flood Attenuation; PG00-06, Develop and Implement an Education, Outreach and Technical Assistance Program and PG00-07, Develop and Implement a Surface Water Management Monitoring Program.

Studies that would provide information to reduce flood hazard impacts are also recommended in the Plan. ST12-02, Identification of Flooded Depression Areas and ST12-03, Detailed Flood Study along South Fork Upstream of Mountain Highway will address these issues. In addition, several CIP's have been proposed to alleviate localized flooding problems through stormwater facility improvements. Other CIP projects involve the acquisition of areas. Many of the problems were identified as the result of information provided by area citizens (See Chapter 3, Stakeholder Involvement, and Chapter 6, Flooding Problems.)

The Plan is intended to identify projects and processes that will reduce flood hazards, and contains a wide range of approaches to meet that goal. Those projects or processes that do not support that goal were not included in the Plan. Examples of proposals that were rejected outright include:

- Construction of a stormwater facility that is not sized sufficiently to accommodate flood events;
- Recommend actions to increase development densities major in-stream flow augmentation; and
- Extensive channel morphology modifications.

### **Major Tributaries**

Flood problems along the main tributaries within the Muck Creek Basin are comparatively few. Some flooding in the City of Roy has occurred in the past when the Lacamas Creek overflowed its banks due to thick channel vegetation (Section 5.3) and culvert blockages under SR 507. Periodic channel clearing has been carried out in the past to address this problem. Riparian revegetation and tree planting, contained in CIP recommendations, are long-term measures to permanently shade out the offending reed canary grass growths in the stream channel to ease this problem. High flows in the South Fork, just upstream of its crossing of SR 7 (Mountain Highway), can threaten several homes and block local access roads. To address this problem, it is recommended that a detailed hydraulic study (supported by 2-foot topography) be carried out of a one-mile length of stream upstream of the Mountain Highway. Finally, there are several undersized road culverts recommended where high flows can overtop the road. CIP improvements address these flooding problems. Flood studies and improved mapping of flood zones would also help alleviate such problems.

### **Ponded Water**

The most common flooding problems in the Basin result from ponded water conditions which can occur after heavy periods of rain. The topography across much of the Basin is flat to gently rolling and frequently forms shallow depressions. As a result, many areas within the Basin do not have a surface connection to a stream. Instead, rainfall runoff frequently flows to such depressions where the water will pond while it slowly infiltrates. Although ponded water locations and depths are not well-documented in the Basin, the maximum ponded depths are typically three feet or less. Roads, homes or other property located within these depressions can be impacted until the ponded water subsides. Piping this water to some other location is rarely a practical option since it typically would involve relatively long pipelines. The low density of housing and other structures in the Basin generally precludes regional drainage measures covering large areas. For new development and associated roads, the most effective measure

is avoidance of depressions. If a road crosses a depression, it should be elevated above the potential ponding level.

Homes with an existing water ponding problem have limited options. The home may be physically raised in place or moved. Both are expensive approaches for a home-owner. In one observed case, the owner dealt with the problem by excavating a depression and directed runoff from the area around his home to this pond. However, if the seasonal water table rises near the ground surface, this approach may not provide much relief.

The available topographic mapping for the Muck Creek Basin is laid out in 5-foot contour intervals. This is not detailed enough to reliably identify local depressions that might pond runoff. It is recommended that 2-foot topography be developed for the Basin. Internally-draining depressions could then be mapped using the County's GIS System. It is recognized that not all of these depressions would necessarily pond and cause potential flood problems, but this would provide valuable information for potential development and for the routing of new roads.

Proposals for major new development in the County require, among other things, that an assessment be made of the drainage conditions downstream from the development. For the Muck Creek Basin, this downstream assessment should explicitly review whether the project will be impacted 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 impacted by onsite ponding nor contribute substantially to an offsite ponding problem. In addition to site-specific ponding information provided by the County, information regarding past ponding incidents should be sought from the local residents. Access roads routed through a depression may be mitigated by providing a second access road through an area which is not subject to potential flooding.

### **Graham Area**

Runoff from the northeast portion of the Basin does not directly flow to any tributary (Section 4.4). Instead, it infiltrates locally or collects in several depressions and seeps into the ground. Some of this groundwater reaches Patterson Springs and the upper North Fork of Muck Creek, and is critical in maintaining the year-round flow of this stream. However, some of this groundwater may travel northwest and enter the Clover Creek Basin. Although several regional groundwater studies have been conducted, none have specifically addressed groundwater flow in the Graham area. A large portion of the Graham area drains to a depression located west of the shopping center at the intersection of Meridian and 224<sup>th</sup> Street. A large regional infiltration basin is proposed for this location as part of the CIP List in this Chapter. Additional information is needed with respect to regional groundwater movement in the Graham area. This study may include further recommendations for stormwater management in the area.

**Conclusion:** The County should develop and implement programs and projects that reduce flood hazards. These programs would include adoption of more stringent Flood Hazard Area Regulations, public education and outreach programs, compliance assurance programs, conducting studies that provide additional information about potential flood hazard areas, and acquisition of lands that are within riparian and wetland areas. Capital Improvement Projects that will reduce flood hazards should be constructed.

## 9.2.8 Water Quality

### NPDES Stormwater Management, Countywide

The Washington Department of Ecology (WDOE) issued its updated the Stormwater Management Manual for Western Washington in 2001. This updates the 1992 Puget Sound Stormwater Management Manual. The requirements for detention and for water quality treatment from higher-density land uses have been strengthened. The list of BMP's has been broadened. The manual is aimed primarily at urbanizing areas and commercial and industrial developments. It is thus most applicable to the Roy and Graham areas of the Basin. Individual jurisdictions will be required to adopt stormwater regulations which are functionally equivalent to those of the new Ecology Manual within the next several years. The County's NPDES permit requires implementation of equivalent standards contained in the manual. The County's current Stormwater Management and Site Development Manual, Title 17A, is the technical equivalent of the 1992 Ecology Manual.

**Conclusion:** The County should adopt updated stormwater management standards that are consistent with the most recent WDOE stormwater manual.

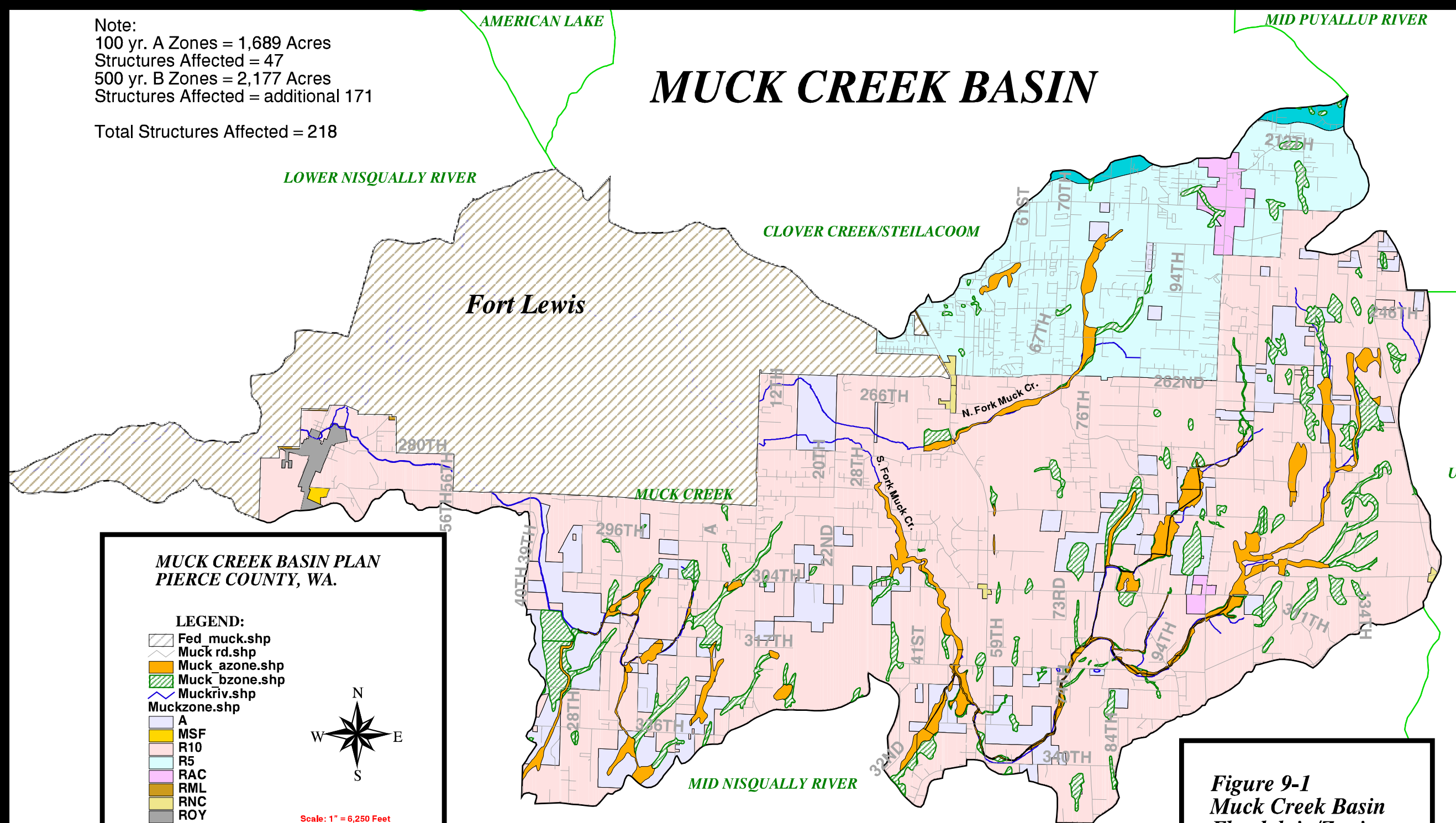
### Basin-Specific Water Quality Management

The two water quality parameters which most consistently exceed state standards are water temperature and bacteria (coliforms). (See Chapter 7.) In addition, the settlement of fine sediment in the channel bottom is a common cause of degradation of fish habitat. The measures needed to bring improvements to these parameters are quite similar to those identified for stream and riparian habitat improvement. Restriction of livestock access to streams in the Basin will greatly reduce the amount of stream bank and channel instability caused by this practice. This, in turn, will reduce stream sedimentation and allow the re-establishment of higher quality gravel substrate in the stream bottoms. Bacterial contamination of the streams due to animal sources will also decline.

Riparian revegetation is a key measure which 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 increases during warm, sunny days. However, there are several factors in the Basin that may limit the effectiveness of a tree canopy in reducing stream temperature rises. Large portions of the central basin lie within prairie areas. Riparian trees are typically limited to the immediate area of the stream, itself. Conifers are not a natural component of the streamside vegetation. Oregon ash and cottonwood may be more appropriate riparian trees in this setting. Riparian restoration in the prairie areas should be closely coordinated with Fort Lewis, where the majority of this ecosystem is located within the Basin. Another factor influencing stream temperature through the Roy area is the upstream lakes: Muck and Chambers lakes. The open water of these shallow lakes cannot be shaded and is subject to direct heating by sunlight. Inflow from Lacamas Creek, at Roy, probably moderates this temperature increase somewhat. Warm water release from these lakes typically occurs only during the early summer, as the main stem usually goes dry after mid-summer.

Note:  
 100 yr. A Zones = 1,689 Acres  
 Structures Affected = 47  
 500 yr. B Zones = 2,177 Acres  
 Structures Affected = additional 171  
 Total Structures Affected = 218

# MUCK CREEK BASIN



**MUCK CREEK BASIN PLAN  
 PIERCE COUNTY, WA.**

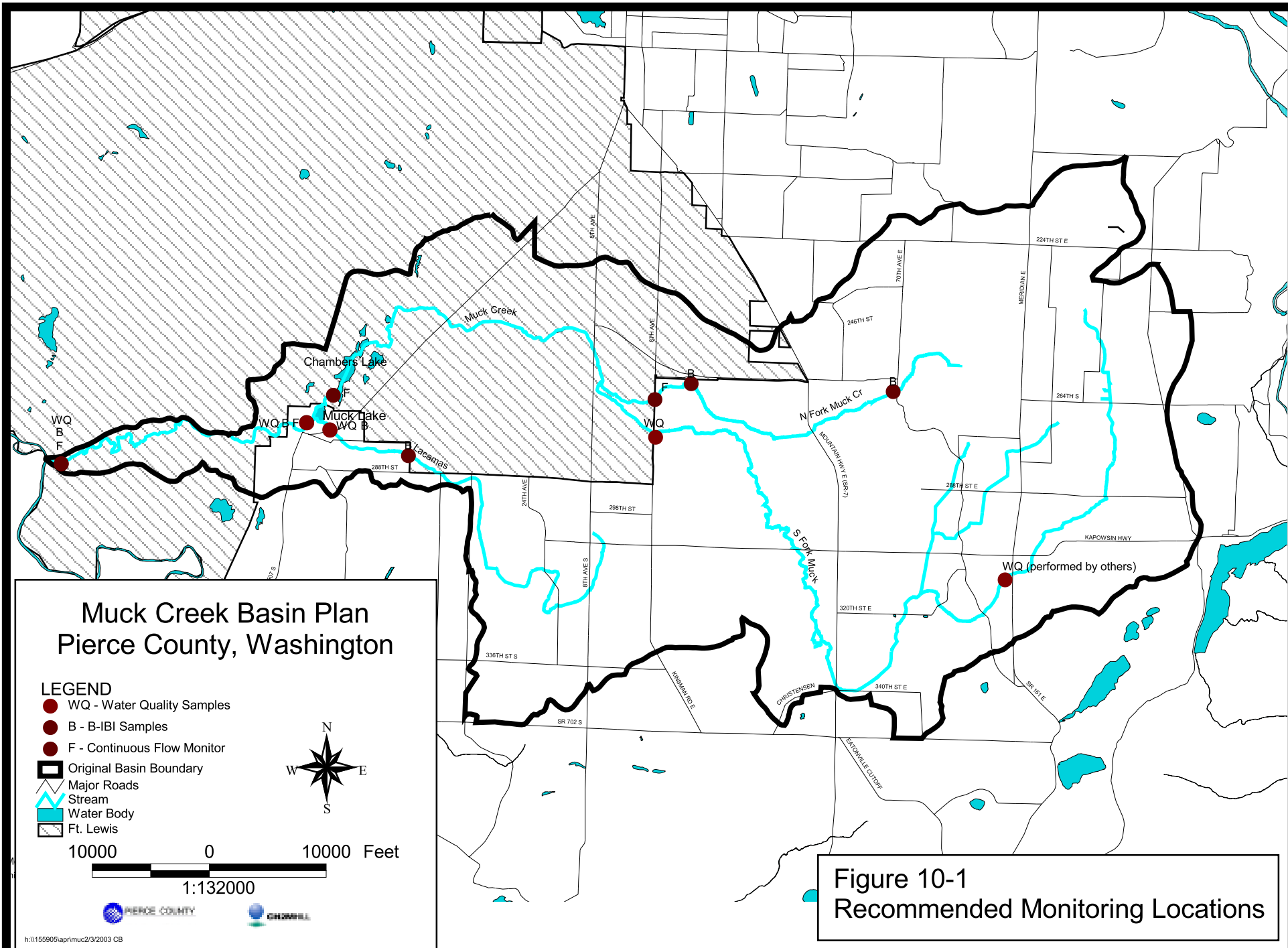
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- Fed muck.shp
- Muck rd.shp
- Muck\_azone.shp
- Muck\_bzone.shp
- Muckriv.shp
- Muckzone.shp
- A
- MSF
- R10
- R5
- RAC
- RML
- RNC
- ROY
- Rsv10
- muck.shp
- Disolv1.shp

Scale: 1" = 6,250 Feet

**Figure 9-1  
 Muck Creek Basin  
 Floodplain/Zoning**

Catographer: D. Grinstead  
 /Data/swm/crs03/muckcrs.apr  
 (GO-GLOBAL)



An additional benefit from the establishment and revegetation of riparian buffers 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 buffer. 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. Thus, an effective riparian restoration program in the Basin will have benefits for both water quality and stream habitat.

Long-term data on the Muck Creek system is needed to document flow and water quality trends. Long-term data is also essential to document improvements which may occur as a result of implementing the programmatic and other recommendations and the CIP's listed. Monitoring can be costly and an attempt has been made to strike a balance in obtaining the proper amount of data to adequately characterize Basin trends.

Water quality monitoring points on each of the major tributaries and at two key locations on the main stem of Muck Creek (Figure 9-2) would aid in documenting ambient conditions. Monthly samples should be collected and analyzed for a similar suite of parameters as was monitored in the Fort Lewis and the Nisqually Tribe monitoring programs during the 1990s (Table 9.3). This assures continuity of the water quality data and aids in trend analysis. As part of the monitoring program, water samples could be collected and analyzed for herbicides and pesticides commonly used in the Basin to determine if this might pose a water quality problem. The Agricultural Extension Service can be consulted for candidate chemical parameters.

**TABLE 9-3**  
**Water Quality Monitoring Parameters**

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Temperature
Dissolved Oxygen
pH
Suspended Solids
Turbidity
Total Phosphorus
Ortho Phosphate
Nitrate
Ammonia
Fecal Coliform

---

The two recording flow meters installed during the current study should be retained. The North Fork meter records the only perennial stream within the upper basin. The Roy Gauge, on the main stem of Muck Creek, adds to the continuous flow record dating from the 1950s to the 1970s. In addition, this is a good location for recording those periods when stream flow ceases during the dry season. Two additional flow monitoring locations are recommended, both on Fort Lewis. A flow recorder should be installed at or just downstream of the Chambers Lake outlet. This would be very useful in achieving proper gate adjustment of the outlet gate, both for fish passage and for minimizing downstream flow fluctuations. A continuous recorder should also be installed near the mouth of the creek where it discharges to the Nisqually River. The lower two to four miles of the stream are perennial and offer the most consistent spawning habitat within the Basin. Long-term data on stream outflow would also allow for a better estimate of the proportion of runoff that leaves the Basin via the regional groundwater aquifer.



B-IBI samples were collected during 2000 and 2001. They should continue to be taken annually during the late summer. This data provides a good indicator of stream health and can effectively document trends in water quality.

Every three to five years a report should be developed which summarizes the monitoring data collected in the Muck Creek Basin. This report should document discuss CIP's that have been constructed during the period and review any flow and water quality trends, particularly as they are related to constructed CIP's and/or programmatic measures in the Basin. It would also document flooding problems which occurred during this period. The report should include a summary of ongoing County drainage maintenance and flood control activities in the Basin. This report would also be an opportunity to add additional programmatic measures or CIP's and to modify priorities, as needed, to address emerging problems or changing conditions. Thus the report would document the adaptive management process used to assure that the Basin Plan remains current and continues to effectively address flooding, water quality and stream habitat problems.

**Conclusion:** The County should develop and implement programs that will protect and preserve water quality within habitat areas. One means to accomplish this is to establish and maintain buffers along habitat areas, education and outreach programs would also be valuable. The County should establish an on-going water quality monitoring plan with regular reports, and enough information for adaptive management opportunities.

### 9.2.9 Reed Canary Grass Management

There are numerous large-scale opportunities for reed canary grass eradication within the Muck Creek Basin. The largest contiguous stand is on Lacamas in the reach between 288<sup>th</sup> Street S and a large dairy located more than a mile upstream. The reach is about two miles long. The growth is thick enough to block fish movement and passage. The lack of shade for such a long length probably increases water temperature significantly. Another, more important reach is at the mouth of Lacamas Creek in Roy, near the vicinity of Muck Lake. The position of this monotypic stand of reed canary grass low in the Lacamas system makes it especially important. There are a number of fairly long reaches of reed canary grass on the South Fork in the vicinity 320<sup>th</sup> Street E. and SR 7. There are numerous smaller stands of reed canary grass throughout the upper basin that should be controlled. Many of these are on smaller properties. Several landowners indicated that they would be very pleased if the County would help them deal with this problem as they have been battling reed canary grass on their own unsuccessfully for flood control purposes.

**Conclusion:** The County should develop and implement a program to reduce impacts in the aquatic environment caused by invasive plant species.

### 9.2.10 Riparian Corridor Management

Perhaps the most important and practical single measure that can be implemented to enhance salmon habitat in the long-term, is riparian tree planting. With high temperatures, lack of LWD, and extensive reed canary grass problems, riparian planting programs should play a major role in the Muck Creek Basin. While a number of groups are already conducting such programs in the Basin, much more is needed. The most effective way to remove reed canary grass is by shading it into submission. Conifers are considered by some to be best for this, as hardwoods

allow early spring and late fall growth to occur unhindered. But willows can crowd out reed canary grass with their root mass if allowed to become established through a program of proper maintenance during the interim period. 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.

In the areas which have historically been prairie, there is the potential to enhance the natural oak habitat which has declined in the Basin (see Section 4.7). The distinguishing tree is the Oregon white oak. Hanna and Dunn (1996) identify three distinct types of oak habitats: oak savannas and open woodlands, riparian oak woodlands and wetland oaks. The latter two habitat types could be appropriate for prairie areas recommended for riparian restoration. Riparian oak woodlands most often appear as thin bands of vegetation which form between grasslands and a watercourse. The oaks typically are located upland from the more moisture-tolerant trees which typically border a stream. A revegetation plan for such areas should incorporate oaks and their associated understory where appropriate. The Nisqually Indian Tribe has prepared an analysis of riparian habitat on Fort Lewis that is a good resource for information about appropriate plant species. (Dorner, et. al., 2002).

**Conclusion:** The County should develop and implement a program(s) for restoration and enhancement of habitat areas within the Basin. The program should include opportunities for coordination with other stakeholders.

### 9.2.11 Instream Habitat Improvement

There are several fish habitat elements that are in need of improvement in the Muck Creek Basin. The two most important instream elements are channel morphology and LWD. As mentioned previously, much of the stream channel appears to have been intentionally made narrow at some time in the distant past, and there is far too little LWD present. Unfortunately, extensive channel morphology modifications would be entirely too expensive to be practical. The potential habitat improvements are also constrained by the intermittent nature of Muck Creek downstream of many potential channel restoration sites which are largely unavailable to anadromous fish. Placement of instream LWD would create much needed pool habitat, but due to the narrow stream conditions may create local flooding problems if this potential problem is not considered carefully. One of the reasons why there is so little instream LWD is because it has historically been removed from the channel to prevent flooding. Because of its position relatively low in the watershed and its perennial nature, Lacamas Creek is a likely candidate for LWD placement. Instream habitat restoration will be most practical when it is implemented along with other measures such as riparian enhancement in a comprehensive restoration project.

Even established older stands of alder do not provide the same quality of salmon habitat function as do conifers. 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. Conifers may not be appropriate in the prairie areas of the Basin. 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 the group mentioned. Conifers can be interplanted in alder and maple stands. Cedars are especially shade tolerant. One potential limitation to the ultimate success of such a program is that agreements should be made with landowners or regulations put in place to preclude the ability of landowners to cut down these plantings at a later date when they become

commercially harvestable in 40+ years. Species selection should take the local ecosystem and historic character of the area into account.

**Conclusion:** The County should develop and implement a program(s) for restoration and enhancement of habitat areas within the Basin. The program should include opportunities for coordination with other stakeholders.

### 9.2.12 Livestock/Riparian Interactions

Livestock enclosures allow riparian buffers to become established and also limit the spatial extent to which animals are allowed contact with stream channels. If watering access is limited to sections of stream that are narrow, perhaps 30 feet, and the banks are graded back and hardened, these sacrificial areas can protect hundreds of yard of habitat. The use of nose pumps or electric pumps can completely eliminate the need for livestock to come in direct contact with the stream.

**Conclusion:** The County should develop and implement a program for education and outreach so that homeowners can be educated about the value of restricting livestock access and to provide information about available assistance.

### 9.2.13 Filling Information Gaps

During development of this Basin Plan, it became evident that there was a need for additional data to effectively address a number of issues. Recommendations for additional studies are given below.

An aerial photographic survey immediately following a major storm event would provide valuable information about flood problems across the Basin. Many of the flooding investigations carried out during the course of this Basin study stemmed from limited County records of ponding and drainage problems following a major storm which occurred in 1996. The County personnel recorded hundreds of problems throughout the County during a several-day period. Many of these records were too sketchy to evaluate. An aerial photographic record of Muck Creek and other basins in the County would be a cost-effective way to more accurately document these types of flooding problems.

Additional detailed topographic mapping at the 2-foot contour interval would be useful for the Muck Creek Basin. This mapping could be used to better define local topographic depressions that may be subject to periodic flooding. Such information is important reviewing new development proposals in the Basin and would also be very useful in evaluating existing flooding problems. In conjunction with this, flood hazard mapping should be conducted along the upper portions of Lacamas Creek and the South Fork of Muck Creek, both of which currently lack this information.

A detailed flood study (with supporting 2-foot topography) should be conducted along the South Fork, upstream of Mountain Highway (SR 7). Floods through this area periodically threaten homes.

Information presented in Section 4.4 indicates that groundwater recharge which occurs in the Graham area may be contributing to seasonally high water tables and flooding in the

Clover/Chambers Basin, which is located immediately north of the Muck Creek Basin. It is recommended that a study of groundwater levels and movement be conducted in this area to determine the degree (if any) to which the northeastern portion of the Muck Creek Basin contributes to flooding problems in the adjacent basin. Virtually all of the stormwater runoff in this portion of the Basin infiltrates to the groundwater. To the degree that the groundwater from this area moves into the Clover/Chambers Basin, an adjustment in the Basin boundary should be evaluated.

**Conclusion:** The County should conduct Basin specific studies that provide information required to reduce flood hazards.

### 9.2.14 Stakeholder Involvement

Broad, multi-stakeholder groups such as the Muck Creek Council can be instrumental in implementation of the Basin Plan. Representatives of environmental interest groups, tribes, and individual citizens provide valuable review and support of specific activities and ongoing progress of the Basin Plan recommendations. These groups can also be instrumental in carrying out an effective public education campaign. The Muck Creek Council should continue to serve as a forum on Basin issues.

Businesses in the Basin should be contacted to involve them in implementation of the Basin Plan recommendations. The private sector will need to comply with regulations to protect the water resources and habitat of the Muck Creek Basin. Additionally, businesses may be partners in developing creek and natural resource protection strategies, and may also offer funding assistance for individual and/or ongoing watershed activities.

Farmers and other large landowners with extensive property along Muck Creek and its tributaries can play a critical role in addressing the temperature and sedimentation problems. The establishment and revegetation of riparian buffers is the single most important measure for improving water quality within the Basin. The Pierce County Conservation District can be effective in this regard especially in its efforts to promote agricultural BMP's and farm water quality plans.

Actions carried out on Fort Lewis are critical in maintaining and improving stream habitat and water quality. Activities the Fort could consider include:

- Implementation of the planned on-Fort stream and wetland restoration projects
- Completion of the on-Fort field assessment of Muck Creek
- Manage flow releases from Chambers lake in a manner that reduces downstream flow fluctuations
- Assistance in the long-term monitoring program (see Section 9.5)

**Conclusion:** The County should develop and implement a program that provides for outreach to, and coordination with, other agencies and jurisdictions within the Basin and that facilitates stakeholder involvement.

## 9.3 Specific Recommendations for the Muck Creek Basin

The following are specific recommendations to address flooding, water quality, and habitat problems within the Muck Creek Basin.

### Capital Improvement Projects

#### Flooding and Drainage Problems

The locations of these projects are shown on Figure 9-3 of the Muck Creek Basin Plan.

**CIP12NF-CUL01:**      “216<sup>th</sup> St. E Conveyance Improvements”  
    (216<sup>th</sup> St. E and 118<sup>th</sup> Ave. E)  
**Cost: \$4000**                      **Score: 45**

**Problem:** Runoff from large area consisting of public streets and adjacent property drains to a ditch northwest of the 216th St and 188th Ave E intersection. The ditch crosses private property and is overgrown with grass vegetation. This ditch can back water up onto 216<sup>th</sup> St E and can cause intersection flooding.

**Solution:** Perform maintenance of the ditch north of 216<sup>th</sup> St E for a distance of 300 feet. Since this ditch lies within private property, an easement covering about 0.15 acres will be needed. An 80-foot culvert needs to be constructed from the existing drywell, west across 118th Ave to an existing road ditch.

**CIP12NF-RD01:**      “238<sup>th</sup> St. E Conveyance Improvements”  
    (238<sup>th</sup> St. E. and 103<sup>rd</sup> Ave. E)  
**Cost: \$2000**                      **Score: 45**

**Problem:** Water from 238th St E enters a private property and then flows down an embankment onto an adjacent driveway.

**Solution:** Construct a 100-foot curb extending from the crest of 238th St E to an existing road curb to prevent road runoff from leaving the road and entering private property.

**CIP12NF-CULO2:**      “70<sup>th</sup> Ave. E Culvert Improvements”  
    (242<sup>nd</sup> St. E and 70<sup>th</sup> Ave. E)  
**Cost: \$39,000**                      **Score: 100**

**Problem:** Flooding occurs along 70th Ave E. Water flows across a low spot along the road about 500 ft north of 242nd St E and floods private property. No culvert exists to drain the east roadside ditch to the lower west side at the road sag. A house on the property west of the road lies adjacent to a possible wetland.

**Solution:** Construct a 50-foot culvert under 70th Ave E at the low point to convey water to the west side of the street. A detailed site survey and hydrologic/hydraulic investigation should be

carried out to delineate the wetland on the west side of the street, identify property lines, topography and soil properties to determine if an infiltration pond or some other means of stormwater management is necessary to prevent/eliminate flooding of the nearby house.

**CIP12NF-INF01:**      “242<sup>nd</sup> St. E Infiltration Pond”  
                                  (242<sup>nd</sup> St. E. and 49<sup>th</sup> Ave E)  
                                  Cost: \$136,000      Score: 85

**Problem:** A private road 242nd St E floods about 100' west of 49th Ave E during large storm events. Some private property floods as well and there is no outlet for accumulated runoff. The ponded water can block the sole access available to a number of homes in the area.

**Solution:** A 7.5 acre-ft infiltration pond with a depth of 6 ft should be constructed. The pond would be located a short distance north and west of the existing low point in the gravel road. Five hundred feet of ditch would be installed along the road to convey runoff to the facility. Acquisition of 1.5 acres of land would be required.

**CIP12NF-CUL03:**      “252<sup>nd</sup> St. E Conveyance Improvements”  
                                  (252<sup>nd</sup> St. E and 75<sup>th</sup> Ave. E)  
                                  Cost: \$179,000      Score: 155

**Problem:** 252nd St E experiences frequent shallow flooding. This road crosses the upper portion of the North Fork. The two existing culverts underneath 252nd St E have inadequate capacity.

**Solution:** Install a 12' x 6' arch culvert to provide the needed capacity to eliminate road flooding. A detailed survey of several cross-sections downstream of the culverts would allow for a more refined hydraulic analysis and the possible reduction in the number of added culverts.

**CIP12SF-CUL01:**      “288<sup>th</sup> St E Culvert Replacement I”  
                                  (288<sup>th</sup> St. E and 125<sup>th</sup> Ave. E)  
                                  Cost: \$128,000      Score: 180

**Problem:** A tributary of the South Fork crosses 288th St E (7,200 feet east of Meridian E) in three 36" diameter concrete culverts. The culverts do not have sufficient capacity to pass the 100-year storm event and water from the creek overtops the road. In addition, the culverts are susceptible to debris blockage and frequently need to be maintained.

**Solution:** Replace the existing culverts with two 8' x 7' Concrete Box culverts 40 feet in length. The culverts are sized to allow for stream bed material in the bottom of the culvert.

**CIP12SF-CUL02:      “Orting-Kapowsin Highway Conveyance Improvements”  
(288th St. E and Orting-Kapowsin Highway)  
Cost: \$10,000                      Score: 85**

**Problem:** Stormwater overtops 288th St E and floods the property owner on the southwest corner of the intersection of 288<sup>th</sup> St E and the Orting-Kapowsin Highway. In the winter, frozen water over the road and poor lighting presents a safety hazard.

**Solution:** Roadside ditch regrading and maintenance is needed in all ditches surrounding the intersection. Construct a 50-foot 18" culvert across 288<sup>th</sup> St E allowing drainage to the ditch on the north side ditch. It is also recommended that traffic accident records be reviewed to assess accident frequency; illumination of the intersection should be considered.

**CIP12SF-PIP01:      “47<sup>th</sup> Ave E Conveyance Improvements”  
(296<sup>th</sup> St. E and 47<sup>th</sup> Ave. E)  
Cost: \$34,000                      Score: 60**

**Problem:** Roadside runoff drains through an 18" road culvert under 47<sup>th</sup> Ave E. The pipe daylights on the west side of 47th Ave E. and then flows through a 12" pipe on private property. During large storm events, stormwater often bypasses the 12" private pipe and travels overland through the private property, washing out a driveway.

**Solution:** Replace the existing 12" pipe with 170 feet of 18" pipe and install a catch basin with a solid locking cover to connect the existing 18" culvert under 47<sup>th</sup> Ave E. A 5-foot drainage easement extending 170 feet through a low-density residential area (0.02 acres) should be acquired. In addition, install a 60-foot 12" culvert along 296th underneath its intersection with 47<sup>th</sup> Ave E.

**CIP12SF-DIV01:      “Mountain Highway Conveyance Improvements”  
(Christensen Muck Road and SR 7)  
Cost: \$319,000                      Score: 95**

**Problem:** Several homes located in the vicinity of Christensen-Muck Road experience flooding resulting from runoff passing through a large culvert under Mountain Highway (SR 7), south of 340th St. E, which can also flood Christensen-Muck Road, itself.

**Solution:** Install a flow splitter at the upstream end of the existing culvert under Mountain Highway. Convey high flows along the west side of the highway via 730 feet of 24" pipe and 490 feet of drainage ditch directing the high flows north directly to the South Fork. The completed project would be monitored to see if additional improvements are warranted. A second phase of this project may be an infiltration pond. This involves work under a State Highway and should be coordinated with WSDOT.

**CIP12MS-INF01** :     **“288<sup>th</sup> St. S Infiltration Pond”**  
                                  **(288<sup>th</sup> St. S and 11<sup>th</sup> Ave. S)**  
                                  **Cost: \$297,000     Score: 115**

**Problem:** A large drainage area in the vicinity of 288th St S, west of 8th Ave S, drains through an existing drainage channel and passes through a culvert under 288th St S. A short distance downstream, the culvert terminates in a shallow-ponding area on Fort Lewis property with no outlet. Both the road culvert and the drainage channel tend to pond under higher rainfall conditions. As a result, 288th St S is flooded during periods of most winters.

**Solution:** Construct a 30 acre-ft infiltration pond with a depth of 8 feet. The pond would be located on vacant land located immediately west of the existing culvert on the south side of 288th St E. This would require the acquisition of 5 acres of land.

**CIP12LC-RD01**:       **“336<sup>th</sup> St S Grade Change”**  
                                  **(336<sup>th</sup> St. S and 14 Ave. S)**  
                                  **Cost: \$303,000     Score: 150**

**Problem:** A low point exists on 336th St S about 2,200 feet west of 8th Ave S. Wetlands lie on either side of the road at this point. 336th St S frequently floods, forcing the County to close the road.

**Solution:** Raise the road an average of 1.5 feet along a length of 1,700 feet to eliminate the low point and the associated flooding. A detailed site survey and hydrologic/hydraulic investigation would be carried out to delineate the adjacent wetland, topography and soil properties to determine how high to raise the road. This project could have substantial wetland impacts which would need to be mitigated.

**CIP12LC-CUL01**:     **“Schudy Rd S Culvert Replacement”**  
                                  **(311<sup>th</sup> St. S and Schudy Road)**  
                                  **Cost: \$100,000     Score: 175**

**Problem:** The lower-most Lacamas Creek culvert crossing of Schudy Rd S does not have sufficient capacity to pass the 100-year storm event and water from the creek overtops the road.

**Solution:** Replace the existing culverts with one 10'-11" wide by 6'-4" deep metal box culvert, 29 feet in length. The culvert is sized to allow for stream bed material in the bottom of the culvert. Install large woody debris upstream and downstream of culvert to increase stream habitat value.



**CIP12SF-CUL03:**      “288<sup>th</sup> St E Culvert Replacement II”  
                                 (288<sup>th</sup> St. E and 113<sup>th</sup> Ave. E)  
                                 Cost: \$41,000      Score: 165

**Problem:** A tributary to the South Fork crosses 288th St E (0.7 miles east of Meridian E) through a 36” diameter concrete culvert. The culvert does not have sufficient capacity and flood waters can overtop the road.

**Solution:** Install a 43-foot long 6’ x 5’ Concrete Box Culvert to convey the 100-year, 24-hour storm event. The culvert is sized to allow for stream bed material in the bottom of the culvert.

**CIP12SF-CUL04:**      “288<sup>th</sup> St E Culvert Replacement III”  
                                 (288<sup>th</sup> St. E and 95<sup>th</sup> Ave. E.)  
                                 Cost: \$133,000      Score: 170

**Problem:** A tributary to the South Fork crosses 288th St E (0.4 miles west of Meridian E) through two 24” concrete culverts. The culverts do not have sufficient capacity to pass the 100-year storm event and water from the drainage channel overtops the road.

**Solution:** Replace existing culverts with two 44-foot long 6’ x 5’ Concrete Box Culverts to convey the 100-year storm event. The culvert is sized to allow for stream bed material in the culvert bottom. Raise the road grade to pass over the culvert top.

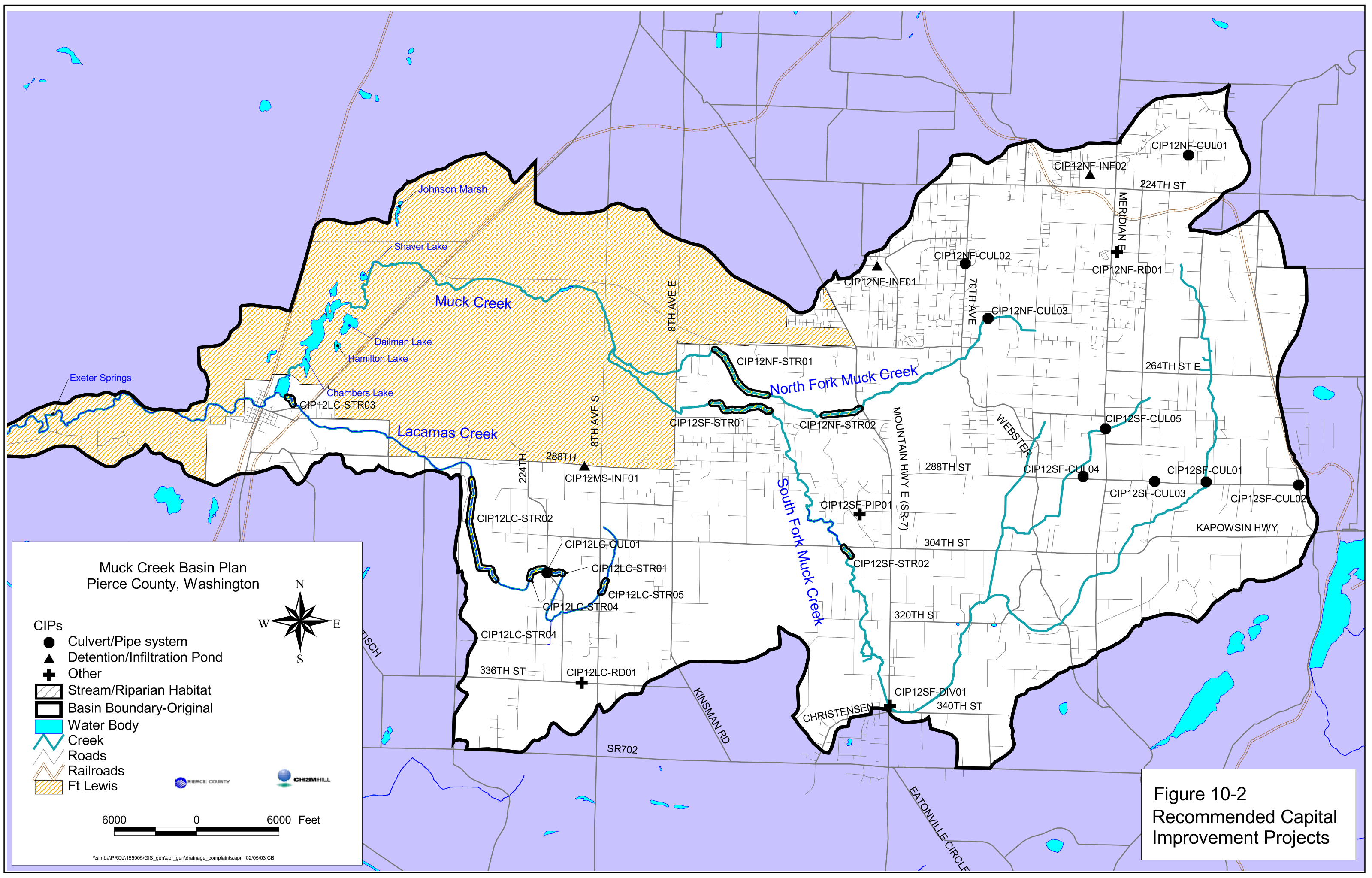
**CIP12SF-CUL05:**      “Meridian East Culvert Replacement”  
                                 (277<sup>th</sup> St. E and Meridian)  
                                 Cost: \$46,000      Score: 195

**Problem:** A tributary to the South Fork crosses Meridian E (north of 288th St E) in a 36” diameter concrete culvert and an 18” diameter concrete culvert. The culverts do not have sufficient capacity to pass the 100-year storm event and water from the drainage channel overtops the road.

**Solution:** Construct a 41-foot long 7’ x 5’ Concrete Box Culvert to convey the 100-year storm event. The culvert is sized to allow for stream bed material in the culvert bottom. This involves work under a State Highway and should be coordinated with WSDOT.

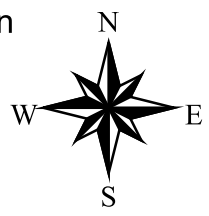
**CIP12NF-XXX:**      “Graham Regional Stormwater Facility”  
                                 (224<sup>th</sup> St. E and Meridian)  
                                 Cost: \$2,500,000\*      Score: 200

**Problem:** A natural low spot within a large privately-owned, undeveloped area located along 224th St E., one-half mile west of Meridian, currently receives runoff from a large area of developed and undeveloped land in the Graham area. Natural infiltration at this site currently handles most storm events. During large storm events the site is flooded. One small infiltration basin has been excavated on the west side of the flooded area. A mobile home park lies a short distance further west while a subdivision lies a short distance to the north. Possible future development may impact the infiltration which occurs at this site, potentially causing flooding to adjacent areas.



Muck Creek Basin Plan  
Pierce County, Washington

- CIPs
- Culvert/Pipe system
  - ▲ Detention/Infiltration Pond
  - ⊕ Other
  - ▨ Stream/Riparian Habitat
  - ▭ Basin Boundary-Original
  - Water Body
  - ~ Creek
  - Roads
  - Railroads
  - ▨ Ft Lewis



6000 0 6000 Feet



Figure 10-2  
Recommended Capital  
Improvement Projects

**Solution:** Project ST12-01 is a study to evaluate groundwater migration in this vicinity. A solution to area flooding problems will be developed after the study has been completed and reviewed. \*The estimated cost of this solution is not yet known. This planning level cost estimate is based upon the estimated cost of a 12' deep, 10.7 acre infiltration pond that had been proposed as a possible solution, however the ultimate solution and cost may differ.

**CIP12LC-CUL02      “Highway 507 Culvert Replacement”  
 (Highway 507 and Lacamas Creek)  
 Cost: \$345,000      Score: 215**

**Problem:** Lacamas Creek crosses under Highway 507 through three 4-foot high arch culverts. On several past occasions, high flows have overflowed the highway at a low spot in the road, south of the culverts. This has disrupted highway traffic and caused downstream flooding and creek damage.

**Solution:** Replace the existing triple arch culverts with a 20'x5' concrete box culvert convey the 100-year, 24-hour storm event and meet the current Pierce County design standards. The culvert is sized to allow for stream bed material in the bottom of the culvert. During detailed design, the low spot in the highway, south of the stream crossing, needs to be factored into the design.

## **Water Quality and Habitat Improvement**

The following capital improvement projects are included to address water quality and stream habitat problems in the Basin. Many will have added benefits, such as flood hazard reduction. Sites will be identified as part of a comprehensive land acquisition program which focuses upon flood reduction, water resource protection and habitat protection and improvement. Projects will be developed as sites are evaluated and prioritized on an annual basis. Projects may involve partnering with others to accomplish program goals. There are three main “Project Reaches”. Projects will include acquisition and/or restoration.

### **Project reaches:**

**North Fork:** The headwaters of the North Fork are in the Graham area, adjacent to Patterson Springs, from which it flows west to its confluence with the South Fork on Ft. Lewis. The North Fork is a perennial system, with year round flow. Anadromous fish are unable reach the North Fork due to the intermittent nature of the Mainstem. Most of the land use in the upper reaches of the North Fork is residential, becoming more rural downstream.

**Mainstem:** Most of this reach of the stream is located within the boundaries of Ft. Lewis, or the City of Roy, outside County jurisdiction. For purposes of this study, the Mainstem is defined as that area of Muck Creek below the confluence of the North and South Forks on Ft. Lewis. The creek flows west and south through Ft. Lewis, through wetland areas and man-made impoundments to Muck Lake, in unincorporated Pierce County, just north of Roy, where it merges with Lacamas Creek and through the City of Roy, then back onto Fort Lewis to its mouth at the Nisqually River. The Mainstem currently contains the best fish habitat in the

system. Portions of the stream, especially near Highway 507 are dry for significant parts of the year, limiting upstream migration of anadromous fish.

Muck Lake has become choked with vegetation to the point that it has become a fish passage problem. The Nisqually Indian Tribe, Muck Creek Council and Pierce Conservation District have already done some rehabilitation work in the Mainstem area. For purposes of the Plan CIP, the Mainstem will be part of the North Fork project reach.

**Lacamas Creek:** Lacamas Creek originates at about 300th St. S. and 8th Ave. S, in the southwestern portion of the basin. It flows northwest to its confluence with the Mainstem at Muck Lake. The creek has been channelized in several areas. Much of the area it passes through is agricultural land. Local residents have indicated that it has historically not been a major fish bearing stream.

**South Fork:** The South Fork of Muck Creek (also known as South Creek) originates in the northeast portion of the Basin and flows south and west to its confluence with the North Fork on Ft. Lewis. It is the largest tributary of Muck Creek. It flows through a landfill site, residential development and agricultural areas. Much of the tributary is dry for periods of time throughout the year. Some channelization has occurred.

## **Riparian Restoration**

A long-term restoration plan for Muck Creek within unincorporated Pierce County should focus on establishment of a functional riparian corridor, by large scale plantings of riparian vegetation and exclusion of agricultural activities, primarily grazing by cattle and horses, from the corridor. The program should be focused in those areas of the creek that maintain perennial flow, e.g. the North Fork, Lacamas Creek, and a two-mile segment of the South Fork from approximately 3 to 5 miles above the confluence with the North Fork. Altogether these areas include about 12 stream miles.

### **Cost Assumptions for Riparian Restoration**

To get some idea of what might be reasonably accomplished using this approach we have developed an idealized project concept, on a 500-foot long stream segment, buffered on both sides with 100 foot of vegetation and surrounded by fencing to exclude farm animals. The total cost of this conceptual project is \$62,800. The cost estimate includes the acquisition of an easement or outright purchase of property. Development of this cost estimate is described below, using a conceptual project.

A total budget amount of \$3,800,000 has been set forth for restoration projects. A percentage of that total amount has been allotted to each Project Reach, based upon the number of miles of perennial flow identified within each reach area. With a budget of \$3,700,000 (less \$100,000 for potential wetland restoration in South Fork) and if project sites could be obtained, approximately 59 riparian restoration projects could be accomplished in the Muck Creek Basin, covering almost 5.6 miles of stream, and including approximately 136 acres of riparian re-vegetation. (To restore the entire 12 miles of stream area initially identified, a budget of nearly \$8 million would be required during the 10-year plan period using these estimates. The current budget assumes no volunteer labor or contributions by other groups or agencies. The projects may, however, involve such partnerships, which could increase the amount of restoration that could be accomplished).

**Conceptual Project – Cost Estimate**

500 foot long stream segment, buffered by 100 feet on both sides from top of bank. This area is approximately 2.3 acres.

Fencing

Estimated fence cost for field fence (4-foot high wire mesh) is \$7/foot installed. This cost estimate is based on Water Programs experience contracting for fencing as a part of capital improvement projects. An independent estimate from the Pierce Conservation District was also \$7/foot installed.

Fence 1400 feet @ \$7/LF	<b><u>\$ 9,800</u></b>
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Plantings

Costs can vary greatly, based on the suitability of the site soils, the presence of invasive species such as reed canarygrass, and plant stock specifications. In most cases we have taken a conservative approach and assumed more costly stock and difficult site conditions. We have also assumed that labor would be paid, rather than relying on volunteer labor. Cost savings would occur if bare-root stock was used, and if volunteer labor was available.

Assumptions:

Plant density of 1000 stems/acre (2300 plants/project)

2300	Potted stock (1 gallon) @ \$3/plant	\$ 6,900
2300	Tree tubes @ \$1.25 each	\$ 2,875
2300	Weed control mat @ \$.75/plant	\$ 1,725
460 hrs.	Labor @ \$16/hour, 5 plants/hour	\$ 7,360
	Design/mgmt @ \$5,000/project	\$ 5,000
	Maintenance @ 60 hours/year for 4 years (\$16/hour)	\$ 3,840
subtotal		<b><u>\$27,700</u></b>

Land Costs (e.g., easement or acquisition)

Estimate of \$11,000 per acre of undeveloped rural land	<b><u>\$ 25,300</u></b>
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<b>Estimated total cost per project:</b>	<b>\$ 62,800</b>
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<b>Estimated cost per mile of stream restoration:</b>	<b>\$663,000</b>
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**The standard cost estimate for wetland creation and restoration in the framework document for the purpose of project budgeting, based upon average costs is \$100,000 per acre, including land costs. Actual projects may be higher or lower.**

## **Projects:**

**CIP12NF-STR01: “North Fork Habitat Restoration”  
(North Fork and Main Stem of Muck Creek within  
unincorporated Pierce County)**

**Project Description:** A total of approximately 5.6 miles of potential stream restoration area have been identified within this stream reach. It is unlikely that all the potential restoration sites will be accessible. The budget would be sufficient for restoration of approximately 2.5 miles of stream reach.

**Budget: \$1,748,000      Score: 380**

**CIP12SF-STR01: “South Fork Habitat Restoration”  
(South Fork of Muck Creek, a.k.a. “South Creek”,  
within unincorporated Pierce County)**

**Project Description:** A total of approximately 1.9 miles of potential stream restoration area have been identified within this stream reach. Some of the areas to be restored could include wetlands, for increased flow attenuation to the Creek. It is unlikely that all the potential restoration sites will be accessible. The budget would be sufficient for restoration of approximately .8 miles of stream reach.

Funds are budgeted for 1 acre of wetland restoration during the plan period.

**Budget: \$608,000      Score: 365**

**CIP12 LC-STR01: “Lacamas Creek Habitat Restoration”  
(Lacamas Creek, within unincorporated Pierce County)**

**Project Description:** A total of approximately 4.6 miles of potential stream restoration area have been identified within this stream reach. It is unlikely that all the potential restoration sites will be accessible. The budget would be sufficient for restoration of nearly 2.2 miles of stream reach.

**Budget: \$1,444,000      Score: 375**

## **Land Acquisition**

The Plan recommends the acquisition of some lands that are valuable for habitat and water resource protection. Such lands might include wetland areas, buffers areas, or areas within floodplains. For purposes of a budget estimate, an amount of \$11,000 per undeveloped rural acre of land is used to be consistent with the Framework document guidelines. The cost of developed acreage would be greater, and the amount of land that could be purchased would be reduced substantially. At the time of actual land acquisition, professional appraisals will be used to establish a purchase cost. Some of these lands may later be part of a restoration project.

## **Projects**

### **CIP12NF-ACQ01:**

The headwaters of the North Fork of Muck Creek are at Patterson Springs, in the Graham area. The area has been under development pressure. A large amount of land in the area has been acquired by other agencies to ensure its preservation as a resource area. Approximately 350 acres of land have been identified as desirable for acquisition. Some of the purchases may involve partnerships with other agencies. It is also assumed that not all properties desired will be available. The cost estimate is for acquisition of approximately 60 acres in the Patterson Springs area.

**Budget: \$1,500,000**

**Score: 265**

## **Programmatic Measures**

Nine programmatic measures for addressing Muck Creek Basin issues are described below.

### **PG12-01      Conduct a Low Impact Development Pilot**

A pilot would be conducted that incorporates low impact development techniques and tools. Pierce County would adopt low impact development guidelines and work with local property interests to implement those guidelines. A development project in the Graham area would be targeted for implementation of the pilot. Based upon the experience from this one or more other LID pilot projects in other basins, Pierce County would make recommendations on how low impact development guidelines might be applied in the Muck Creek Basin and throughout Pierce County. The pilot project would be a one-time event.

**Cost Assumption:** Includes 0.5 FTE per year for two years for a pilot project within the Basin.

**Cost:**                               **\$100,000**

**Application:**                   **Basin-specific**

**Score:**                               **346**

### **PG00-02      Adopt Updated Stormwater Quality Standards**

The Washington State Department of Ecology provided local jurisdictions, including Pierce County, with updated guidance on stormwater management standards with the issuance of the 2001 Western Washington Stormwater Manual. Pierce County Water Programs would update its current manual.

**Cost Assumption:** Includes 0.25 FTE as one-time, one-year cost. Prorated for the Muck Creek share of the County-wide cost (3.4%).

**Cost:**                               **\$1000**

**Application:**                   **County-wide**

**Score:**                               **380**

**PG00-03 Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit**

Pierce County Water Programs would increase the amount 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 would be targeted for inspection to confirm that regular maintenance is occurring and that maintenance standards and agreements are being met. When a violation is identified, inspectors would offer education and technical assistance, but enforcement actions would be taken when necessary.

**Cost Assumption:** Includes 6.0 FTEs per year County-wide. The estimated costs include funding to support additional inspection staff. Lifecycle cost then prorated for the Muck Creek share of the County-wide cost (3.4%).

**Cost:** \$204,000  
**Application:** County-wide  
**Score:** 398

**PG00-04 Develop and Implement a Land Acquisition Program for Riparian and Wetland Habitat Protection and Flood Hazard Reduction**

Pierce County Water Programs would develop a system for acquiring and managing properties for habitat protection. The program would have the following elements:

- **Standards for Property Acquisition:** Pierce County Water Programs would develop criteria for determining which properties or types of properties will be acquired.
- **Acquisition:** Pierce County Water Programs would pursue acquisition of properties through outright purchase, easements, or other legal mechanisms preferable to the property owner. Tracking streamside and/or wetland parcels as they come on the market, reviewing the current or potential habitat value of the parcels, and negotiating with sellers would be included in this element.
- **Inventory Development:** Pierce County Water Programs would maintain an inventory of desired properties and a method for tracking when they become available. Properties identified through the Basin Planning process would help build the inventory
- **Consultation with Other Stakeholders:** Pierce County Water Programs would develop standards for coordination with other agencies or groups that have a stake in acquisition sites.
- **Management:** Pierce County Water Programs would develop a program to manage properties after acquisition has occurred. The program would address



issues such as access, preventing vandalism and illegal dumping, restoration, maintenance, and liability. Pierce County may consider working with private or non-governmental agencies on managing certain parcels where appropriate.

**Cost Assumption:** Includes 0.5 FTE for one year to develop the inventory, establish the policies and procedures for acquisition and management. Also, 0.25 FTE per year for nine years to pursue purchases and oversee property management issues. Prorated Muck Creek share for County-wide cost (3.4%)

**Cost:** \$9,000

**Application:** County-wide

**Score:** 389

**PG00-05 Develop and Implement Program to Enhance Riparian and Wetland Habitat, Water Quality and Provide Flood Hazard Attenuation**

Pierce County Water Programs would develop and implement projects in riparian and wetland areas that require restoration or enhancement to improve the ecosystem function, where property owners have given permission. Property owners could grant an easement to Pierce County covering all or part of their lands for habitat enhancement purposes or sell the land outright to the County. The primary function of the program would be to manage the restoration sites contained in the Basin Plan. Duties would include identifying potential projects, obtaining access, developing restoration plans, identifying resources to help in the restoration including recruiting volunteers where appropriate or hiring contractors, ordering supplies, and publicizing planting events or completed projects. The County could form partnerships with volunteer groups and other organizations such as the Pierce Conservation District, Pierce Stream Team, Muck Creek Council, the Nisqually Indian Tribe, and Fort Lewis to restore or enhance riparian and estuarine areas.

**Cost Assumption:** Includes 1 FTE to establish and run the program for a 10-year period. Prorated for the Muck Creek share of the County-wide cost (3.4%). The actual site restoration costs are included in the CIP element.

**Cost:** \$34,000

**Application:** County-wide

**Score:** 325

**PG00-06 Develop & Implement an Education, Outreach, & Technical Assistance Program**  
 Pierce County Water Programs would develop a comprehensive education, outreach, and technical assistance program that includes the following elements:

- **Awareness:** Activities under this element include public notification of department activities, availability of data such as updated floodplain and groundwater information and mapping, and Basin Plan-related information as it is developed.
- **Topics:** Topics may address specific pollutants such as pathogens, metals, nutrients; or issues such as flooding, lawn and garden chemicals, native plant landscaping, or small farm management. Generally, increasing public awareness of best management practices that they can implement to reduce water quality, flooding, and habitat impacts in their Basin will be the focus of each educational effort. Emergency information related to flooding needs to be well-coordinated and easily accessible.
- **Target audiences:** Audiences would include Basin residents but may also specifically target specific stakeholders such as floodplain residents, business owners, real estate professionals, or homebuyers. Coordination with other education providers such as schools and non-governmental organizations would be addressed.
- **Methods:** Methods to distribute information may include a variety of techniques such as posting information on the internet, use of libraries and public bulletin boards, speakers, news releases, newsletters, utility bill inserts, targeted mailings, fair booth displays, billboards, Pierce County Speaks segments, and other options. These methods will be utilized based on the information to be distributed and the target audience.
- **Direct Technical/Financial Assistance:** In addition to basic awareness, Pierce County’s education program could include an assistance program to directly aid residents in taking desired actions. This may include supporting volunteer monitoring programs, offering technical and financial assistance to floodplain residents, offering incentives for establishing buffers, and coordinating with other agencies that provide technical support such as the 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:** In order to efficiently communicate Water Programs messages, the education, outreach and technical assistance program will include a coordination element with other agencies, groups and jurisdictions. Coordination efforts will include other education providers but also technical staff.

**Cost Assumption:** Includes 1 FTE to establish and run the program for a 10-year period. Prorated for the Muck Creek share of the County-wide cost (3.4%). The actual site restoration costs are included in the CIP element.

**Cost:** \$111,000  
**Application:** County-wide  
**Score:** 397

**PG00-07 Develop and Implement a Surface Water Management Monitoring Program**

Pierce County Water Programs should implement a monitoring program that would include the following aspects:

- **Water Quantity:** The water quantity element would monitor both base and flood flows on main stem creeks and selected tributaries. Groundwater and pothole flooding would also be tracked. Specific studies or modeling may be performed to accurately identify flood hazard areas. This would include maintaining gauging stations.
- **Water Quality:** Water quality sampling for Basin Plan effectiveness should include temperature, dissolved oxygen, biochemical oxygen demand, solids, nutrients, pH, metals, oils and grease, and bacteria. Pierce County should consider occasional sampling for certain pesticides and herbicides. Specific outfalls may be identified for regular sampling and additional sampling may be done to trace sources of contamination.
- **Biological Health:** Currently, Pierce County is participating in macroinvertebrate sampling which follows the protocols established for the Benthic-Index Biological Integrity (B-IBI). This sampling program would continue unless a more effective protocol or methodology is identified for assessing biological health.
- **Habitat:** Habitat would be assessed by arranging to have all major streams surveyed at least once every five years. The Tri-County Urban Issues assessment methodology would be used to maintain consistency with surveys performed to characterize the original Basin Plans. Pierce County would 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.
- **Waterbodies:** The sampling program will include methodologies for evaluating conditions in streams, wetlands, lakes, and surfacing groundwater.
- **Dissemination/Mapping:** Information collected under this monitoring program would be evaluated and shared with other appropriate agencies. Where feasible, data would be recorded in GIS systems and mapped. Pierce County would have a strategy for posting updated information on the internet.
- **Adaptive Management:** As the monitoring program generates data, that information would be shared and used to assess the effectiveness of current policies, programs, and procedures. Every three to five years, Pierce County would perform an in-depth analysis of available data and publish a report on the overall health of the Basin and on the effectiveness of existing programs.
- **Training:** Competent personnel are needed to generate reliable data. Pierce County would 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.

**Cost Assumption:** Assumes total of 3.75 FTE County-wide plus \$91,000. Lifecycle cost over 10 years then prorated for the Muck Creek share of the County-wide cost (3.4%).

**Cost:** \$158,000  
**Application:** County-wide  
**Score:** 244

**PG00-08      Develop and Implement BMP Manual for Pierce County Surface Water Maintenance Activities**

Pierce County Water Programs would develop a maintenance manual containing Best Management Practices for Pierce County’s stormwater management facilities and would address pond, river, and levee maintenance activities. The maintenance manual would be patterned after the Tri-County transportation facilities approach and would involve practices and techniques to protect water quality and habitat while preserving flood control functions of the facilities. The manual would provide standard operating procedures for work crews. It would also be designed to achieve compliance with Pierce County’s NPDES permit. Distribution of the manual will be accompanied by training sessions on its purpose and use.

**Cost Assumption:** Includes one-time cost for 0.5 FTE plus \$7500 for a consultant contract to develop a BMP manual and an additional .10 FTE annually to support ongoing training sessions and updates. Lifecycle cost over 10 years, prorated for the Muck Creek share of the County-wide cost (3.4%).

**Cost:**                                 **\$7,000**  
**Application:**                   **County-wide**  
**Score:**                               **427**

**PG00-09      Develop and Implement an Invasive Species Management Program**

Pierce County Water Programs would develop a program for addressing invasive species impacts to surface waters and County surface water management facilities. A general inventory of invasive plant problems in Pierce County would be conducted and entered into Pierce County’s GIS database. A Best Management Practices manual would be developed to offer guidance in identifying problematic species, information on their preferred conditions, and options for controlling each problem species. Water Programs will confer with other agencies, including the Noxious Weed Control Board, Washington State Departments of Ecology and Fish and Wildlife and the Washington State University Cooperative Extension programs in developing the guidance document. Upon completion of the guidance document, invasive species training will be provided to drainage system maintenance personnel and invasive species issues will be included in public outreach and education programs. Water Programs will survey their facilities and properties to identify the presence of invasive species and the extent to which they are impacting the facility. This information will be incorporated into division work plans. Implementation of this recommendation could also include organizing and orchestrating volunteer groups and working with other groups and agencies to conduct invasive species control such as hand or mechanical harvesting, native species plantings, and other techniques.

**Cost Assumption:** Includes one-time cost for .5 FTE and \$7500 for a consultant to develop the BMP document, complete the inventory and data layer, and 0.1 FTE annually for ongoing volunteer organization and implementation. Lifecycle cost over 10 years then prorated for the Muck Creek share of the County-wide cost (3.4%).

**Cost:** \$7,000

**Application:** County-wide

**Score:** 420

**Additional Studies Recommendations**

This section identifies additional studies needed to fill priority information gaps in the Muck Creek Basin. Cost estimates for these studies are additive to Plan CIP and programmatic recommendations. These studies were not scored by the prioritization process due to their analytical nature as compared with preventative and corrective CIP’s and programmatic recommendations.

**ST12-01 Evaluate Groundwater Flow in the Graham Area**

Pierce County Water Programs would conduct a study determine whether it is appropriate to revise the Northeast Muck Creek/Clover Creek Basin boundary to more accurately include areas where surface water that is collected and infiltrates into the ground and ultimately arrives in the Clover Creek system. The Basin delineation conducted for the Plan was based strictly on topographic analysis (i.e., surface drainage patterns), and did not include areas outside the topographic boundaries that may contribute subsurface drainage. In addition to providing a basis for determining appropriate basin boundaries, the study would include information to develop alternatives for stormwater management within this particular area. Specifically, the study should (a) confirm groundwater movement in the area; (b) determine and assess impacts of alternative solutions for stormwater management; (c) determine basin boundaries; and (d) contain a public process for local community involvement during the study.

**Cost Assumption:** 0.25 FTE for one year, four new 6” 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 consultant services

**Cost:** \$205,000

**Application:** North Fork

**ST12-02 Identification of Flooded Depression Areas (“Potholes”)**

A common drainage problem in the Muck Creek Basin is flooding which occurs when runoff following intense storms collects and ponds, temporarily, in local topographic depressions which have no surface outlet. The current 5-foot contours in most of the Basin are inadequate for identifying these depressions. Two-foot topographic contours will be generated. Aerial photography will be flown shortly after a major storm event to document stormwater ponding. These photos plus the 2-foot contours will be used to map depressional areas on the County’s GIS system.

This data will assist in addressing existing flooding problems and in siting new development to avoid future problems. At this time this work is recommended for the Graham area only, due to its relatively high potential (relative to the rest of the Basin) for development.

**Cost Assumption:** 0.25 FTE for one year

**2-foot contours for a  
15 square mile area:** \$60,000

**Aerial photography  
following storm event:** \$5,000

**Cost:** \$90,000

**Application:** North Fork and portion of South Fork

**ST12-03 Detailed Flood Study along South Fork upstream of Mountain Highway**

Periodic flooding along the South Fork of Muck Creek has impacted a number of homes located in a half-mile stretch of creek upstream of Mountain Highway. A detailed flood study starting at the SR 7 (Mountain Highway) crossing and extending one mile upstream is recommended so that options to reduce flood damage to these properties can be properly evaluated. For purposes of this study, the existing HEC1 hydrology from the 1991 County *Storm Drainage and Surface Water Management Plan* is adequate. Two-foot cross-sections are needed to define the flood area. A hydraulic model can then be applied to accurately determine flood water levels and to map flood damage. The study could then produce recommendations for flood damage avoidance or minimization.

**Cost Assumption:** 0.5 FTE for one year + \$10,000 for additional survey work.

**Cost:** \$60,000

**Application:** South Fork

**ST12-04 Study of the Basin to Determine Appropriate Wetland Acquisition Sites**

Wetlands are valuable surface water resources. They provide habitat, flood storage and stream flow attenuation, in addition to other functions they serve within an ecosystem. The protection and/or restoration of selected wetlands will benefit the Muck Creek system. This study would identify wetlands for acquisition and restoration purposes.

**Cost Assumption:** 0.1 FTE for two years + \$50,000 for professional

**Cost:** **\$70,000**

**Application:** **Basin-wide**