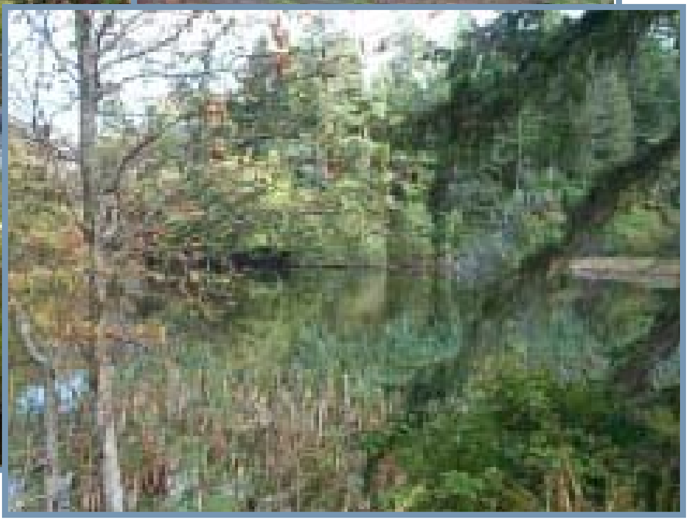
Key Peninsula-Islands Basin Plan
Volume 1 - Basin Plan & SEIS

KEY PENINSULA-ISLANDS BASIN PLAN

Volume 1 - Basin Plan & SEIS

As Adopted PCC 2006-102
December 2006



Pierce County
Public Works & Utilities
Water Programs Division

Sponsored by: Councilmembers Terry Lee and Dick Muri File No. 21-A
Requested by: County Executive/Public Works & Utilities Department

ORDINANCE NO. 2006-102

An Ordinance of the Pierce County Council Amending Chapter 19D.60 of the Pierce County Code, "Storm Drainage and Surface Water Management Plan," and Adopting the "Key Peninsula – Islands Basin Plan" for the Unincorporated Area of Pierce County as an Area Update to the Pierce County Storm Drainage and Surface Water Management Plan.

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

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

Whereas, the 1991 Plan focused on county-wide flood hazard reduction, analyzed the Key Peninsula-Islands basins as rural drainage areas, and recommended a set of capital improvement projects and actions, many of which have been implemented; and

Whereas, the 1991 Plan was adopted as another comprehensive planning document in Pierce County Code 19D.60; and

Whereas, since the 1991 Plan was adopted, the Pierce County Council adopted the Comprehensive Plan for Pierce County Washington in November 1994 pursuant to the State Growth Management Act; and

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

Pierce County Council
930 Tacoma Ave S, Rm 1046
Tacoma, WA 98402

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BARBARA ANN SMOLKO, SENIOR PLANNER, WATER PROGRAMS ✓
BOOK ✓

12-20-06 Stm
DATE/INITIALS

Whereas, since adoption of the 1991 Plan, Pierce County has been issued a National Pollutant Discharge Elimination System (NPDES) stormwater permit under the federal Clean Water Act, which imposes water quality requirements and standards on stormwater discharges; and

Whereas, since adoption of the 1991 Plan Chinook salmon and Bull Trout that exist in Pierce County, waters have been listed as threatened species, and

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

Whereas, the Pierce County Council has received a recommendation for approval of the Key Peninsula-Islands Basin Plan from the Pierce County Storm Drainage and Surface Water Management Advisory Board; and

Whereas, the Pierce County Council has received the Finding of Fact, Staff Report, and recommendation for approval of the Key Peninsula-Islands Basin Plan from the Pierce County Planning Commission; and

Whereas, the Economic Development and Infrastructure Committee of the Council conducted a public hearing on the proposed Key Peninsula-Islands Basin Plan on November 7, 2006; and

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

BE IT ORDAINED by the Council of Pierce County:

Section 1. The Pierce County Council hereby adopts the "Key Peninsula-Islands Basin Plan" dated June 2006 as set out in Exhibit A, which is attached hereto and incorporated herein by this reference.

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

Pierce County Council
930 Tacoma Ave S, Rm 1046
Tacoma, WA 98402

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

PASSED this 12th **day of** December **2006.**

ATTEST:

Patricia L. Face, for

Denise D. Johnson
Clerk of the Council

PIERCE COUNTY COUNCIL
Pierce County, Washington

Shawn Bunney
Council Chair

John W. Ladenburg
Pierce County Executive
Approved ✓ Vetoed ________, this 15 day of Dec, 2006.

Date of Publication of Notice of Public Hearing: November 29, 2006

Effective Date of Ordinance: December 25, 2006

Key Peninsula-Islands Basin Plan

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ACRONYMS AND ABBREVIATIONS

CRS	Community Rating System
CWA	Clean Water Act
DO	Dissolved Oxygen
DOH	Washington State Department of Health
EDT	Ecosystem Diagnosis and Treatment
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FIMW	Fox Island Mutual Water
GMA	Washington State Growth Management Act
HPA	Hydraulic Project Approval
KPI	Key Peninsula-Islands
LFA	Limiting Factors Analysis
LWD	Large Woody Debris
MS4	Municipal Separate Storm Sewer System
NFIP	National Flood Insurance Program
NMFS	National Marine Fisheries Service
NOAA Fisheries	National Marine Fisheries Service (National Oceanic and Atmospheric Administration)
NPDES	National Pollutant Discharge Elimination System
NWI	National Wetland Inventory
PCD	Pierce Conservation District
SASSI	Salmon and Steelhead Stock Inventory
SDWA	Safe Drinking Water Act
SEPA	Washington State Environmental Policy Act
SMA	Washington State Shoreline Management Act
SPSSEG	South Puget Sound Salmon Enhancement Group
SSHIAP	Salmon and Steelhead Habitat Inventory Assessment Program
TMDL	Total Maximum Daily Load
UGA	Urban Growth Area
USBEM	Tri-County Urban Stream Baseline Evaluation Method
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service
WAC	Washington Administrative Code
WADOH	Washington State Department of Health, Office of Shellfish Programs
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area
FAZ	Forecast Area Zone

Executive Summary

ES.1 INTRODUCTION AND PURPOSE

The 2006 Draft Key Peninsula-Islands Basin Plan (KI Basin Plan) is a comprehensive guide to surface water management in the Key Peninsula-Islands 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) guided surface water management throughout the county. The plan addressed flooding concerns, as those were the issues at the time, for all basins in the County. Water quality and wildlife habitat issues were not included as part of the analysis nor in the recommendations for improvements. The 1991 Plan was used as a source of information on pertinent studies, plans, and regulatory mechanisms related to water resources in the KI Basin. The Key Peninsula-Islands Basin is one of 26 Pierce County basins.

The purpose of the Draft Key Peninsula-Islands 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 suite of projects and programs to reduce flood hazards and improve water quality and habitat in the Basin. The KI Basin Plan assumes implementation over a ten-plus year period and will guide annually updated work plans for capital improvement projects and programmatic measures. Programmatic measures are non-structural measures, 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 reducing fish and wildlife habitat degradation that could jeopardize the continued existence of 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. This enables WDFW to approve an entire program allowing Pierce County Water Programs to proceed with implementation of projects without the necessity of acquiring a permit for each individual project.

ES.2 GOALS OF THE DRAFT KEY PENINSULA-ISLANDS BASIN PLAN

Specific goals and objectives of the Draft Key Peninsula-Islands Basin Plan are:

Reduce flood hazards

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

Improve fish and wildlife habitat

- Number of stream miles available for wild, native fish populations is increased.
- Population numbers of species listed as endangered or threatened under the Federal Endangered Species Act (ESA) are maintained or increased.
- Quality and quantity of available wetland, riparian, and upland habitat is improved.

Improve water quality

- State Surface Water Quality Standards (WAC 173-201a) are met or exceeded.
- Potential for impaired (303d listed) water bodies is reduced.
- Pierce County is in compliance with its NPDES permit for stormwater by meeting permit terms and conditions.
- All commercial and recreational shellfish beds meet Department of Health water quality criteria for harvest.
- Risk of groundwater contamination is reduced.
- Rates of erosion are reduced.

Coordinated and responsible use of public resources

- Cost of maintaining stormwater facilities is reduced.
- Project value is favorable when measured against costs and benefits.

- Polls demonstrate that public awareness of flooding, habitat, and water quality issues has increased.
- Monitoring and enforcement programs demonstrate an increase in services per dollar spent.
- Basin plan implementation also implements elements of other Pierce County plans.
- Basin plan development and implementation include soliciting and incorporating input from other departments and agencies.

Influence location and methods for new development

- New development in flood prone, riparian, or significant habitat areas is prohibited.
- Low Impact Development techniques are widely used.
- Effective BMPs are identified and widely used.

ES.3 DESCRIPTION OF BASIN

The Key Peninsula-Islands Basin is an agglomeration of four separate surface water drainage basins identified by Pierce County Water Programs. These are the Key Peninsula Basin (#10), the Islands Basin (#17), the Burley–Minter Basin (#25), and the Fox Island Basin (#26). Combined, these basins have an area of approximately 114 square miles.

The Key Peninsula extends southward into Puget Sound and is bounded on the west by Case Inlet and on the east by Carr Inlet. Islands surrounding the Key Peninsula are also included in the Basin and include: Fox, Raft, Cutts, Ketron, Anderson, and Herron Islands. McNeil Island and a small area of Mason County are not included in this plan. Several drainages located along the Pierce/Kitsap County line form the northern boundary of the KI Basin.

Much of the peninsula consists of rolling, rather flat-topped hills and ridges. Bluffs drop to the waters of Puget Sound on all three sides of the peninsula and on the islands. There are approximately 57 streams in the Basin. The climate of the KI Basin is mild. It receives between 50 and 55 inches of precipitation annually, including approximately 5 inches of snow on average.

In the year 2000, the KI Basin had 20,900 residents. The population is expected to grow to 24,400 by 2020. The KI Basin lies largely within unincorporated Pierce County except for the area at the northern edge that lies within unincorporated Kitsap County.

ES.4 STAKEHOLDER AND PUBLIC INVOLVEMENT

Two public meetings were held in 2003 to describe the Basin planning process and to solicit information at the beginning of Phase 1. Two additional public meetings were held at the end of Phase 1, in 2004, to describe the findings. One of these meetings was with the Anderson Island Homeowner's Association. In addition to these meetings, letters and surveys were sent to approximately 500 streamside property owners. Regular updates on the progress of the plan have been provided at monthly meetings of the Key Peninsula-Gig Harbor-Islands Watershed Council.

Additional stakeholder and public involvement opportunities will be provided when the Draft Key Peninsula-Islands Basin Plan is distributed for public review. The stakeholder mailing list developed in Phase 1 will be used to publish a Notice of Availability, as well as provide notice about public meetings. One public meeting will be held in cooperation with the Key Peninsula-Gig Harbor-Islands Watershed Council and one public meeting will be held separately. Additionally, the plan will be presented at public meetings of the Pierce County Storm Drainage and Surface Water Management Advisory Board (SWAB), the Pierce County Planning Commission, appropriate committees of the Pierce County Council, and to the Pierce County Council as a whole before it is adopted. All of these meetings will provide opportunities for public comment.

ES.5 PROBLEMS, PROPOSED SOLUTIONS AND PRIORITIZATION PROCESS

Four types of interrelated problems were identified in this study:

- Only minor flooding has occurred in the basin in the past. While some roadway culverts do not meet current flood protection standards, flooding is not expected to greatly increase because the basin should remain largely rural.
- Water quality in streams appears to be generally good but with some significant impairments. Bacteriological water quality in most streams does not comply with state standards. Elevated bacterial levels in streams may be contributing to the contamination of shellfish beds that are located near the point of discharge of streams to Puget Sound. Some streams exhibit depressed dissolved oxygen levels which may be harmful to aquatic life.
- Streamside fish habitat and wildlife is in relatively good condition with 44% of instream aquatic habitat and 72% of the riparian corridor receiving "Good" ratings. Access to streams for migratory fish is impaired with 34 culverts identified as full fish passage barriers, blocking upstream passage to instream habitat in the Key Peninsula-Islands Basin. An additional 12 culverts have been identified as potential fish passage barriers, requiring further evaluation.

- Finally, it is apparent that some land use practices, such as agricultural activities and residential landscaping, cause impairment of healthy riparian corridors and aquatic habitat through excessive erosion and fecal coliform contributions to the streams.

Each of the potential capital improvement projects and programmatic recommendations were evaluated for their net natural resource management benefit and then prioritized based on cost-to-benefit considerations.

In determining net benefit, each project and program was scored using an instrument that assigned points for the project/program's potential for various aspects of flood reduction (approximately 35% of total), water quality protection or improvement (approximately 30% of total), natural resource improvement (approximately 30% of total), and other factors such as multiple use, education, and recreation (approximately 5% of total). Each project and program was reviewed and scored using approximately 40 specific criteria.

A scoring worksheet was prepared for each proposed project. These worksheets are included in *Appendices G* and *H* 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[1]: 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

The Key Peninsula Island Basin Plan identifies and recommends capital improvement projects and programmatic actions. These actions are summarized in the projects and programs prioritized for benefit and ranked by cost table. In the table, columns provide project identification numbers, project description, lifecycle (10-year) costs, total benefit priority score, and relative priority (High, Medium, and Low).

[1] Note: "low priority" does not mean "no benefit" for flood control, water quality protection, or natural resource protection. All of the recommendations in the Basin Plan 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.

Actions recommended in the plan total $34,486,000 over a ten year period. Of that amount:

- $19,026,000 is for actions identified as High-Priority;
- $12,777,000 is for actions identified as Medium-Priority;
- $ 2,683,000 is for actions identified as Low-Priority;

Of the total estimated basin plan cost, $26,914,500 is for capital improvement projects and $7,571,500 is for programmatic additions.

Eighty capital improvement projects are recommended in the Basin Plan. These include a variety of culvert replacements for improved fish passage and reduced flood hazards; implementation of bank stabilization measures; improvements to aquatic habitat; improvements to riparian corridors; and stream-side property acquisitions for protection and improvement of riparian corridors and aquatic habitat. Stream-side restoration and land acquisition recommendations far exceed the amount of culvert replacement recommendation.
This reflects the rural nature of the Basin and that the most effective use of limited resources is to focus on preserving existing good water quality and fish and wildlife habitat and preventing future roadway and structure flooding by:

- A total of $9,242,000 are for stream enhancements and wetland restoration, and
- A total of $3,477,500 of the recommendations is for culvert replacements and fish passage projects, and
- A total of $14,195,000 is for land acquisition.

Programmatic measures recommended in the Key Peninsula-Islands Basin Plan include:

- PG-01 Implement Low Impact Development Program
- PG-02 Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit
- PG-03 Develop & Implement a Land Management Program
- PG-04 Develop & Implement Program to Enhance Degraded Riparian Habitat & Water Quality
- PG-05 Develop & Implement an Education, Outreach & Technical Assistance Program
- PG-06 Develop & Implement Surface Water Quality Monitoring Program
- PG-07 Develop & Implement Stormwater Education Program for Shoreline Property Owners
- PG-08 Develop & Implement BMP Manual for Water Programs Maintenance Activities
- PG-09 Provide Technical Assistance to Nonprofit Groups Installing Fish-Friendly Culverts

- PG-10 Develop & Implement Habitat Monitoring Program
- PG-11 Encourage Installation of Permanent Buffer Markings and/or Signage
- PG-12 Establish a Wetlands Banking or Advanced Mitigation Program
- PG-13 Develop & Implement an Invasive Species Management Program
- PG-14 Implement Elements of Shellfish Protection Program

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 *Table S-1*. These factors include the following:

- Available funds;
- Contingent projects[2];
- 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.

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 and flood hazards are removed, and should be sequenced accordingly.

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

[2] 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 staff resources. The implementation strategy will include performance measurements and provide for periodic evaluation of progress.

ES.7.1 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?

Table ES-1:
All Projects in KPI Basin Plan Sorted by Priority and Cost

Row #	Priority	Subbasin	Number/Code	Type	Location/Name	Estimated Cost ($)	Score
1	High	Basin-wide	PG-13	Programmatic	Invasive Species	$ 7,000	285
2	High	Basin-wide	PG-09	Programmatic	Tech Assistance	$ 8,700	294
3	High	Basin-wide	PG-03	Programmatic	Land Management	$ 9,570	407
4	High	Basin-wide	PG-04	Programmatic	Restoration Program	$ 34,500	310
5	High	Basin-wide	PG-12	Programmatic	Wetlands Banking	$ 50,000	414
6	High	Basin-wide	PG-08	Programmatic	BMP Manual	$ 71,000	426
7	High	Basin-wide	PG-01	Programmatic	LID	$ 100,000	351
8	High	Basin-wide	PG-05	Programmatic	Education & Outreach	$ 104,000	388
9	High	Basin-wide	PG-02	Programmatic	Inspections	$ 208,800	403
10	High	Vaughn Creek	VA-AC03	Land Acquisition	Reach VA03	$ 289,256	260
11	High	Rocky Creek	RC-AC06	Land Acquisition	Reach RC06	$ 289,256	265
12	High	Huge Creek	HG-AC03	Land Acquisition	Reach HG03	$ 413,223	265
13	High	Rocky Creek	RC-AC01	Land Acquisition	Reach RC01	$ 590,909	265
14	High	Basin-wide	PG-07	Programmatic	Shoreline Education	$ 600,000	281
15	High	East Fork Rocky	EF-AC04	Land Acquisition	Reach EF04	$ 600,000	265
16	High	Vaughn Creek	VA-AC05	Land Acquisition	Reach VA05	$ 619,835	270
17	High	East Fork Rocky	EF-RST04	Stream Restoration	Reach EF04	$ 630,000	270
18	High	Purdy Creek	PR-CR02	Culvert Replacement	144th	$ 718,272	280
19	High	Huge Creek	HG-AC01	Land Acquisition	Reach HG01	$ 1,006,198	285
20	High	Huge Creek	HG-AC02	Land Acquisition	Reach HG02	$ 1,165,289	280
21	High	Rocky Creek	RC-AC04	Land Acquisition	Reach RC04	$ 1,561,983	275
22	High	Rocky Creek	RC-AC03	Land Acquisition	Reach RC03	$ 1,733,471	260
23	High	Rocky Creek	RC-AC02	Land Acquisition	Reach RC02	$ 2,014,463	260
24	High	Basin-wide	PG-14	Programmatic	Shellfish Protection	$ 6,200,000	368
				Total High Priority Projects		**$ 19,025,726**	
25	Medium	Basin-wide	PG-10	Programmatic	Habitat Monitoring	$ 7,750	194
26	Medium	Basin-wide	PG-11	Programmatic	Buffer Signs	$ 7,750	193
27	Medium	Dutcher Creek	DU-CR06	Culvert Replacement	70th Street	$ 18,672	140
28	Medium	Rocky West	RW-CR01	Culvert Replacement	144th St.	$ 32,951	145
29	Medium	Schoolhouse Ck.	AI-CR03	Culvert Replacement	Oro Bay Road	$ 35,070	240
30	Medium	Minter Creek	MN-RST11	Stream Restoration	Reach MN11	$ 40,000	150
31	Medium	Schoolhouse Ck.	AI-CR02	Culvert Replacement	Eckenstam Johnson Road,	$ 43,837	235
32	Medium	Vaughn Creek	VB-CR02	Culvert Replacement	South Vaughn Rd.	$ 58,482	165
33	Medium	Purdy Creek	PR-RST01	Stream Restoration	Reach PR01	$ 60,000	255

Table ES-1:
All Projects in KPI Basin Plan Sorted by Priority and Cost

Row #	Priority	Subbasin	Number/Code	Type	Location/Name	Estimated Cost ($)	Score
34	Medium	Huge Creek	HG-CR06	Culvert Replacement	160th St.	$ 60,837	160
35	Medium	Purdy Creek	PR-CR07	Culvert Replacement	160th St.	$ 66,198	130
36	Medium	Dutcher Creek	DU-FP01	Fish Passage	Lackey Road	$ 81,000	140
37	Medium	Schoolhouse KPI	SC-RST03	Stream Restoration	Reach SC03	$ 110,000	165
38	Medium	Whiteman Crk.	WH-RST01	Stream Restoration	Reach WH01	$ 119,000	170
39	Medium	Whiteman Creek	WH-CRNS1	Culvert Replacement	Bay Road	$ 125,518	145
40	Medium	Whiteman Creek	WH-CRNS2	Culvert Replacement	Bay Road	$ 125,518	145
41	Medium	Purdy Creek	PR-RST02	Stream Restoration	Reach PR02	$ 128,000	230
42	Medium	Schoolhouse AI	AI-RST04	Stream Restoration	Reach AI04	$ 128,000	130
43	Medium	Purdy Creek	PR-RST05	Stream Restoration	Reach PR05	$ 138,000	185
44	Medium	Minter Creek	MN-RST08	Stream Restoration	Reach MN08	$ 140,600	150
45	Medium	Dutcher Creek	DU-CR04	Culvert Replacement	Lackey Road	$ 142,158	155
46	Medium	Vaughn Creek	VA-CR04	Culvert Replacement	McFadden Rd.	$ 146,163	165
47	Medium	Little Minter	LM-RST08	Stream Restoration	Reach LM08	$ 150,000	150
48	Medium	Purdy Creek	PR-RST07	Stream Restoration	Reach PR07	$ 154,000	185
49	Medium	Amsterdam Bay	AIT-CR01	Culvert Replacement	Sandberg Rd.	$ 154,554	150
50	Medium	Basin-wide	PG-06	Programmatic	WQ Monitoring	$ 162,000	154
51	Medium	Rocky West	RW-RST02	Stream Restoration	Reach RW02	$ 168,000	190
52	Medium	Schoolhouse Ck.	AI-CR08	Culvert Replacement	Eckenstam Johnson Road	$ 190,452	135
53	Medium	Minter Creek	MN-RST05	Stream Restoration	Reach MN05	$ 200,000	170
54	Medium	Home Creek	HM-RST01	Stream Restoration	Reach HM01	$ 200,000	130
55	Medium	Minter Creek	MN-RST07	Stream Restoration	Reach MN07	$ 205,400	190
56	Medium	Vaughn Creek	VA-WTRST04	Wetland Restoration	Reach VA04	$ 230,000	225
57	Medium	Whiteman Crk.	WH-WTRST01	Wetland Restoration	Reach WH01	$ 273,700	220
58	Medium	Schoolhouse AI	AI-WTRST04	Wetland Restoration	Reach AI04	$ 294,400	225
59	Medium	Huge Creek	HG-AC04	Land Acquisition	Reach HG04	$ 363,636	255
60	Medium	Taylor Bay	TB-RST01	Stream Restoration	Reach TB01	$ 420,000	165
61	Medium	Herron Lake	HL-RST01	Stream Restoration	Reach HL01	$ 420,000	135
62	Medium	Purdy Creek	PR-RST06	Stream Restoration	Reach PR06	$ 428,000	180
63	Medium	Vaughn Creek	VA-RST02	Stream Restoration	Reach VA02	$ 440,000	175
64	Medium	Little Minter	LM-RST02	Stream Restoration	Reach LM02	$ 448,000	185
65	Medium	Minter Creek	MN-RST01	Stream Restoration	Reach MN01	$ 480,000	185
66	Medium	Huge Creek	HG-RST01	Stream Restoration	Reach HG01	$ 487,000	225
67	Medium	East Fork Rocky	EF-AC02	Land Acquisition	Reach EF02	$ 516,529	255
68	Medium	East Fork Rocky	EF-AC03	Land Acquisition	Reach EF03	$ 626,033	245

Table ES-1:
All Projects in KPI Basin Plan Sorted by Priority and Cost

Row #	Priority	Subbasin	Number/Code	Type	Location/Name	Estimated Cost ($)	Score
69	Medium	East Fork Rocky	EF-AC01	Land Acquisition	Reach EF01	$ 710,744	255
70	Medium	Little Minter	LM-RST01	Stream Restoration	Reach LM01	$ 744,000	190
71	Medium	Rocky Creek	RC-AC07	Land Acquisition	Reach RC07	$ 826,446	260
72	Medium	Rocky Creek	RC-AC05	Land Acquisition	Reach RC05	$ 867,769	260
73	Medium	Minter Creek	MN-RST09	Stream Restoration	Reach MN9	$ 1,160,000	180
				Total Medium Priority Projects		**$ 13,136,167**	
74	Low	Schoolhouse Ck.	AI-CR09	Culvert Replacement	Logging Rd. N. of 108th	$ 5,000	90
75	Low	Dutcher Creek	DU-CR05	Culvert Replacement	68th Street	$ 5,000	65
76	Low	Knackstedt Creek	HE-CR01	Culvert Replacement	21st Avenue	$ 52,099	120
77	Low	Devil's Head	DHT-CR01	Culvert Replacement	88th Street	$ 54,369	80
78	Low	Schoolhouse KP	SCT-CR02	Culvert Replacement	Mahnke Rd., Filucy Bay	$ 54,822	90
79	Low	Vaughn Creek	VA-RST01	Stream Restoration	Reach VA01	$ 60,000	125
80	Low	Glen Cove	GCT-CR02	Culvert Replacement	Thomas Rd.	$ 69,336	70
81	Low	Glen Cove	GCT-CR01	Culvert Replacement	Thomas Rd.	$ 81,672	70
82	Low	Filucy Bay	FBT-CR02	Culvert Replacement	South of 56th St	$ 82,377	125
83	Low	Purdy Creek	PR-CR04	Culvert Replacement	62nd Avenue	$ 85,108	120
84	Low	Filucy Bay	FBT-CR01	Culvert Replacement	Erickson Rd.	$ 91,692	115
85	Low	Schoolhouse Ck.	SC-CR01	Culvert Replacement	East of KP Hwy, west of	$ 98,825	110
86	Low	Vaughn Creek	VA-RST04	Stream Restoration	Reach VA04	$ 100,000	120
87	Low	Huge Creek	HG-RST05	Stream Restoration	Reach HG05	$ 106,000	95
88	Low	Whiteman Creek	WH-CR02	Culvert Replacement	Whiteman Cove Road	$ 119,188	70
89	Low	Home Creek	HM-RST02	Stream Restoration	Reach UC01	$ 120,000	120
90	Low	Schoolhouse KP	SCT-CR01	Culvert Replacement	Mahnke Rd., Filucy Bay	$ 122,974	95
91	Low	Rocky Creek	RC-CR03	Culvert Replacement	144th St.	$ 143,388	120
92	Low	Herron Lake Creek	HL-FP01	Fish Passage	Mouth of creek	$ 150,000	70
93	Low	Vaughn Creek	VAT-FP02	Fish Passage	Wright-Bliss Rd.	$ 150,000	70
94	Low	Whiteman Creek	WH-CR03	Culvert Replacement	Whiteman Road	$ 154,200	100
95	Low	Huge Creek	HG-RST06	Stream Restoration	Reach HG06	$ 190,000	105
96	Low	Little Minter	LM-RST03	Stream Restoration	Reach LM03	$ 270,000	115
97	Low	Vaughn Creek	VAT-CR01	Culvert Replacement	Hall Rd.	$ 316,755	105
				Total Low Priority Projects		**$ 2,682,805**	
				Total - All Projects		**$ 34,844,698**	

Table ES-2:
Key Peninsula Islands Basin Plan CIPs Grouped by Stream

Priority	Score	Subbasin	CIP name	CIP	Location	Estimated Cost ($)	Reach Subtotal
DEVIL's HEAD							
Low	80	Devil's Head	DHT-CR01	Culvert Replacement	88th Street	$ 54,369	$ 54,369
Stream Average Priority	**80**	**Devil's Head Total**					**$ 54,369**
DUTCHER CREEK							
Medium	140	Dutcher Creek	DU-FP01	Fish Passage Project	West of Lackey Road	$ 81,000	$ 81,000
Medium	155	Dutcher Creek	DU-CR04	Culvert Replacement	Lackey Road	$ 142,158	$ 142,158
Low	65	Dutcher Creek	DU-CR05	Culvert Replacement	68th Street	$ 5,000	$ 5,000
Medium	140	Dutcher Creek	DU-CR06	Culvert Replacement	70th Avenue	$ 18,672	$ 18,672
Stream Average Priority	**125**	**Dutcher Creek Total**					**$ 246,830**
EAST FORK ROCKY CREEK							
Medium	255	East Fork Rocky	EF-AC01	Land Acquisition	Reach EF01	$ 710,744	$ 710,744
Medium	255	East Fork Rocky	EF-AC02	Land Acquisition	Reach EF02	$ 516,529	$ 516,529
Medium	245	East Fork Rocky	EF-AC03	Land Acquisition	Reach EF03	$ 626,033	$ 626,033
High	270	East Fork Rocky	EF-RST04	Stream Restoration	Reach EF04	$ 630,000	
High	265	East Fork Rocky	EF-AC04	Land Acquisition	Reach EF04	$ 600,000	$ 1,230,000
Stream Average Priority	**258**	**East Fork Rocky Total**					**$ 3,083,306**
FILUCY BAY							
Low	115	Filucy Bay	FBT-CR01	Culvert Replacement	Erickson Road	$ 91,692	$ 91,692
Low	125	Filucy Bay	FBT-CR02	Culvert Replacement	South of 56th St.	$ 82,377	$ 82,377
Stream Average Priority	**120**	**Filucy Bay**					**$ 174,069**

Table ES-2:
Key Peninsula Islands Basin Plan CIPs Grouped by Stream

Priority	Score	Subbasin	CIP name	CIP	Location	Estimated Cost ($)	Reach Subtotal
GLEN COVE							
Low	70	Glen Cove	GCT-CR01	Culvert Restoration	Thomas Road	$ 81,672	$ 81,672
Low	70	Glen Cove	GCT-CR02	Culvert Restoration	Thomas Road	$ 69,336	$ 69,336
Stream Average Priority	**70**						**$ 151,008**
HERRON LAKE CREEK							
Medium	135	Herron Lake	HL-RST01	Stream Restoration	Reach HL01	$ 420,000	$ 420,000
Low	70	Herron Lake	HL-FP01	Fish Passage Project	Mouth of Herron Lake Cr.	$ 150,000	$ 150,000
Stream Average Priority	**103**	**Herron Lake Total**					**$ 570,000**
HOME CREEK							
Medium	130	Home Creek	HM-RST01	Stream Restoration	Reach HM01	$ 200,000	$ 200,000
Low	120	Home Creek	HM-RST02	Stream Restoration	Creek #150043	$ 120,000	$ 120,000
Stream Average Priority	**125**	**Home Creek Total**					**$ 320,000**
HUGE CREEK							
High	285	Huge Creek	HG-AC01	Land Acquisition	Reach HG01	$ 1,006,198	
Medium	225	Huge Creek	HG-RST01	Stream Restoration	Reach HG01	$ 487,000	$ 1,493,198
High	280	Huge Creek	HG-AC02	Land Acquisition	Reach HG02	$ 1,165,289	$ 1,165,289
High	265	Huge Creek	HG-AC03	Land Acquisition	Reach HG03	$ 413,223	$ 413,223
Medium	255	Huge Creek	HG-AC04	Land Acquisition	Reach HG04	$ 363,636	$ 363,636
Low	95	Huge Creek	HG-RST05	Stream Restoration	Reach HG05	$ 106,000	$ 106,000
Medium	160	Huge Creek	HG-CR06	Culvert Replacement	160th St.	$ 60,837	
Low	105	Huge Creek	HG-RST06	Stream Restoration	Reach HG06	$ 190,000	$ 250,837
Stream Average Priority	**209**	**Huge Creek Total**					**$ 3,792,183**

Table ES-2:
Key Peninsula Islands Basin Plan CIPs Grouped by Stream

Priority	Score	Subbasin	CIP name	CIP	Location	Estimated Cost ($)	Reach Subtotal
KNACKSTEDT CREEK							
Low	120	Knackstedt Creek	HE-CR01	Culvert Replacement	21St. Avenue	$ 52,099	$ 52,099
Stream Average Priority	**120**	**Knackstedt Creek Total**					**$ 52,099**
LITTLE MINTER CREEK							
Medium	190	Little Minter	LM-RST01	Stream Restoration	Reach LM01	$ 744,000	$ 744,000
Medium	185	Little Minter	LM-RST02	Stream Restoration	Reach LM02	$ 448,000	$ 448,000
Low	115	Little Minter	LM-RST03	Stream Restoration	Reach LM03	$ 270,000	$ 270,000
Medium	150	Little Minter	LM-RST08	Stream Restoration	Reach LM08	$ 150,000	$ 150,000
Stream Average Priority	**160**	**Little Minter Creek Total**					**$ 1,612,000**
MINTER CREEK							
Medium	185	Minter Creek	MN-RST01	Stream Restoration	Reach MN01	$ 480,000	$ 480,000
Medium	170	Minter Creek	MN-RST05	Stream Restoration	Reach MN05	$ 200,000	$ 200,000
Medium	190	Minter Creek	MN-RST07	Stream Restoration	Reach MN07	$ 205,400	$ 205,400
Medium	150	Minter Creek	MN-RST08	Stream Restoration	Reach MN08	$ 140,600	$ 140,600
Medium	180	Minter Creek	MN-RST09	Stream Restoration	Reach MN9	$ 1,160,000	$ 1,160,000
Medium	150	Minter Creek	MN-RST11	Stream Restoration	Reach MN11	$ 40,000	$ 40,000
Stream Average Priority	**171**	**Minter Creek Total**					**$ 2,226,000**

Table ES-2:
Key Peninsula Islands Basin Plan CIPs Grouped by Stream

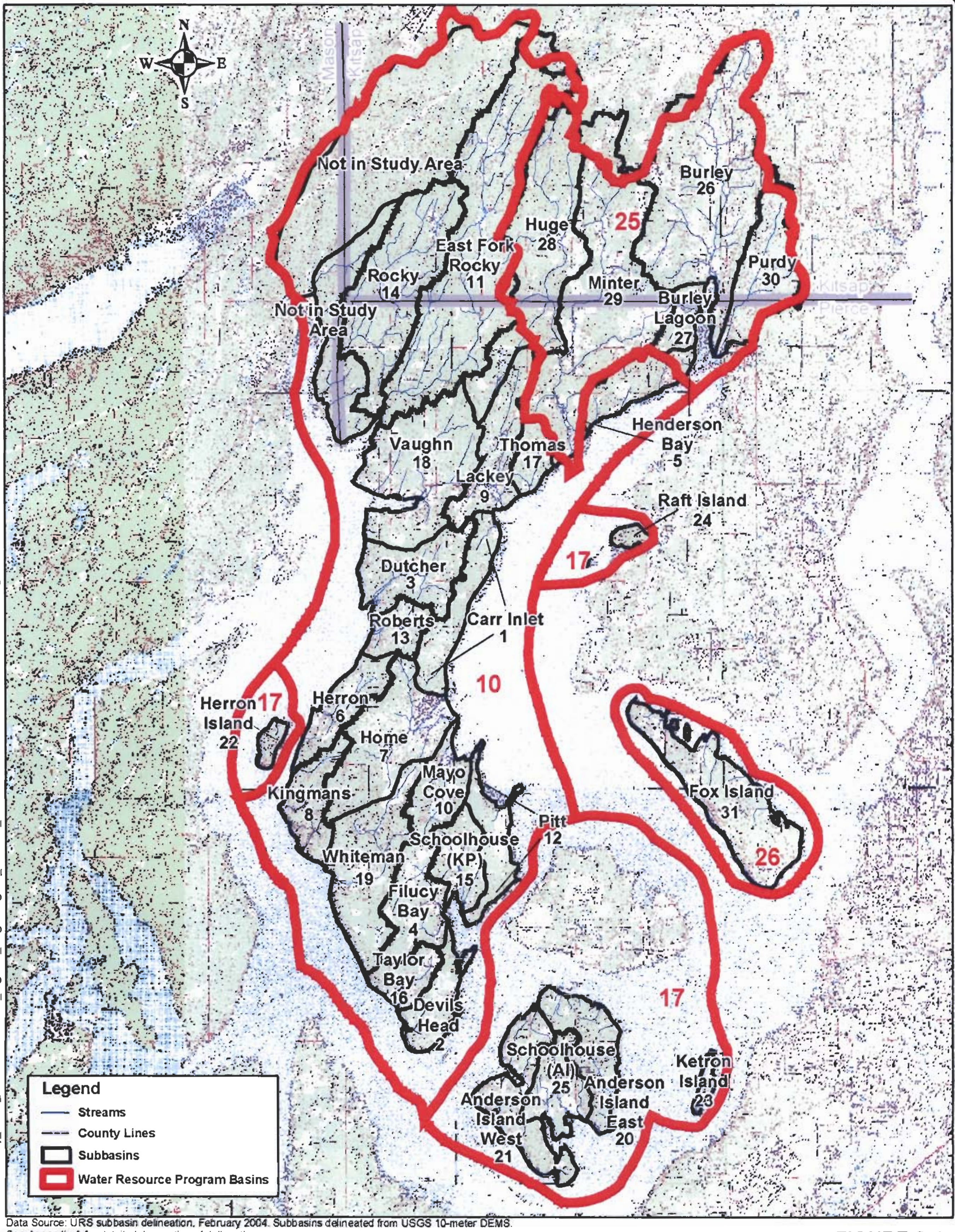
Priority	Score	Subbasin	CIP name	CIP	Location	Estimated Cost ($)	Reach Subtotal
PURDY CREEK							
Medium	255	Purdy Creek	PR-RST01	Stream Restoration	Reach PR01	$ 60,000	$ 60,000
Medium	230	Purdy Creek	PR-RST02	Stream Restoration	Reach PR02	$ 128,000	
High	280	Purdy Creek	PR-CR02	Culvert Replacement	144th	$ 718,272	$ 846,272
Low	120	Purdy Creek	PR-CR04	Culvert Replacement	62nd Avenue	$ 85,108	$ 85,108
Medium	185	Purdy Creek	PR-RST05	Stream Restoration	Reach PR05	$ 138,000	$ 138,000
Medium	180	Purdy Creek	PR-RST06	Stream Restoration	Reach PR06	$ 428,000	$ 428,000
Medium	185	Purdy Creek	PR-RST07	Stream Restoration	Reach PR07	$ 154,000	
Medium	130	Purdy Creek	PR-CR07	Culvert Replacement	160th St.	$ 66,198	$ 220,198
Stream Average Priority	**196**	**Purdy Creek Total**					**$ 1,777,578**
ROCKY CREEK							
High	265	Rocky Creek	RC-AC01	Land Acquisition	Reach RC01	$ 590,909	$ 590,909
High	260	Rocky Creek	RC-AC02	Land Acquisition	Reach RC02	$ 2,014,463	$ 2,014,463
High	260	Rocky Creek	RC-AC03	Land Acquisition	Reach RC03	$ 1,733,471	
Low	120	Rocky Creek	RC-CR03	Culvert Replacement	144th St.	$ 143,388	$ 1,876,859
High	275	Rocky Creek	RC-AC04	Land Acquisition	Reach RC04	$ 1,561,983	$ 1,561,983
Medium	260	Rocky Creek	RC-AC05	Land Acquisition	Reach RC05	$ 867,769	$ 867,769
High	265	Rocky Creek	RC-AC06	Land Acquisition	Reach RC06	$ 289,256	$ 289,256
Medium	260	Rocky Creek	RC-AC07	Land Acquisition	Reach RC07	$ 826,446	$ 826,446
Stream Average Priority	**246**	**Rocky Creek Total**					**$ 8,027,685**
ROCKY WEST CREEK							
Medium	145	Rocky West	RW-CR01	Culvert Replacement	144th St.	$ 32,951	$ 32,951
Medium	190	Rocky West	RW-RST02	Stream Restoration	Reach RW02	$ 168,000	$ 168,000
Stream Average Priority	**168**	**Rocky West Total**					**$ 200,951**

Table ES-2:
Key Peninsula Islands Basin Plan CIPs Grouped by Stream

Priority	Score	Subbasin	CIP name	CIP	Location	Estimated Cost ($)	Reach Subtotal
SCHOOLHOUSE CREEK and AMSTERDAM BAY-ANDERSON ISLAND							
Medium	235	Schoolhouse (AI)	AI-CR02	Culvert Replacement	Eckenstam Johnson Road,	$ 43,837	$ 43,837
Medium	240	Schoolhouse (AI)	AI-CR03	Culvert Replacement	Oro Bay Road	$ 35,070	$ 35,070
Medium	225	Schoolhouse (AI)	AI-WTRST04	Wetland Restoration	Reach AI04	$ 294,400	
Medium	130	Schoolhouse (AI)	AI-RST04	Stream Restoration	Reach AI04	$ 128,000	$ 422,400
Medium	135	Schoolhouse (AI)	AI-CR08	Culvert Replacement	Eckenstam Johnson Road and 108th St.	$ 190,452	$ 190,452
Low	90	Schoolhouse (AI)	AI-CR09	Culvert Replacement	Abandoned logging road north of 108th St.	$ 5,000	$ 5,000
Medium	150	Amsterdam Bay	AIT-CR01	Culvert Replacement	Sandberg Rd.	$ 154,554	$ 154,554
Stream Average Priority	**176**	**Schoolhouse Creek (AI) Total**					**$ 851,313**
SCHOOLHOUSE CREEK-KEY PENINSULA							
Low	110	Schoolhouse (KP)	SC-CR01	Culvert Replacement	East of KP Hwy, west of 148th Ave, on Reeves Rd.	$ 98,825	$ 98,825
Medium	165	Schoolhouse (KP)	SC-RST03	Stream Restoration	Reach SC03	$ 110,000	$ 110,000
Low	95	Schoolhouse (KP)	SCT-CR01	Culvert Replacement	Mahnke Road, Trib. to Filucy Bay	$ 122,974	
Low	90	Schoolhouse (KP)	SCT-CR02	Culvert Replacement	Mahnke Road, Trib. to Filucy Bay	$ 54,822	$ 177,796
Stream Average Priority	**115**	**Schoolhouse (KP) Total**					**$ 386,621**
TAYLOR BAY							
Medium	165	Taylor Bay	TB-RST01	Stream Restoration	Reach TB01	$ 420,000	$ 420,000
Stream Average Priority	**165**	**Taylor Bay Total**					**$ 420,000**

Table ES-2:
Key Peninsula Islands Basin Plan CIPs Grouped by Stream

Priority	Score	Subbasin	CIP name	CIP	Location	Estimated Cost ($)	Reach Subtotal
VAUGHN CREEK							
Low	125	Vaughn Creek	VA-RST01	Stream Restoration	Reach VA01	$ 60,000	$ 60,000
Medium	175	Vaughn Creek	VA-RST02	Stream Restoration	Reach VA02	$ 440,000	$ 440,000
High	260	Vaughn Creek	VA-AC03	Land Acquisition	Reach VA03	$ 289,256	$ 289,256
Medium	165	Vaughhn Creek	VA-CR04	Culvert Replacement	McFadden Rd.	$ 146,163	
Medium	225	Vaughn Creek	VA-WTRST04	Wetland Restoration	Reach VA04	$ 230,000	
Low	120	Vaughn Creek	VA-RST04	Stream Restoration	Reach VA04	$ 100,000	$ 476,163
High	270	Vaughn Creek	VA-AC05	Land Acquisition	Reach VA05	$ 619,835	$ 619,835
Low	105	Vaughn Creek - Tributary to Vaughn Bay	VAT-CR01	Culvert Replacement	Hall Road	$ 316,755	
Low	70	Vaughn Creek - Tributary to Vaughn Bay	VAT-FP02	Fish Passage Project	Wright-Bliss Rd.	$ 150,000	$ 466,755
Medium	165	Vaughn Bay	VB-CR01	Culvert Replacement	South Vaughn Rd.	$ 58,482	$ 58,482
Stream Average Priority	**169**	**Vaughn Creek Total**					**$ 2,410,491**
WHITEMAN CREEK							
Medium	145	Whiteman Creek	WH-CRNS1	Culvert Replacement	Bay Road	$ 125,518	
Medium	145	Whiteman Creek	WH-CRNS2	Culvert Replacement	Bay Road	$ 125,518	$ 251,036
Medium	170	Whiteman Crk.	WH-RST01	Stream Restoration	Reach WH01	$ 119,000	
Medium	220	Whiteman Crk.	WH-WTRST01	Wetland Restoration	Reach WH01	$ 273,700	$ 392,700
Low	70	Whiteman Creek	WH-CR02	Culvert Replacement	Whiteman Cove Road	$ 119,188	$ 119,188
Low	100	Whiteman Creek	WH-CR03	Culvert Replacement	Whiteman Road	$ 154,200	$ 154,200
Stream Average Priority	**142**	**Whiteman Creek Total**					**$ 917,124**
				Total - All Projects		**$ 27,273,627**	



Data Source: URS subbasin delineation, February 2004. Subbasins delineated from USGS 10-meter DEMS.
See Appendix A for detailed description of delineation.

Pierce County Water Programs

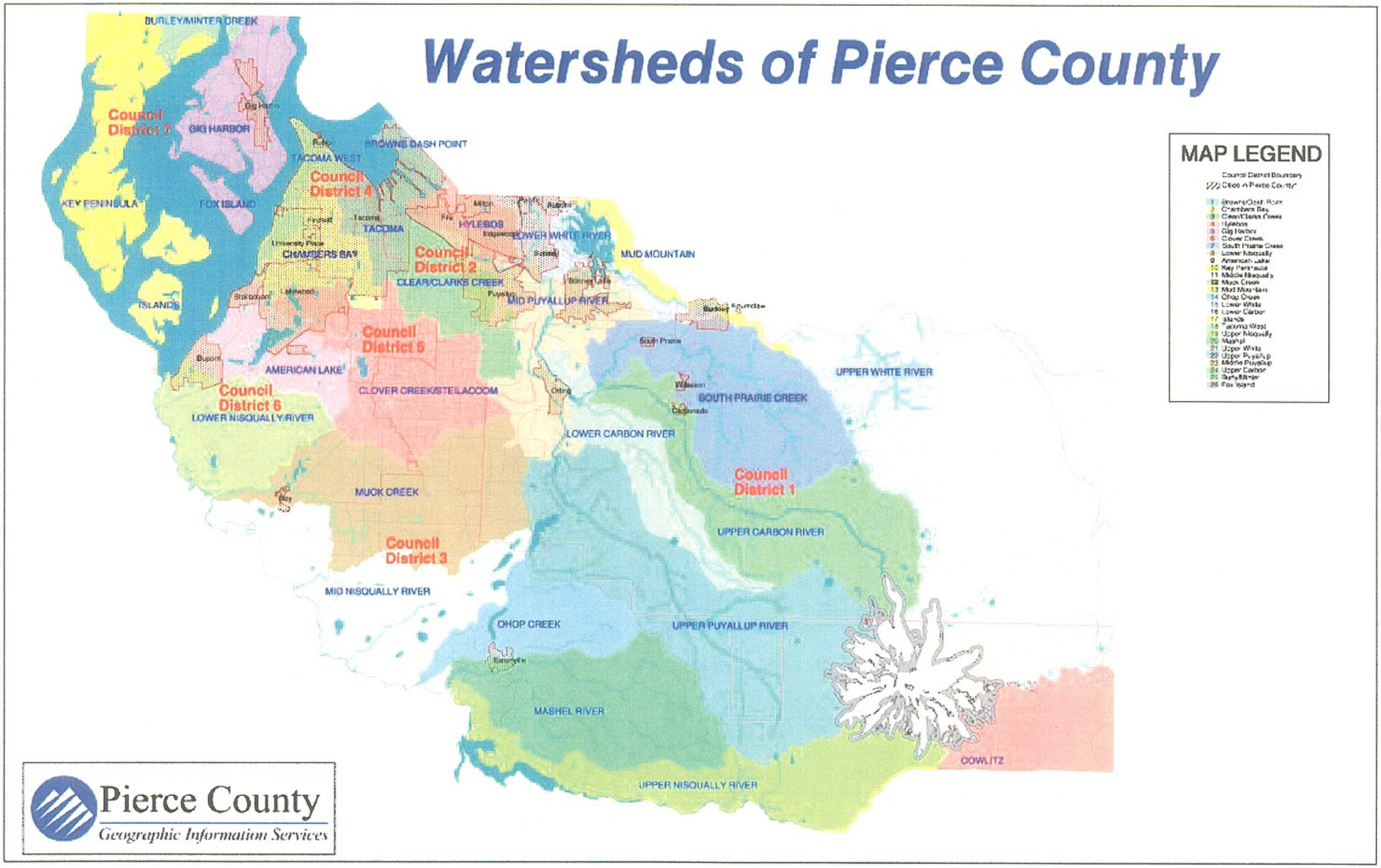
1 inch equals 15,000 feet

0 5,000 10,000 20,000 30,000 Feet

0 1,250 2,500 5,000 7,500 Meters

FIGURE S-1
SUBBASIN INDEX

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON


Watersheds of Pierce County
MAP LEGEND
Council District Boundary
Cities in Pierce County
1 Browns/Dash Point
2 Chambers Bay
3 Clear/Clarks Creek
4 Hylebos
5 Gig Harbor
6 Clover Creek
7 South Prairie Creek
8 Lower Nisqually
9 American Lake
10 Key Peninsula
11 Middle Nisqually
12 Muck Creek
13 Mud Mountain
14 Ohop Creek
15 Lower White
16 Lower Carbon
17 Islands
18 Tacoma West
19 Upper Nisqually
20 Mashel
21 Upper White
22 Upper Puyallup
23 Middle Puyallup
24 Upper Carbon
25 Burley/Minter
26 Fox Island
BURLEY/MINTER CREEK
Council District 7
GIG HARBOR
KEY PENINSULA
FOX ISLAND
ISLANDS
BROWNS DASH POINT
TACOMA WEST
Council District 4
TACOMA
CHAMBERS BAY
HYLEBOS
LOWER WHITE RIVER
MUD MOUNTAIN
Council District 2
CLEAR/CLARKS CREEK
MID PUYALLUP RIVER
Council District 5
AMERICAN LAKE
CLOVER CREEK/STEILACOOM
Council District 6
LOWER NISQUALLY RIVER
UPPER WHITE RIVER
SOUTH PRAIRIE CREEK
LOWER CARBON RIVER
Council District 1
MUCK CREEK
UPPER CARBON RIVER
Council District 3
MID NISQUALLY RIVER
OHOP CREEK
UPPER PUYALLUP RIVER
MASHEL RIVER
COWLITZ
UPPER NISQUALLY RIVER
Pierce County
Geographic Information Services

CHAPTER ONE
Introduction

Pierce County is responsible for surface water management in unincorporated areas of the County. The County builds and maintains surface water management facilities. Property owners are charged a fee for surface water management services. Planning, design, permitting, construction, and maintenance of surface water management facilities is the responsibility of the Water Programs Division of the Pierce County Public Works and Utilities Department (Water Programs).

1.1 THE BASIN PLANNING PROGRAM

The Water Programs Division is preparing ten plans for drainage basins in the County. The purpose of the plans, referred to as basin plans, is to describe the actions needed to reduce flood hazards and protect water quality and wildlife habitat in each of the 26 drainage basins in Pierce County and to optimize the available funds for implementation. Water Programs will use the basin plans to set priorities within each basin and revise or supplement existing storm drainage programs outlined in the *Pierce County Storm Drainage and Surface Water Management Master Plan*, also known as the *Countywide Storm Drainage Plan*, prepared in 1991 (1). The plans also include advisory recommendations that may be useful to other departments or agencies.

The basin plans embody a new approach to surface water management. Historically, conventional stormwater drainage plans have had a single purpose, removal of excess water from city streets and away from properties as rapidly as possible. With this single purpose in mind, stormwater drainage solutions have tended to rely on piped systems and engineered channels that minimize resistance to water flow. But the conventional approach has significant disadvantages. The value of natural water bodies as fish and wildlife habitat and as a public amenity is often lost, as is the water body's ability to remove and break down pollutants. Rapid downstream flow of stormwater decreases opportunities for groundwater recharge that in turn leads to a reduction in stream flow during dry periods. Water Programs seeks to avoid these disadvantages by preparing basin plans that provide practical solutions to surface water problems without sacrificing environmental quality. The specific goals and objectives of the basin plans are described in the following section.

The basin plans also provide opportunities to ensure that actions taken to improve stormwater drainage are in compliance with federal and state laws and regulations. Of particular concern is compliance with two federal laws, the Clean Water Act and the Endangered Species Act. The requirements of both have changed since the earlier *Countywide Storm Drainage Plan* was prepared. In 1995, Pierce County was issued a National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit to discharge stormwater pursuant to the Clean Water Act. To comply with its NPDES MS4 permit the County developed and implemented a stormwater management plan, which protects water quality. The permits are up for renewal. The Washington Department of Ecology has developed a draft permit that is expected to be issued for public comment in October, 2005, and finalized in March, 2006. In 1999, Puget Sound chinook salmon and bull trout were listed as threatened under the terms of the Endangered Species Act (ESA). The ESA prohibits any activities that kill, injure or harass the listed species, or damage or destroy their habitat.

The basin plans further the County’s compliance with its federal Clean Water Act NPDES MS4 stormwater permit. The County’s NPDES MS4 stormwater permit provides for and favors basin planning as a major strategy for water quality compliance. Specific recommendations in the basin plans will result in improved compliance for the County. Also, under the stormwater NPDES MS4 Phase II program that went into effect in March 2003, numerous Pierce County cities are required to address stormwater quality. The basin plans enable coordination with cities within and adjacent to the basin and provides for programs that can leverage both County and cities’ compliance requirements.

In addition, the basin plans further the County’s Endangered Species Act (ESA) compliance by identifying projects and programs intended to eliminate or reduce existing potential habitat issues that could cause “jeopardy” for protected species. The basin plans also provide information and recommendations that could be used for salmonid conservation and recovery planning. The information in the basin plans will support the County’s efforts to utilize the Ecosystem Diagnosis and Treatment (EDT) method to determine the effects of environmental change on salmonid populations and assess the overall effectiveness of County actions on salmonid conservation and recovery.

The basin plans are intended to support Pierce County’s upgrade to a Class 4 or better Community Rating under the Federal Emergency Management Agency’s (FEMA) Community Rating System (CRS). Under that system, communities that conduct effective flood hazard management planning and develop infrastructure associated with that planning are eligible for discounts on flood insurance premiums for local residents. Some of the CRS Class 4 prerequisites are accomplished through the basin plans.

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

Finally, Water Programs will submit the basin plans to the Washington Department of Fish and Wildlife (WDFW) for consideration as a programmatic memorandum of agreement or five-year maintenance approval agreement under RCW 77.55.100 which allows counties, at their request, to complete certain types of work without needing individual permits. In this instance, certain aspects of the basin plans would serve as an agreement with WDFW.

Work on each basin proceeds in three phases. In the first, or basin characterization phase, basic data that are needed for analysis and basin plan development will be acquired in the field or compiled from published and other data sources. A strategy for stakeholder involvement will also be developed. In the second phase, present and potential future flooding and environmental problems will be analyzed, and alternative solutions to the problems will be developed. Alternative solutions will be reviewed with stakeholders, preferred solutions selected, and a recommended basin plan will be prepared for consideration by policy makers. Each basin plan will be implemented and its effectiveness monitored in a third phase of work.

This report documents the results of the first and second phases of planning work for the Key Peninsula-Islands Basin. It is designed to supplement and build on other planning programs in the basin.

1.2 GOALS AND OBJECTIVES

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

1.2.1 Purpose

The purpose of the basin planning program is to create a comprehensive approach to reducing flood hazards, improving fish and wildlife habitat, and improving water quality throughout unincorporated Pierce County by updating the Pierce County Storm Drainage and Surface Water Management Plan.

1.2.2 Goals and Objectives

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

Reduce flood hazards

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

Improve fish and wildlife habitat

- Number of stream miles available for wild, native fish populations is increased.
- Population numbers of species listed as endangered or threatened under the Federal Endangered Species Act (ESA) are maintained or increased.
- Quality and quantity of available wetland, riparian, and upland habitat is improved.

Improve water quality

- State Surface Water Quality Standards (WAC 173-201a) are met or exceeded.
- Potential for impaired (303d listed) waterbodies is reduced.
- Pierce County is in compliance with it's National Pollutant Discharge Elimination System (NPDES) permit for stormwater by meeting permit terms and conditions.
- All commercial and recreational shellfish beds meet Department of Health water quality criteria for harvest.
- Risk of groundwater contamination is reduced.
- Rates of erosion are reduced.

Coordinated and responsible use of public resources

- Costs of maintaining stormwater facilities are reduced.
- Project value is favorable when measured against costs and benefits.
- Polls demonstrate that public awareness of flooding, habitat, and water quality issues has increased.
- Monitoring and enforcement programs demonstrate an increase in services per dollar spent.
- Basin plan implementation also implements elements of other Pierce County plans.
- Basin plan development and implementation include soliciting and incorporating input from other departments and agencies.

Influence location and methods for new development

- New development in flood prone, riparian, or significant habitat areas is prohibited.
- Low Impact Development techniques are widely used.
- Effective BMPs are identified and widely used.

1.3 THE KEY PENINSULA-ISLANDS BASIN PLAN

The Key Peninsula-Islands Basin Plan is a comprehensive guide to surface water management in unincorporated areas of four Pierce County Basins: Key Peninsula (Basin 10), Islands (Basin 17), Burley-Minter (Basin 25), and Fox Island (Basin 26). The plan focuses on multiple aspects of surface water management, including water quality, flooding, and habitat issues. The plan was developed as part of Pierce County's Basin Planning Program, discussed above in Section 1.1.

The purpose of the Key Peninsula-Islands Basin Plan is to ensure that available financial and staff resources are applied to the best capital facility projects and programs for comprehensive surface water management in the basin. To that end, the basin plan strategically identifies and evaluates surface water management issues in the basin and recommends a comprehensive suite of projects and programs to reduce flood hazards, improve water quality, improve fish passage, and improve riparian habitat throughout the Key Peninsula-Islands Basin. This plan complements the actions developed for the *Key Peninsula–Gig Harbor–Islands Watershed Characterization and Action Plan*, the result of a multi-year planning effort to identify projects for implementation by local stakeholder groups.

1.4 REPORT ORGANIZATION

Following this introduction, Chapter 2 provides a description of the regulatory context in which the basin plan was prepared including existing related planning programs. Chapter 3 describes stakeholder involvement in plan preparation. A description of existing physical, biological, and socioeconomic conditions in the Key Peninsula-Islands Basin is contained in Chapter 4. This chapter includes a detailed description of surface streams in the basin and their condition as recorded in the course of field surveys conducted in September and October of 2003.

Chapter 5 describes various problems in the basin including flooding, degradation of water quality and degradation of fish and wildlife habitat. Problems are analyzed and conceptual solutions developed in Chapters 6, 7 and 8. The development of basin plan alternatives is discussed in Chapter 9. Chapter 10 describes the recommended basin plan. Chapter 11 provides the Final Environmental Impact Statement (Final EIS), which analyzes the environmental impacts of the basin plan, as required by the State Environmental Protection Act.

NOTES:

(1) *Pierce County Storm Drainage and Surface Water Management Master Plan*, 1991, Montgomery Engineers

CHAPTER TWO

Related Programs and Regulations

The Pierce County basin plans will be implemented within a framework provided by existing federal, state and local policies, laws, regulations and programs. A brief discussion of the major federal, state and county water management policies and regulations is provided in this section. It is followed by a more detailed description of several plans and programs that affect the Key Peninsula-Islands (KI) area but not the county at large.

2.1 FEDERAL WATER MANAGEMENT POLICIES AND REGULATIONS

There are several major federal regulations that guide the management of water resources. These include the Clean Water Act (CWA), the National Flood Insurance Program (NFIP), the Safe Drinking Water Act (SDWA), and the Endangered Species Act (ESA).

2.1.1 Clean Water Act

The Clean Water Act regulates water quality by setting discharge limits and requiring National Pollutant Discharge Elimination System (NPDES) permits for municipal and industrial wastewater discharges and municipal stormwater discharges in order to meet those limits. The CWA also requires states to establish standards to protect water quality and prepare a list of water bodies that are not meeting those standards. If a water body is out-of-compliance with standards for a particular pollutant the CWA requires that the water body be placed on a 303d list and that a total maximum daily load (TMDL) of the pollutant be calculated. The TMDL is the maximum load of the pollutant that can be imposed on the water body without violating the water quality standard for the pollutant. Finally, placement of fill in waters of the United States (U.S.) is regulated under Section 404 of the CWA while work in navigable waters is regulated under Section 10.

National Pollutant Discharge Elimination System

In 1987, amendments to the federal Clean Water Act (CWA) required the Environmental Protection Agency (EPA) to promulgate regulations for stormwater discharges. EPA defined certain stormwater discharges as point source discharges subject to federal regulations under the National Pollutant Discharge Elimination System (NPDES) Permit Program. Two broad areas were created to address industrial and municipal discharges.

The municipal stormwater system permitting process has occurred in two phases. Phase I applies to municipalities with populations greater than 100,000 people. Phase II requirements, implemented in 2005-06, apply to municipalities with populations of 10,000 people or more and certain urban areas. EPA delegated responsibility for implementation of the NPDES permit program to the Washington State Department of Ecology (Ecology).

Ecology issued the "Phase I" NPDES permit for the South Puget Sound Water Quality Management Area (which includes Pierce County) in July 1995. It was administratively extended in 2000 pending development of a "Phase II" permit. In spring 2005, Ecology published a pre-draft permit for Pierce County.

The NPDES stormwater permit requires that permit holders control pollutants in stormwater to the maximum extent practicable, primarily by implementing a stormwater management program, a functional component of which is the basin plans. Ecology approved Pierce County's Stormwater Management Program in 1998. Required elements include:

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

Section 303(d) List and Total Maximum Daily Loads

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

If a waterbody is not in compliance with standards for a particular pollutant, the CWA requires that a total maximum daily load (TMDL) of the pollutant be calculated. The TMDL is the maximum amount of the pollutant that can be discharged to the waterbody without violating the water quality standard for the pollutant. Limits for all pollutant sources discharging to the water body are adjusted downward until the TMDL can be met.

Section 404 Permits for Discharge of Fill Material to the Waters of the United States

Placement of fill in waters of the United States (U.S.) is regulated under Section 404 of the CWA. For the purposes of Section 404, waters of the United States are defined as wetlands adjacent to streams with flow greater than five (5) cubic feet per second and isolated wetlands greater than one acre that are hydraulically connected to regulated streams.

Storm drainage projects that involve filling or work in small areas of wetlands may be permitted under one of several nationwide general permits. An individual permit, which is subject to a broader level of review must be obtained for projects that that exceed the limits for nationwide permits. (Work in navigable waters (below MHHW) may require Section 10 permits, which are related to the Section 404 permits through the CWA. Activities requiring Section 10 permits include structures (e.g., piers, wharfs, breakwaters, bulkheads, jetties, weirs, transmission lines) and work such as dredging, disposal of dredged material, excavation, filling, or other modifications to the navigable waters of the United States.)

In Pierce County, Section 404 permits are issued and administered by the U.S. Army Corps of Engineers (Corps), Seattle District. The goal of Section 404 is to protect the nation's aquatic environment, which includes wetlands. Projects requiring a Section 404 permit may need to provide compensatory mitigation.

2.1.2 National Flood Insurance Program

In 1968, the U.S. Congress initiated the National Flood Insurance Program (NFIP) (Chapter 44 in the Code of Federal Regulations (CFR) under the National Flood Insurance Act to relieve the burden of disaster relief on the national treasury and state and local tax bases. The NFIP is administered by the Federal Insurance Administration, which is part of the Federal Emergency Management Agency (FEMA). The NFIP makes available affordable flood insurance to communities that adopt approved floodplain management regulations. Federally subsidized flood insurance is available to local residents within identified flood hazard areas. Pierce County participates in the NFIP. To maintain coverage for county residents, the County must remain in the NFIP and maintain minimum floodplain management regulations.

Additionally, communities that do not participate in the NFIP have limited eligibility for federal flood disaster relief. FEMA's Flood Insurance Rate Maps (FIRMs) form the basis for critical area zoning for flood hazards. FEMA requires a certification letter for any revisions to a FIRM. Certification activities include stream channel modifications, installation of culverts, and bridge construction.

Flood hazard management regulations are codified in Title 18E.70 of the County Code and criteria and procedures are laid out in Chapter Nine of the *Pierce County Stormwater Management and Site Development Manual.*

Community Rating System

As an incentive for communities to do more than meet minimum NFIP requirements by taking actions to minimize flood losses and promote public awareness of flood hazards, FEMA created the Community Rating System (CRS). Community participation in the CRS is voluntary. The

CRS offers reduced insurance rates based upon the class rating of a community. The CRS contains ten classes. "Class 1" gives the greatest insurance premium reduction. A "Class 10" community receives no premium reduction. Pierce County was the first county in the nation to earn a "Class 5" rating. Basin plans serve as part of the flood hazard mitigation plan for Pierce County.

2.1.3 Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) of 1974 transferred responsibility for regulation of drinking water to the U.S. Environmental Protection Agency (EPA) and called on that agency to take a number of steps to protect the quality of the nation's drinking water supplies. The EPA has set maximum contaminant levels in drinking water for more than one hundred substances. The SDWA was amended in 1986.

A new provision of the act required every state develop a wellhead protection program. A wellhead protection program is a program that seeks to protect the quality of groundwater bodies that are used for water supply waters so that water arrives at the wellhead uncontaminated. In Washington State, the Department of Health was designated as the lead agency for wellhead protection program development and administration but delegated the responsibility to the counties.

The SDWA also regulates stormwater drywells, referred to as the Underground Injection Control (UIC) program. Drywells, often used for discharging stormwater to the ground in the absence of a drainage system, are required to be registered and to assure that the stormwater runoff is protective of groundwater quality. Washington Department of Ecology, expects to finalize rules for this process in September 2005.

2.1.4 Endangered Species Act

The Endangered Species Act seeks to conserve and recover endangered and threatened species. It directs the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NOAA Fisheries, formerly known as NMFS) to promulgate a list of endangered and threatened species and designate critical habitat for these species. The species listings with the greatest potential to affect surface water management in Pierce County include chinook salmon, which was listed as threatened in March 24, 1999, and bull trout, which was listed as threatened in November 1, 1999. NOAA Fisheries has indicated that additional salmonid species may be listed in the next few years.

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

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

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

Pierce County is implementing early actions to preserve and restore salmonid habitat in coordination with King and Snohomish Counties. NOAA Fisheries has approved a set of transportation maintenance procedures that, if followed, protect transportation maintenance projects from liability under ESA. Other early actions include culvert replacements to improve fish passage, and restoration and acquisition of key habitat.

2.2 STATE WATER MANAGEMENT POLICIES AND REGULATIONS

There are a number of state and local laws and regulations that guide the management of water resources. The most relevant laws and regulations include the State Water Quality Standards, the Growth Management Act (GMA), the State Environmental Policy Act (SEPA), the Shoreline Management Act (SMA), the State Hydraulic Code, the Watershed Management Act, the State Shellfish Management Regulations, and the Nonpoint Rule.

2.2.1 State Water Quality Standards

The State Water Quality Standards are established based on the requirements of the CWA. Washington Administrative Code (WAC) 173-201A and 173-200 affect the discharge of stormwater to surface water and groundwater, respectively, by establishing water quality standards for each of the different classes of water and articulating the federal anti-degradation policy. WAC 173-200 also calls for designation of special groundwater protection areas based on unique characteristics (e.g., aquifer recharge areas, wellhead protection areas, or sole source aquifers).

In July 2003, Washington adopted a new set of water quality standards. The EPA has only partially approved the revised standards. The State uses the 2003 standards for the parts that EPA has approved, and uses the 1997 standards for the parts that EPA has not approved. (See Ecology's website for the (http://www.ecy.wa.gov) for the adoption status.) The updated rules establish standards for temperature to protect temperature-sensitive fish species, such as bull trout and Dolly Varden. A new indicator (enterococci) will be used to measure the amount of bacteria in marine waters that are not used for shellfish harvesting. Also, new values for ammonia in waters without salmon species have been added.

2.2.2 Aquifer and Wellhead Protection

The Safe Drinking Water Act of 1974 (SDWA) transferred responsibility for regulation of drinking water to the EPA and called on the EPA to take a number of steps to protect the quality of the nation's drinking water supplies. EPA has set maximum contaminant levels in drinking water for more than 100 substances. Section 1424(e) of the SDWA established a Sole Source Aquifer Program. EPA was authorized to identify aquifers that are the only or principal source of drinking water for an area. The program also calls for EPA to review all federally funded projects planned for the area. Based on the review, the EPA administrator may withhold federal financial assistance for projects determined to be potential threats to a designated aquifer. In 1986, a new provision of the SDWA (Section 1428) required every state to develop a wellhead protection program to guard the quality of groundwater bodies used for water supply so that water arrives at a well uncontaminated. The Tacoma-Pierce County Health Department administers the wellhead protection program in Pierce County.

2.2.3 Growth Management Act

The Washington State Legislature enacted the Growth Management Act in 1990. The GMA specifies a comprehensive framework for counties and cities/towns to follow in managing growth and coordinating land use development with provision of infrastructure to support development. This framework includes the designation of critical areas, conservation and natural resource lands; adoption of countywide planning policies that provide a general framework for regional planning; adoption of urban growth area (UGA) boundaries and development regulations; adoption of county and city comprehensive plans, including capital facilities elements and implementing regulations.

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

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

The GMA influences the provision of storm drainage and surface water management services and facilities by requiring that: 1) frequently flooded areas (flood hazard areas) be identified and protected; 2) urban facilities be constructed in urban areas only; 3) a level of service standard be established for storm drainage facilities; and 4) capital improvements be identified to meet the adopted level of service given planned land use. In addition, RCW 36.70A.030(5) lists five types of critical areas that must be designated and protected: (1) fish and wildlife habitat conservations areas, (2) wetlands, (3) frequently flooded areas, (4) critical aquifer recharge areas, and (5) geologically hazardous areas.

Fish and wildlife conservation areas and wetlands are protected primarily to preserve and maintain their ecological functions and values. Frequently flooded areas are protected to preserve ecological and hydrological functions of floodplains and to prevent loss of property and human life caused by inappropriate development in floodplains. Critical aquifer recharge areas are protected to maintain the quality of potable underground water supplies. Geologically hazardous areas are protected primarily to prevent loss of property and human life caused by inappropriate development and development in inappropriate areas.

Land use activities, determined by the County Comprehensive Plan and implementing regulations, can influence stormwater management infrastructure needs. The design of new facilities usually takes into account the impacts of zoning on potential future development within an area. Critical areas designations are used to determine the suitability of potential sites for stormwater facilities, such as infiltration ponds (aquifer recharge areas) or natural stormwater detention sites (wetlands and riparian corridors). Information in basin plans can influence land use too. An example would be that a basin plan might identify areas such as potholes where development could be restricted.

Pierce County was required to prepare a comprehensive plan that meets the GMA precepts. The *Comprehensive Plan for Pierce County, Washington* (County Comprehensive Plan) became effective in December 1994. Development regulations to implement the County Comprehensive Plan were adopted in 1995.

The GMA mandates that comprehensive plans be internally consistent (Revised Code of Washington (RCW) 36.70A.070) and that counties perform their activities and make capital budget decisions in conformity with their comprehensive plans (RCW 36.70A.120). Because basin plans recommend capital improvement projects and form the basis of the annual capital budget for the County Storm Drainage and Surface Water Management Utility, basin plan recommendations are required to be consistent with the County Comprehensive Plan. Basin plans are also used to formulate the longer-term (six-year) capital improvement plan, also known as the "Capital Facilities Element" of the County Comprehensive Plan. (The *Supplemental Environmental Impact Statement* in Chapter Ten examines the consistency of this plan's recommendations with the County Comprehensive Plan).

2.2.4 State Environmental Policy Act

The State Environmental Policy Act is intended to ensure that environmental values are considered (in addition to technical and economic considerations) by state and local government officials when making decisions. The SEPA process starts when a public agency proposes to take an official action, such as adopting a master drainage plan or issuing a permit for a project. The SEPA environmental process documents the specific project's purpose and includes a determination of the significance of environmental impacts caused by the proposed project. Mitigation measures and management practices that would be used to reduce adverse environmental impacts are also included in the SEPA process. The documentation is reviewed collaboratively with regulatory and implementing agencies for concurrence.

2.2.5 Shoreline Management Act

The Shoreline Management Act was passed by the Washington Legislature in 1971 and adopted by the public in a 1972 referendum. The intent of the act was to slow the loss of shoreline resources to development and reduce the number of problems associated with the use and misuse of shorelines in Washington State. The Act establishes a broad policy giving preference to uses that protect the quality of water and the natural environment, depend on proximity to the shoreline (water-dependent uses), and preserve and enhance public access or increase recreational opportunities for the public along shorelines.

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

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

2.2.6 State Hydraulic Code

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

The WDFW requires any person, organization, or government agency whose project affects the bed or flow of a surface water to obtain a Hydraulic Project Approval (HPA) Permit. The HPA Permit typically specifies how construction projects are designed, managed, sequenced, and conducted to minimize adverse effects on fish and shellfish.

2.2.7 Watershed Management Act

The Legislature passed the Watershed Management Act (HB 2514) in 1998 to provide a framework for local citizens, interest groups, and government organizations to collaboratively identify and solve water resource-related problems in each of the 62 Water Resource Inventory Areas (WRIAs) in the state. The act enables, but does not require, local groups called planning units to be formed to conduct the planning. The planning unit has considerable flexibility in the planning process, but does not have the authority to change any existing laws or treaties.

The goals of these watershed plans are to assess the status of water resources in the WRIA and to determine how to balance the competing demands for water within the WRIA, including making sure that there is enough water in the streams for fish.

Optionally, watershed plans may recommend management improvements for habitat and water quality and establish or revise required in-stream flows. The planning process includes collection of biological and physical data on the watersheds and creation of organizations to facilitate water resource management within the WRIAs.

2.2.8 State Shellfish Management Regulations

The State Department of Health (DOH), in cooperation with local health departments, regulates and monitors recreational shellfish harvesting and beaches according to the State Shellfish Management Regulations. The DOH also regulates commercial growing, harvesting, processing, packing, storage, transporting, and selling of shellfish for human consumption.

The DOH or the health officer for each local health jurisdiction classifies shellfish beaches based on the risk to public health from consuming shellfish and specified water quality conditions. Beach classification dictates the extent to which beaches are open to shellfish harvesting.

A state law requires the formation of shellfish protection districts. Greater details on the current shellfish programs may be found in the appendices.

2.2.9 Nonpoint Rule

The Nonpoint Rule (WAC 400-12) establishes criteria and procedures for ranking watersheds in Washington State and for developing and implementing action plans for watersheds in need of corrective and/or preventive actions. The purpose of WAC 400-12 is to reduce pollutant loading from nonpoint sources, prevent new sources from being created, enhance water quality, and protect beneficial uses.

The planning process encourages collaborative problem solving among local, state, tribal, and federal interests. It relies on voluntary actions, local ordinances, and state, and federal laws, regulations, and programs for implementation. Each lead entity (usually a county) convenes a committee to review and/or rerank the watersheds wholly or partly within the county boundaries, using criteria specified by the state. Local watershed management committees are then formed to develop action plans for the ranked watersheds. Pierce County has prepared an action plan for the Key Peninsula-Gig Harbor-Islands Watershed (2).

2.3 LOCAL PROGRAMS AND PLANS

2.3.1 Pierce County Public Works and Utilities, Water Programs Division

Pierce County Water Programs is the surface water management utility for unincorporated areas of the County. The County builds and maintains surface water management facilities. Property owners are charged a fee for surface water management services.

Pierce County must not only manage surface waters in a manner that protects lives and property but also must maintain compliance with the federal and state water and wildlife management laws and regulations described above. Local water management plans and regulations include the *Countywide Storm Drainage Plan* (3), the *Pierce County Stormwater Management Plan* (4), ordinances enacted pursuant to the state's Growth Management Act, the Pierce County Endangered Species Act Response Program, and the Gig Harbor Community Plan.

2.3.2 Pierce County Storm Drainage and Surface Water Management Master Plan (1991)

The 1991 Plan is the original capital improvement program (CIP) and program plan for the Pierce County Storm Drainage and Surface Water Management Utility. It documents basin characteristics as of 1991, development of the CIP and refinement of alternatives. The 1991 Plan describes physical attributes of the drainage basins, the drainage systems existing at the time; the hydrologic modeling performed and model results. .

Over the course of the fourteen years since adoption of the 1991 Plan, significant changes have occurred in the regulatory environment, program policies of federal and State funding agencies and Pierce County policy affecting stormwater management. In 1994, Pierce County adopted the County Comprehensive Plan, pursuant to the Growth Management Act. The implementing regulations have resulted in a change in stormwater and resource management standards. Portions of the study area have been annexed or have become incorporated.

In 1995, Pierce County secured a stormwater NPDES permit that requires the implementation of a Stormwater Management Program. These factors coupled with continuing land development and other changes in field conditions, have frequently ruled out projects originally recommended and have required that other alternatives be identified and implemented. *Appendix A* presents the high priority projects recommended in the 1991 Plan for the Key Peninsula-Islands Basins and reports how the recommendations have been implemented. It also provides a list of projects, identified after the 1991 Plan, that have been completed.

2.3.3 Pierce County Critical Areas Ordinance

The state's Growth Management Act requires that communities identify critical natural resources and enact ordinances that protect them. Effective in March, 2005, Pierce County passed ordinances to protect critical habitat. These new regulations limit construction and development to within 65 – 150 feet of critical areas, such as streams and wetlands, depending on the water type classification for fish habitat.

2.4 WATERSHED-BASED PROGRAMS & PLANNING EFFORTS

2.4.1 Key Peninsula-Gig Harbor-Island Watershed Characterization and Action Plan

The Puget Sound Water Quality Protection Act (RCW 90.71) established the Puget Sound Water Quality Action Team to address water quality protection in the Puget Sound Basin. The Action Team established the Nonpoint Rule (WAC 400-12), which establishes criteria and procedures for ranking watersheds in the Puget Sound Basin and for developing and implementing action plans for watersheds in need of corrective and/or preventive actions. The purpose of the rule is to reduce pollutant loading from nonpoint sources, prevent new sources from being created, enhance water quality, and protect beneficial uses.

The planning process encourages collaborative problem solving among local, state, tribal, and federal interests. It relies on voluntary actions, local ordinances, and state and federal laws, regulations, and programs for implementation. Each lead entity (usually a county) convenes a committee to review and/or rerank the watersheds wholly or partly within the county boundaries, using criteria specified by the state. Local watershed management committees are then formed to develop action plans for the ranked watersheds. Pierce County, working with a stakeholder group, has prepared an action plan for the Key Peninsula, Gig Harbor, and Islands watershed.

The *Key Peninsula–Gig Harbor–Islands Watershed Characterization and Action Plan* was adopted by the Pierce County Council in 2002 (2). It was the product of a multi-year planning effort. The stakeholder group that prepared the plan is now engaged in implementation of the action plan. The Key Peninsula-Islands Basin Plan is designed to complement the action plan.

The *Key Peninsula- Gig Harbor-Islands Watershed Characterization and Action Plan* includes a number of education, outreach, and technical assistance programs. Some of the action items proposed in the KGI Plan that are appropriate for implementation by Water Programs include (but are not limited to):

- Encourage riparian buffering by offering landowners technical and financial assistance (AF 7).
- Develop an education program on slope stability, shoreline armoring, and vegetation management for shoreline landowners (SH 3).
- Provide technical assistance to landowners concerning shoreline stewardship/management options (SH 4) [It is also recommended as a part of this Basin Plan that this action item be expanded to include streamside property owners].
- Encourage jurisdictions to incorporate culvert evaluation and replacement projects into annual work plans (SW 1)
- Provide assistance to property owners on reducing stormwater flows and implementing BMP’s (SW 7).
- Preserve vegetation on steep slopes and buffer areas (SW11).
- Assess streams and develop habitat improvement projects (SW 13).
- Establish a pet waste education program (GN 1).
- Create a buffer improvement program (GN 7).
- Encourage use of native plants in public installations (GN 25).

2.4.2 Status Report of the Key Peninsula, Gig Harbor and Island Watersheds Fish Passage Inventory and Assessment Project

The Pierce Conservation District helps private landowners manage land and water in a way that conserves and protects natural resources. On request, the district will prepare conservation plans designed specifically for landowners' properties. Property owners can also apply to the district for financial assistance in support of projects that control erosion or improve fish and wildlife habitat. The district has a number of programs related to fish passage barrier removal and stream enhancement. In December 2000, the district published a draft *Status Report of the Key Peninsula, Gig Harbor, and Island Watersheds Fish Passage Inventory and Assessment Project* (5). This report includes information on fish passage barriers that was used in the development of the Key Peninsula-Islands Basin Plan.

2.4.3 Key Peninsula Community Plan

Pierce County began a community land use planning process for the Key Peninsula in the fall of 2004. Community plans provide a framework for consistent land use standards, a growth management tool to promote cost effective public facility development, and guidance for future land use planning. Planning and Land Services Department has held public forums and conducted community surveys as part of the process to develop the community plan. Public meetings are planned to further the development of the plan over the next few years. Both the data and the recommendations developed for the KI Basin Plan will be shared with the Key Peninsula Community Plan staff and board members.

2.4.4 Anderson and Ketron Islands Community Plan

The *Anderson and Ketron Islands Community Plan* (6) was developed to comply with the 1990 Washington State Growth Management Act and the Comprehensive Plan for Pierce County. The plan area consists of Anderson Island, which is approximately 8.1 square miles, and Ketron Island, which is approximately 0.36 square miles. The population on the islands has nearly doubled since the writing of the plan, when the population within the plan area was approximately 410 full time residents.

In general, the plan is intended to: guide the use of land so that one use does not preclude a more appropriate use; guide public and private development in a common direction to reduce the long range public costs of development; help focus public decision making and budgeting in a common direction; be a practical tool to aid the County in making consistent and objective decisions about proposed public and private activities and developments in an atmosphere of fairness and due process; and make public the policy used for these decisions, thereby increasing accountability to help build confidence in local government and consequently increase its effectiveness.

Information gained during the community planning process, including the data gathering and public input, provided the basis for the Community Plan. From this background information, a series of issues were identified for the plan to address, including growth, character of the community, residential development, environmental issues, transportation, and utilities.

At this time, there are no plans to either update or prepare a new Community Plan for the islands. However, the Pierce County Council did authorize the creation of an Anderson Island Citizens' Advisory Board in 2005. Results and recommendations from the KI Basin Plan will be shared with that organization.

2.4.5 WRIA 15 (Kitsap Water Resource Inventory Area) Watershed Management Plan

The Initiating Governments (Kitsap, King, Pierce and Mason Counties; the City of Bremerton; the Silverdale Water District; the Port Gamble S'Klallam and Suquamish Tribes) agreed to plan under the Watershed Management Act (ESHB 2514; RCW 90.82) for WRIA 15 (Kitsap Water Resource Inventory Area) in 1999. In November 2000, the Initiating Governments expanded to also include the Skokomish and Squaxin Tribes; the Cities of Bainbridge Island, Gig Harbor, Port Orchard and Poulsbo; and water purveyors of Annapolis and North Perry water districts as well as the Public Utility District No.1 of Kitsap County. The Expanded Initiating Governments, as well as the other members of the WRIA 15 Planning Unit, have agreed to incorporate the required element of water quality into the management plan as well as the optional elements of water quality, habitat and in-stream flows. In June 2002, the Kitsap Basin (WRIA 15) Watershed Planning Level 1 Assessment was completed. The planning unit has drafted a Watershed Management Plan for the area and is currently working to achieve concurrence on the plan with the initiating governments.

NOTES:

(1) *Salmon and Steelhead Habitat Limiting Factors Water Resources Inventory Area 15*, November 2000, Washington State Conservation Commission

(2) *Key Peninsula–Gig Harbor–Islands Watershed Characterization and Action Plan*, July 1999, Pierce County Water Programs

(3) *Countywide Storm Drainage Plan*, 1991, Montgomery Engineers

(4) *Pierce County Stormwater Management Plan*, 1998, Pierce County

(5) *Status Report of the Key Peninsula, Gig Harbor, and Islands Watersheds Fish Passage Inventory and Assessment Project*, Pierce Conservation District

(6) *Anderson and Ketron Islands Community Plan*, http://www.co.pierce.wa.us/text/services/home/property/pals/landuse/landuse.htm, Adopted December 10, 1991.

CHAPTER THREE
Stakeholder Involvement

The *Key Peninsula-Islands Basin Plan* had two distinct phases that required input from basin residents, other jurisdictions, non-governmental organizations, and others who have an interest in the area. Phase 1 was a data collection phase and public knowledge was needed to identify potential problem areas and confirm the accuracy of the information collected. Stakeholders were introduced to the basin planning process at the beginning of Phase 1 and then were asked to comment on the data collected at its conclusion. In Phase 2, project staff and consultants recommended solutions to problems identified earlier. Public comment was sought on the actions and policies suggested within the plan. Phase 2 included ranking recommendations by priority and public participation was very helpful in that process.

Formal adoption of a proposed basin plan occurs during Phase 2. Meetings of the Pierce County Storm Drainage and Surface Water Management Advisory Board are open public meetings. Public hearings are conducted by the Pierce County Planning Commission, the Economic Infrastructure and Development Committee of the Pierce County Council, and the Pierce County Council so there are many opportunities for stakeholders to share information, opinions, concerns, or support on the various aspects of a basin plan.

The term “stakeholders” refers to the individuals and organizations with a “stake” or interest in the outcome of the planning process for the Key Peninsula-Islands Basin. Stakeholders include residents, elected officials, tribes, government agencies, non-profit groups, and businesses.

Basin planning occurs in two distinct phases. Phase 1 involves gathering information about the study area. Existing data is collected and evaluated, stream surveys are conducted through extensive field reconnaissance, and needs of the basin are assessed with respect to flooding, water quality and fish and wildlife habitat. Phase 1 additionally includes development of goals for the Basin Plan and identifying a strategy for public input and stakeholder involvement. A characterization report of the KI Basin completes Phase 1 work.

Phase 2 involves developing programmatic and capital improvements to correct existing and potential problems related to flooding, water quality, and fish and wildlife habitat, while meeting state and federal regulations. A hydrologic model was used to assess existing and future flooding potential for the larger watersheds. Stream survey data was used to develop recommendations for fish passage projects, and monitoring data was analyzed and used for recommendations to improve water quality. Completion of Phase 2 results in a complete Basin Plan including the characterization report for Phase 1.

3.1 PHASE 1

Two public meetings were held in July 2003 to describe the basin planning process and solicit information from interested parties. Meeting announcements were mailed to streamside property owners and other individuals on the Pierce County Water Programs mailing list for the Key Peninsula-Islands Basin and also published in “Key Peninsula News”.

The first meeting, which took place on July 8, 2003 at the Key Peninsula Civic Center in Vaughn, was attended by 35 people, most of whom were local property owners and residents of the basin.

The second meeting, hosted by the Key Peninsula-Gig Harbor-Islands Watershed Council, was held on July 15, 2003 at Peninsula Light Business Office in Purdy. The July 15, 2003 meeting was attended by 11 people, most representing government agencies and other organizations. Organizations represented included the City of Gig Harbor, Pierce County, and the Key Peninsula-Gig Harbor-Islands Watershed Council.

At both meetings, attendees were asked to provide any information they might have on past flooding or water quality problems and the use of local streams by salmonids. Questionnaires were distributed to the attendees with a request that they answer the questions and return the forms to the County's project manager.

Stream surveys were conducted as part of the Phase 1 work. Letters were sent to approximately 500 streamside property owners. The letters explained why stream surveys are necessary and provided information on their conduct and schedule. Copies of the questionnaire were included with the letters. Twenty-three completed questionnaires were returned.

Pierce County and URS attended a meeting with the South Puget Sound Salmon Enhancement Group (SPSSEG) on September 8, 2003 at the Minter Creek Fish Hatchery regarding the proposed designs for several culvert replacement projects on Minter Creek.

Pierce County and URS presented information on the Phase 1 basin characterization data at a meeting with the Anderson Island Homeowners' Association on March 3, 2004. The March 2004 meeting was attended by 35 people, most of whom were local property owners and residents of the basin.

Pierce County and URS presented information on the Phase 1 basin characterization data at a meeting with the Key Peninsula-Gig Harbor-Islands Watershed Council on April 20, 2004. The April 2004 meeting was attended by 8 people, most of whom were representing government agencies and other organizations. Organizations represented included the City of Gig Harbor, Pierce County, Sylvia Lake Country Club, Pierce County Surface Water Management Advisory Board, Peninsula Light, and the Key Peninsula-Gig Harbor-Islands Watershed Council.

In addition to meetings, Pierce County and URS contacted and coordinated with the South Puget Sound Salmon Enhancement Group, the Pierce Conservation District, Kitsap County, and the Washington Stated Department of Fish and Wildlife during the data collection phase.

3.2 PHASE 2

Public involvement in Phase 2 included a public meeting to review the results of Phase 1 and to solicit comments on the proposed work plan for Phase 2. A meeting was held on December 14, 2004, at Key Peninsula Civic Center, in Vaughn, following the completion of the final draft of the Phase 1 report. Approximately 39 people attended the meeting to discuss the results of the basin characterization and to discuss basin planning and work for Phase 2 of the basin plan.

Copies of the draft documents were distributed for review and comments, following completion of both Phase 1 and Phase 2. The Draft Basin Plan and Draft SEIS were distributed to Pierce County Water Programs staff, Key Peninsula-Gig Harbor-Islands Watershed Council members, Pierce Conservation District, several Key Peninsula-Islands Basin residents, Pierce County Library System libraries in the study area, and other interested or affected parties for public comment. A complete copy of the Draft Basin Plan was posted on the Water Programs Division website.

After stakeholders had an opportunity to review the Draft Basin Plan, several meetings were held to gather comment.

The KI Basin Plan was reviewed by the Storm Drainage and Surface Water Management Advisory Board and by the Planning Commission prior to referral of the proposed plan to the County Executive and County Council.

CHAPTER FOUR
Existing Conditions

4.1 INTRODUCTION

The Key Peninsula-Islands (KI) Basin is located in Pierce County, Washington and is composed of four basins identified by Pierce County Water Programs. The basins included in the KI Basin are the Key Peninsula Basin (#10), the Islands Basin (#17), the Burley-Minter Basin (#25), and the Fox Island Basin (#26). The basins are shown in *Figure 4-1*. The Key Peninsula extends southward into Puget Sound and is bounded on the west by Case Inlet and on the east by Carr Inlet. The following islands that surround the Key Peninsula are also included in the KI Basin: Fox, Raft, Cutts, Ketron, Anderson, and Herron.

Several drainages located along the Pierce/Kitsap County line form the northern boundary of the KI Basin, which extends approximately seven miles north into Kitsap County. The basin covers an area of approximately 114 square miles. The streams within the KI Basin are listed in *Table 4-1*. There are approximately 57 streams in the basin, but many are small, unnamed streams. The major streams in the area include Rocky, East Fork Rocky (Fork Muck), Minter, Huge, Little Minter, Burley, Purdy, Lackey, Schoolhouse, Vaughn, and Dutcher.

The KI Basin supported approximately 20,900 residents in 2000. The population is expected to grow by approximately 18 percent to 24,400 residents by 2020 (1). The basin lies largely within unincorporated Pierce County, except for the area at the northern edge of the basin that lies within unincorporated Kitsap County.

There are no incorporated cities in the basin, although there are several small rural communities including Key Center, Vaughn, Home, Lakebay, Longbranch, Burley, and Wauna. McNeil Island and a small area of Mason County fall within the basin boundary, but are not included in the basin plan. McNeil Island was not included in this study because of the federal correctional facility on the island and no public access. Basin areas within Mason County are not part of this study since they are very small and are therefore not expected to impact downstream areas, and Pierce County has no authority to either investigate existing conditions nor to construct any improvements.

This chapter describes the general characteristics of the KI Basin, with particular emphasis on factors that influence the health of surface waters. The description of general characteristics is followed by more detailed information on the existing condition of streams and stream corridors.

4.2 PHYSICAL CHARACTERISTICS OF WATERSHED

4.2.1 Climate

The climate of the KI Basin is mild with average winter temperatures above freezing and summer temperatures generally below 80 degrees F. Average monthly maximum and minimum temperatures for two weather stations with long records close to the basin are shown in *Table 4-*

2. The Wauna station is located in the KI Basin, near Minter Creek on the northwest side of Henderson Bay to the west of Burley Lagoon. The Grapeview station is located outside the basin approximately three miles west of Vaughn, on the west side of Case Inlet between Stretch and Reach Islands.

The basin typically receives between 50 and 55 inches of precipitation annually, including approximately five inches of snowfall on average. About 90% of the annual precipitation occurs in the eight-month period between October 1 and May 31. *Table 4-3* shows monthly average precipitation at four nearby weather stations. The Tacoma stations are located about 14 miles to the east of the basin. The Tacoma 1 station is located approximately 200 feet in elevation higher than the Tacoma WB station, resulting in a higher average precipitation at the Tacoma 1 station.

4.2.2 Topography and Landforms

The KI Basin is located on a peninsula extending southward into Puget Sound. Several drainages located along the Pierce/Kitsap County line form the northern boundary of the Basin, which extends approximately seven miles north into Kitsap County.

Much of the land surface of the peninsula lies between two and three hundred feet above sea level and is characterized by a terrain of rolling, rather flat-topped hills and ridges. Bluffs drop to the waters of Puget Sound at most locations on all three sides of the peninsula and on the islands. Slopes in the basin typically range from 0 to 30 percent, with most areas having slopes of 6 to 15 percent. Slopes reach 45 to 70 percent along the bluffs at the edges of the peninsula and the islands.

4.2.3 Geology and Soils

The KI Basin is geologically and topographically similar to other regions in the Puget Sound region, reflecting the influences of volcanic activity, tectonic plate movement, and glacial activity (2). Four major geologic formations underlie the KI Basin area. The uppermost layer is the Vashon Drift, which consists mostly of sand and gravel. The permeable Colvos Sand unit of the Vashon Drift occupies much of the area, although a layer of less permeable Vashon Till often covers it. Below that is the Kitsap Formation, which consists primarily of low permeability clay and silt and typically has a depth of about 100 feet, although in some areas it is entirely absent. Another layer of permeable sand and gravel, the Salmon Springs Drift, lies under the Kitsap Foundation and extends below sea level. The Pre-Salmon Springs Deposits, consisting mostly of unconsolidated materials, extend to bedrock at a depth of about 1,000 feet below sea level. The upper portion of the Pre-Salmon Springs Deposits consists of clay and silt, whereas lower portions consist of sand and gravel.

Surface soils in the KI Basin are moderately to highly productive soils well suited to growing Douglas fir trees and other native vegetation, as well as certain crops such as strawberries, raspberries, and hay. Drainage and erosion characteristics of the soils vary according to composition and slope. The most common soils in the basin are classified as the Harstine Association. The Harstine Association soils are moderately well-drained soils that have formed in glacial till. Surface runoff from Harstine soils is categorized as medium, and the erosion hazard is moderate.

Table 4-1: KI Basin Plan Subbasins and Streams

Basin #	Sub-basin #	Subbasin Name	Stream Name	Surveyed for KI Plan (2003)	Stream Abrv.	Stream # (WRIA)
10	1	Carr Inlet	Unnamed Creek	No	-	None
10	2	Devils Head	Unnamed Creek	Windshield	DH	150035
10	3	Dutcher	Dutcher Creek	Yes	DU	150026
10	3	Dutcher	Unnamed Creek	No	-	150027
10	4	Filucy Bay	Unnamed Creek	Windshield	-	None
10	4	Filucy Bay	Longbranch	No	FB	150036
10	5	Henderson Bay	Unnamed Creek	No	-	150053
10	5	Henderson Bay	Unnamed Creek	No	-	150054
10	6	Herron	Herron Creek (Knackstedt)	Yes	HE	150029
10	7	Home	Unnamed Creek	Windshield	VG	150044
10	7	Home	Home Creek	Windshield	-	150043
10	8	Kingmans	Herron Lake Creek	Yes	HL	150030
10	8	Kingmans	Kingmans Creek	Yes	KG	150031
10	9	Lackey	Lackey Creek	Yes	-	None
10	9	Lackey	Glen Cove	No	LA	150046
10	10	Mayo Cove	Bay Lake Creek	Windshield	BA	150042
10	11	Fork Muck	Unnamed Creek	No	MC	150016
10	11	Fork Muck	Muck Creek (East Fork Rocky)	Yes	-	150008
10	11	Fork Muck	Winter Creek (Snow)	No	-	150018
10	11	Fork Muck	Unnamed Creek	No	-	150019
10	11	Fork Muck	Unnamed Creek	No	-	150020
10	11	Fork Muck	Unnamed Creek	No	-	150017
10	12	Pitt	Unnamed Creek	No	-	150041
10	13	Roberts	Unnamed Creek	No	RB	150028
10	14	Rocky	Rocky Creek	Yes	RC	150015
10	14	Rocky	Rocky West Trib	Yes	RW	150021
10	15	Schoolhouse (KP)	Schoolhouse Creek - KP	Yes	SC	150039
10	16	Taylor Bay	Taylor Bay Creek (Twin)	Yes	TB	150034
10	17	Thomas	Unnamed Creek	No	-	None
10	18	Vaughn	Unnamed Creek	Windshield	22	150022
10	18	Vaughn	Unnamed Creek	Windshield	23	150023
10	18	Vaughn	Vaughn Creek	Yes	VA	150023A
10	19	Whiteman	Whiteman Creek	Yes	WH	150032
17	20	Anderson Is. East	Unnamed Creek	No	-	None
17	21	Anderson Is. West	Unnamed Creek	No	-	150092
17	22	Herron Island	Herron Island	No	HI	None
17	23	Ketron Island	Ketron Island	No	KI	None
17	24	Raft & Cutts Islands	Raft & Cutts Islands	No	RI	None
17	25	Schoolhouse (AI)	Schoolhouse Creek - AI	Yes* (150090)	AI	150089
17	25	Schoolhouse (AI)	Unnamed Creek	Yes	AI	150090
25	26	Burley	Burley Creek	Windshield	BR	150057
25	26	Burley	Bear Creek	Windshield	BU	150056
25	26	Burley	Unnamed Creek	No	-	150058
25	26	Burley	Unnamed Creek	No	-	150059
25	27	Burley Lagoon	Unnamed Creek	No	-	None
25	28	Huge	Huge Creek	Yes	HG	150052
25	29	Minter	Minter Creek	Yes	MN	150048
25	29	Minter	Unnamed Creek	No	-	150049
25	29	Minter	Little Minter Creek	Yes	-	150051
25	30	Purdy	Purdy Creek	Yes	PR	150060
25	30	Purdy	Unnamed Creek	No	-	150061
26	31	Fox Island	Six Unnamed Creeks - Fox Island	Windshield	FI	None

* Local name for Stream 150089 is Schoolhouse Creek. In official Washington State documents, Stream 150090 is referred to as Schoolhouse Creek.

Table 4-2

Average Monthly Maximum and Minimum Temperatures

Month	Station: Wauna (#459021) Average Minimum Temperature (°F)	Wauna (#459021) Average Maximum Temperature (°F)	Grapeview (#453284) Average Minimum Temperature (°F)	Grapeview (#453284) Average Maximum Temperature (°F)
Jan	35.1	47.0	34.5	44.5
Feb	38.3	54.1	36.1	48.7
March	37.5	53.8	37.1	53.2
April	40.2	58.7	39.9	59.1
May	44.0	65.3	44.8	66.4
June	51.4	74.6	49.7	70.9
July	51.3	74.3	52.4	76.0
Aug	54.5	76.6	53.2	75.9
Sept	46.6	71.0	49.5	70.4
Oct	41.8	62.4	44.2	59.8
Nov	37.5	54.3	39.4	50.4
Dec	35.6	50.9	36.1	45.5
Annual	42.8	61.9	43.1	60.1
Period of Record	1948-2003		1948-1995	

Source: Western Regional Climate Center, http://www.wrcc.dri.edu/

Notes:
(1) The Wauna station is located near Minter Creek on the northwest side of Henderson Bay to the west of Burley Lagoon.
(2) The Grapeview station is located outside the basin approximately three miles west of Vaughn, on the west side of Case Inlet between Stretch and Reach Islands.

The most common soil in the basin, Harstine gravelly sandy loam, consists of approximately 5 to 36 inches of gravelly sandy loam underlain by a substratum of up to 60 inches of compact glacial till that is cemented in places. A water table is often perched above the very slowly permeable, weakly cemented and compact substratum during periods of heavy rainfall. Thus, in areas of moderate to high population density in Harstine soils, onsite sewage disposal systems such as septic tanks may fail or not function properly during heavy rainfall periods. Ponding is generally of short duration because water flows laterally above the substratum and seeps at the bottom of slopes. Harstine soil is moderately productive under good management, but the available water capacity is low. The soil is capable of supporting large loads but slopes ranging up to 45 percent in the basin may limit suitability for development in some areas.

Other common soils in the basin include Indianola loamy sand and Kitsap silty loam. Indianola soils have rapid permeability and slow surface runoff, and can support high density housing units and onsite sewage treatment systems. Depending on the slope, the erosion hazard is generally low. Kitsap soils are moderately well drained but permeability can be very slow. Surface runoff is medium and erosion hazard is moderate. Kitsap soil is subject to hillside slippage. Under good management, Kitsap soil is highly productive. The available water capacity in Kitsap soils is high, and due to the high seasonal water table septic drainfields do not function properly during the wet season.

Anderson Island and portions in the south of the Key Peninsula contain Bow silt loam in addition to the Harstine Soils. Bow soils are somewhat poorly drained with slow permeability in the substratum. Surface runoff is medium and erosion hazard is moderate. Community sewerage systems are recommended in Bow soils because septic tank drainfields do not function properly in this wet soil. Soils in the Kitsap-Indianola complex and Xerochrepts Associations with 45 to 70 percent slopes are common along the bluffs at the edges of the peninsula and the islands. These soils are well-drained but runoff is very rapid due to the slope and the erosion hazard is very severe.

Geologic History

The following discussion of the geologic history of the KI Basin is adapted from the November 2000 WRIA 15 *Salmon and Steelhead Habitat Limiting Factors Analysis (3)*. Two hundred million years ago, the land area now occupied by the KI Basin was located at the bottom of a shallow sea. Beginning about 50 million years ago, volcanic activity and the folding of the earth's crust caused the land surface to rise above the sea, ultimately forming the Cascade and Olympic mountain ranges. From two and one-half million years ago until 11,000 years ago, the Puget Sound area was subject to repeated glacial advances and retreats which caused the geologic complexities evident today.

The two most significant geologic structures in the basin are layers of glacial outwash and glacial till. Glacial outwash refers to rocks that are carried forward by a glacier as it advances (advance outwash) and left behind as it recedes (recessional outwash). Glacial outwash typically consists of highly permeable well-graded loose sand and gravel. Glacial till is glacial outwash or other soils that have been subject to compaction and erosive forces by advancing and receding glaciers. Glacial till typically consists of poorly sorted, compacted silty sand and gravel. Layers of glacial till have a low permeability and are sometimes referred to as "hardpan".

Table 4-3

Mean Monthly Precipitation (inches)

Month	Station Wauna (#459021)	 Grapeview (#453284)	 Tacoma 1 (#458278)	 Tacoma WB City (#458286)
Jan	8.24	8.11	5.71	5.46
Feb	6.20	6.44	3.98	4.02
March	5.65	5.37	4.21	3.43
April	3.45	3.53	3.11	2.40
May	2.06	1.93	2.02	1.46
June	1.64	1.54	1.70	1.35
July	0.91	0.89	0.81	0.82
Aug	1.20	1.19	0.82	1.21
Sept	1.95	2.18	1.08	2.02
Oct	4.49	4.79	3.43	3.32
Nov	8.19	8.26	6.69	5.34
Dec	8.51	8.48	5.57	6.09
Total	52.50	52.71	39.13	36.92
Period of Record	1948-2003	1948-1995	1982-2003	1948-1981

Source: Western Regional Climate Center, http://www.wrcc.dri.edu/

Notes:
(1) The Wauna station is located in the KI Basin, near Minter Creek on the northwest side of Henderson Bay to the west of Burley Lagoon.
(2) The Grapeview station is located outside the basin approximately 3 miles west of Vaughn, on the west side of Case Inlet between Stretch and Reach Islands.
(3) The Tacoma stations are located about 14 miles to the east of the basin. The Tacoma 1 station is located approximately 200 feet in elevation higher than the Tacoma WB station, resulting in a higher average precipitation at the Tacoma 1 station.

The Pleistocene Epoch (or Ice Age), which began about 2 million years ago, formed most of the geologic features present in the watershed today. Cordilleran Ice Sheets, which originated in the coast and insular mountains of British Columbia, moved south to the southern end of the Puget Sound basin near Olympia. Up to 3,500 feet of glacial ice covered the Kitsap Peninsula. Geologic units from at least five major and several minor glacial advances have been identified in the Puget Sound basin, although only three are exposed (visible) in the KI Basin area.

Each glacial advance is characterized by a similar set of geologic events. Advancing ice blocked rivers, altering drainage patterns, and forming lakes. Meltwater streams deposited widespread, fine-grained, lacustrine sediments. Glacial till was then deposited directly under the glacier as it overrode the outwash sediments. Local recessional outwash sand and gravel deposits later formed from melt water as the front of the ice sheet receded to the north. Non-glacial intervals between the advances are characterized by fluvial (stream) sediments and peat.

The Fraser Glaciation, which occurred from 15,000 to 13,500 years ago, was the last glacial advance in the central Puget Sound basin. It eroded or covered much of the previous deposits. Deposits from the Fraser Glaciation in the area are characterized by silt and clay overlain by thick advance outwash sand, abundant till cover, and local recessional outwash. Recessional meltwater outwash streams, much larger than present day streams, eroded and formed the larger valleys in the area. Valleys with “underfit” streams and estuaries or drowned river mouths were formed by the greater flow rates of outwash streams and a lower sea level during the Fraser Glaciation.

Following the final retreat of the Fraser Glaciation, erosional and depositional processes sculpted, and continue to shape, the landscape. Bluffs along the Puget Sound are being eroded and re-deposited as beaches and spits. Streams are eroding their banks and then depositing sediments in floodplains, wetlands, and bays. All of these natural processes are modified by planned activities, such as road building, and unplanned events, such as erosion and sediment deposition resulting from increased stormwater flows and stream velocities.

4.2.4 Surface Water Hydrology

The KI Basin is drained by a number of small and moderate-sized streams. The catchments of the streams vary in size from a few acres to approximately 19 square miles. Rocky, Burley, and Minter Creeks and their tributaries drain the largest catchments. The larger streams are perennial. Most of the land close to the edges of the peninsula and the islands drains to small, unnamed, ephemeral streams which discharge directly to Puget Sound.

For the purposes of analysis, the KI Basin was divided into a number of hydrologic subbasins. In most cases, the subbasins that comprise the lands drain to the major streams that flow directly to Puget Sound. Other subbasins were created by delineating lands that drain to the numerous small streams. The subbasins are shown in *Figure 4-1*. The subbasins and streams within the subbasins are listed in *Table 4-1*. The subbasins were numbered according to alphabetical arrangement within each of the four basins that comprise the Basin Plan area. The method used for subbasin delineation is described in *Appendix A.*

The surface water hydrology of the subbasins is greatly influenced by land use. Prior to settlement by Euro-Americans, most of the KI Basin was heavily wooded. Very little precipitation flowed directly to surface streams during storms. Most precipitation evaporated from the wetted surfaces of vegetation or percolated first into the thick layer of vegetable matter on the forest floor and then gradually moved laterally toward surface streams or downward into the underlying soil layers. As the basin was settled, the mature trees were logged, and land was cleared for agriculture, homes, and roads. Dense forest that produced very little runoff was replaced by land uses with less ability to detain water. The volume of surface runoff increased, as did the peak flow rates in surface streams. Conversion of land from agriculture and rural residences to suburban neighborhoods and commercial areas in some areas of the basin accelerated hydrologic changes by introducing larger and larger areas of impermeable roofs, streets, and parking lots. To accommodate the altered watershed hydrology, stream channels grew larger. In many cases, this resulted in destabilization of stream banks and the degradation of fish and wildlife habitat.

Because rural and urban development increases the volume of precipitation that runs off rapidly to surface streams, less water percolates into the ground. The volume of water stored in superficial groundwater bodies is lessened, which reduces the discharge of groundwater to streams during dry summer months. Streams that were perennial in undeveloped condition may become ephemeral after development. Groundwater resources available for extraction and usage as drinking water by basin residents may also become less abundant as infiltration decreases.

Effective Impervious Surface

A useful measure of the condition of a watershed is the total effective impervious surface percentage. The total impervious surface percentage is that proportion of the surface a watershed that is occupied by manmade impervious surfaces such as roofs, roads, and parking lots. When the total impervious percentage is adjusted downward to account for impervious surfaces that are not directly connected to surface streams, for example roofs that drain to infiltration trenches, the result is the effective impervious surface percentage. The effective impervious area of an undeveloped natural watershed would be zero. As a watershed is converted to agriculture, its effective impervious percentage would be expected to increase slightly above zero as roads, farmhouses, and barns are built. The effective impervious percentage of a watershed increases more rapidly when a watershed is converted from agriculture to more intensive residential, commercial, and industrial uses. In highly developed areas such as shopping malls, large industrial operations, and city center areas, the effective impervious percentage is close to 100.

Table 4-4 shows the current and future estimated effective impervious surface percentages for subbasins within the KI Basin. *Figure 4-2* illustrates the assignment of impervious categories within the basin. Currently, estimated at 6 to 16 percent of the total area within each subbasin, future estimates of impervious surface in the KI Basin are expected to range from 7 to 30 percent of the total area within each subbasin. The detailed analyses of current and projected future land use in the KI Basin for the percent impervious calculations are shown in *Tables 4-5* and *4-6*, respectively. The method used to make the estimates of imperviousness is based on *Pierce County's Guidelines for Basin Planning* (4) and is fully described in *Appendix B* of this report.

4.2.5 Wetlands

Another important measure of the condition of a watershed is the size and quality of wetlands in the watershed. The National Wetland Inventory (NWI) map for the KI Basin indicates that wetlands are present in each of the 31 subbasins identified for this study. The NWI map identifies approximately 3,111 acres of wetland area features in the study area. NWI wetland linear features generally follow the stream corridors and were not included in the total acreage. *Table 4-7* shows the acres of estuarine, lacustrine, and palustrine type wetlands identified by the NWI in each subbasin. *Figure 4-3* shows the NWI area and linear wetland features and the Pierce County identified wetland features within the subbasin boundaries.

The majority of area wetland features wetlands identified by the NWI map (58%) are palustrine wetlands. Palustrine systems include all nontidal wetlands dominated by trees, shrubs, persistent emergents, and emergent mosses or lichens, as well as wetlands that occur in tidal areas where salinity concentrations are very low. Because palustrine systems may not exhibit open water areas the public may not recognize their importance in the surface water hydrology of an area. The next largest category of wetlands in the KI Basin (26%) is estuarine wetlands. Estuarine systems consist of deepwater tidal habitats and adjacent tidal wetlands in which ocean water is diluted by freshwater runoff from the land. Estuarine wetlands are usually semi-enclosed by land but have some access to Puget Sound. The NWI map identifies 16% of the wetlands in the KI Basin as lacustrine systems. Lacustrine systems include freshwater wetlands and deepwater habitats (such as lakes) that are: greater than 20 acres in size; situated in a topographic depression or a dammed river channel; and lack trees, shrubs, persistent emergents, and emergent mosses or lichens with greater than 30% aerial coverage.

NWI maps are typically created utilizing aerial photographs, with little to no field work performed to supplement the photographic details. Thus, NWI maps may under-represent the actual wetland areas present within a study area, particularly in areas that are heavily forested. It is likely that the KI Basin contains more wetlands than are identified in the NWI maps. NWI maps also do not provide information regarding the quality of wetlands.

Pierce County categorizes wetlands as a part of the implementation and enforcement of the Critical Areas ordinance (*Title 18E.30.110: Development Regulations, Critical Areas*). Under this ordinance, the category of a wetland will not be changed to recognize illegal modifications to the wetland. There are four categories of wetlands under the Pierce County Critical Areas ordinance:

Category I wetlands are high quality wetlands, high quality rare wetlands, wetlands of exceptional local significance, or documented habitat for endangered species. Category I wetlands include high quality estuarine wetlands, sphagnum bogs and fens, and mature forested swamps.

Category II wetlands are regulated wetlands that do not contain features outlined in Category I but are habitat for sensitive species, rare wetlands not of high quality, wetlands with significant habitat based on size or diversity, wetlands contiguous with salmonid fish-bearing waters, wetlands with significant use by fish or wildlife, or wetlands with significant functions that may not be adequately replicated through creation or restoration. Category II wetlands include significant spring fed systems, peat systems, forested swamps with three canopy layers, wetlands along salmonid fish-bearing streams, and certain open water wetlands.

Table 4-4
Estimated Average Current and Future Impermeable Percentages in Each Subbasin

Basin Subbasin #	**Subbasin**	**Estimated Average Current % Impermeable**	**Estimated Average Future % Impermeable**
Key Peninsula (#10)			
1	Carr Inlet	8%	10%
2	Devils Head	6%	9%
3	Dutcher	8%	10%
4	Filucy Bay	6%	7%
5	Henderson Bay	11%	14%
6	Herron	9%	11%
7	Home	10%	12%
8	Kingmans	8%	11%
9	Lackey	10%	12%
10	Mayo Cove	6%	9%
11	Fork Muck	9%	10%
12	Pitt	7%	10%
13	Roberts	9%	10%
14	Rocky	9%	10%
15	Schoolhouse (KP)	7%	9%
16	Taylor Bay	9%	11%
17	Thomas	7%	9%
18	Vaughn	8%	10%
19	Whiteman	7%	10%
Islands (#17)			
20	Anderson Is. East	11%	18%
21	Anderson Is. West	6%	9%
22	Herron Island	13%	21%
23	Ketron Island	16%	30%
24	Raft Island	13%	15%
25	Schoolhouse (AI)	6%	13%
Burley-Minter (#25)			
26	Burley	10%	11%
27	Burley Lagoon	8%	10%
28	Huge	9%	10%
29	Minter	9%	11%
30	Purdy	9%	10%
Fox Island (#26)			
31	Fox Island	8%	11%

NOTES:

[1] Impervious categories by hydrologic subbasin both presently and in the future are shown in Table 4-4. These data were used to compute the percentages of impervious surface in each subbasin shown in Tables 4-5 and 4-6 using the process described in Appendix B.

Table 4-5: Current Land Use in KI Basin for Percentage Impervious Calculations

Sub-basin #	Basin Subbasin	Total sub-basin area (acres)	Open Space (acres)	Low Density Residential (acres)	Resource Land (acres)	Mobile Home (acres)	Agricultural Land (acres)	Unknown Land Use (acres)	Commercial (acres)	Surface Water (acres)	Quasi-Public (acres)	Roads (acres)	Secondary Schools (acres)	Elementary Schools (acres)	Religious Center (acres)	Industrial (acres)	College (acres)	High Density Residential (acres)	Multi-family Residential (acres)	Group Home (acres)
	Key Peninsula (#10)																			
1	Carr Inlet	1,527.8	518.7	358.0	497.2	134.9				10.9		3.2			4.9					
2	Devils Head	1,107.7	554.7	357.7	123.4	50.3	20.9			0.1		0.6								
3	Dutcher	2,043.6	858.2	539.6	229.4	229.2	125.7			12.0		0.9	48.7							
4	Filucy Bay	1,623.7	690.4	443.0	111.8	136.2	230.6		2.4	2.1	1.9	4.5			0.8					
5	Henderson Bay	1,238.2	337.5	694.9	151.2	36.7	2.9		2.5	2.3		10.1								
6	Herron	1,232.8	372.1	372.0	221.4	209.5	45.6	5.0		0.4		0.7						5.9		
7	Home	2,961.2	1,146.2	715.9	276.4	611.2	180.3		5.8	9.1	3.5	9.1			3.8					
8	Kingmans	1,286.6	680.7	178.0	191.9	185.7		44.3				6.0								
9	Lackey	1,770.3	756.2	652.1	41.0	201.4	55.2	7.6	39.2	1.5	6.5	2.0				5.4			2.3	
10	Mayo Cove	1,043.7	622.8	269.4	45.7	87.5	12.3	1.5		0.9	0.5	2.1		0.0	0.9					
11	Fork Muck	7,790.4	2,159.3	947.6	3,466.9	757.2	26.3	418.6	7.3	0.0	1.3	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
12	Pitt	1,140.5	610.5	270.8	117.6	76.5	60.6	0.5		2.3		1.6								
13	Roberts	816.7	326.0	194.8	163.0	77.9	19.0			8.5		0.4	27.1							
14	Rocky	4,037.0	693.8	408.5	2,512.8	294.3	0.0	126.5	0.0	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	Schoolhouse (KP)	1,164.0	486.7	291.0	130.6	62.5	172.7			20.6		0.0								
16	Taylor Bay	797.2	247.1	194.2	120.5	136.3	94.3			4.5		0.4								
17	Thomas	714.4	295.1	351.3	4.4	63.0						0.5								
18	Vaughn	3,873.8	1,366.6	982.4	832.4	506.9	135.6	9.7	11.8	6.0	2.3	3.4		14.2	1.2					1.4
19	Whiteman	2,975.7	1,485.6	471.3	408.0	334.9	225.1	25.6				3.0		7.2			15.0			
	Islands (#17)																			
20	Anderson Island East	1,558.2	920.2	422.4	83.4	34.6		10.2	1.5	74.2		8.7			2.9					
21	Anderson Island West	1,953.7	1,087.7	537.7	220.6	28.6	27.4	0.4		6.4		5.6		39.2						
22	Herron Island	248.0	89.1	124.0	35.0															
23	Ketron Island	150.5	98.0	22.1				1.3		10.0		19.1								
24	Raft Island	201.8	34.8	158.9	4.8	3.3						0.1								
25	Schoolhouse (AI)	1,227.2	714.9	237.8	201.6	14.4	42.4	1.4	5.3	3.6	1.0	4.1		0.7						
	Burley-Minter (#25)																			
26	Burley	7,000.7	1,931.3	2,945.0	96.1	1,063.5	149.1	639.7	113.1	0.3	18.3	10.4	13.2	0.0	10.7	2.0	0.0	1.5	6.3	0.0
27	Burley Lagoon	627.6	162.5	387.6	0.7	65.0	8.5	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	Huge	4,675.1	1,112.0	1,309.1	976.9	898.5	58.7	319.5	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	Minter	6,632.7	2,474.0	2,148.9	368.3	811.7	469.1	191.4	37.4	0.0	97.5	5.6	0.0	10.0	3.7	15.2	0.0	0.0	0.0	0.0
30	Purdy	2,152.2	640.9	637.0	398.2	348.8	24.5	85.7	3.9	0.0	0.1	0.6	0.0	10.2	0.0	0.0	0.0	2.0	0.1	0.0
	Fox Island (#26)																			
31	Fox Island	3,065.0	1,035.5	1,657.4	206.7	60.0	63.4	21.3	1.3	0.0	3.4	0.9		5.0	9.3			0.8		
	TOTAL	**68,638**	**24,509**	**19,280**	**12,238**	**7,520**	**2,250**	**1,914**	**232**	**176**	**137**	**110**	**89**	**86**	**38**	**23**	**15**	**10**	**9**	**2**

Table 4-6: Projected Future Land Use in KI Basin for Percentage Impervious Calculations

Sub-basin #	Basin Subbasin	Total sub-basin area (acres)	Open Space (acres)	Low Density Residential (acres)	Resource Land (acres)	Mobile Home (acres)	Agricultural Land (acres)	Unknown Land Use (acres)	Commercial (acres)	Surface Water (acres)	Quasi-Public (acres)	Roads (acres)	Secondary Schools (acres)	Elementary Schools (acres)	Religious Center (acres)	Industrial (acres)	College (acres)	High Density Residential (acres)	Multi-family Residential (acres)	Group Home (acres)
	Key Peninsula (#10)																			
1	Carr Inlet	1,528	64.1	812.6	497.2	134.9				10.9		3.2			4.9					
2	Devils Head	1,108	157.3	755.1	123.4	50.3	20.9			0.1		0.6								
3	Dutcher	2,044	109.8	1283.2	229.4	229.2	125.7			12.0		0.9	48.7			4.8				
4	Filucy Bay	1,624	10.8	1122.6	111.8	136.2	230.6		2.4	2.1	1.9	4.5			0.8					
5	Henderson Bay	1,238	70.0	941.7	151.2	36.7	2.9		23.2	2.3		10.1								
6	Herron	1,233	18.9	718.4	221.4	209.5	45.6	5.0		0.4		0.7				6.9		5.9		
7	Home	2,961	45.4	1816.7	276.4	611.2	180.3		5.8	9.1	3.5	9.1			3.8					
8	Kingmans	1,287	203.3	655.4	191.9	185.7		44.3				6.0								
9	Lackey	1,770	153.8	1246.4	41.0	201.4	55.2	7.6	47.2	1.5	6.5	2.0				5.4			2.3	
10	Mayo Cove	1,044	109.2	783.1	45.7	87.5	12.3	1.5		0.9	0.5	2.1			0.9					
11	Fork Muck	7,790	782.2	2029.0	3762.5	757.2	26.3	418.6	7.3		1.3	5.4								0.5
12	Pitt	1,140	75.3	806.1	117.6	76.5	60.6	0.5		2.3		1.6								
13	Roberts	817	68.8	452.0	163.0	77.9	19.0			8.5		0.4	27.1							
14	Rocky	4,037	16.4	914.4	2684.3	294.3	0.0	126.5		0.6	0.6									
15	Schoolhouse (KP)	1,164	13.8	742.5	130.6	62.5	172.7			20.6						21.3				
16	Taylor Bay	797	26.8	414.5	120.5	136.3	94.3			4.5		0.4								
17	Thomas	714	0.5	645.9	4.4	63.0						0.5								
18	Vaughn	3,874	48.5	2297.5	832.4	506.9	135.6	9.7	14.9	6.0	2.3	3.4		14.2	1.2					1.4
19	Whiteman	2,976	184.1	1772.7	408.0	334.9	225.1	25.6				3.0		7.2			15.0			
	Islands (#17)																			
20	Anderson Island East	1,558	56.8	1285.8	83.4	34.6		10.2	1.5	74.2		8.7			2.9					
21	Anderson Island West	1,954	190.5	1435.0	220.6	28.6	27.4	0.4		6.4		5.6		39.2						
22	Herron Island	248	8.6	204.5	35.0															
23	Ketron Island	151	4.5	115.4				1.3	0.1	10.0		19.1								
24	Raft Island	201.8		193.6	4.8	3.3						0.1								
25	Schoolhouse (AI)	1,227	178.9	770.3	201.6	14.4	42.4	1.4	8.9	3.6	1.0	4.1		0.7						
	Burley-Minter (#25)																			
26	Burley	7,001	0.7	4656.7	96.1	1063.5	149.1	639.7	115.5	0.3	234.9	10.4	13.2		10.7	2.0		1.5	6.3	
27	Burley Lagoon	628	13.2	536.5	0.7	65.0	8.5	3.4	0.5											
28	Huge	4,675	89.6	2312.2	986.8	898.5	58.7	319.5	9.4			0.5								
29	Minter	6,633	417.9	4181.2	368.3	811.7	469.1	191.4	61.2		97.5	5.6		10.0	3.7	15.2				
30	Purdy	2,152	131.1	1146.3	398.2	348.8	24.5	85.7	4.4		0.1	0.6		10.2				2.0	0.1	
	Fox Island (#26)																			
31	Fox Island	3,065	61.4	2631.5	206.7	60.0	63.4	21.3	1.3		3.4	0.9		5.0	9.3			0.8		
	TOTAL	**68,638**	**3,312**	**39,679**	**12,715**	**7,520**	**2,250**	**1,914**	**304**	**176**	**353**	**110**	**89**	**86**	**38**	**56**	**15**	**10**	**9**	**2**

Table 4-7
KPI Plan - Acreages of Wetlands by NWI Classification

Sub-basin #	Subbasin Name	NWI Estuarine Areas* (Acres)	NWI Lacustrine Areas** (Acres)	NWI Palustrine Areas*** (Acres)	Total NWI Areas (Acres)	Subbasin Area (Acres)	Wetlands Percentage of Subbasin
1	Carr Inlet	12	-	1	13	1,564	1%
2	Devil's Head	15	-	9	24	1,151	2%
3	Dutcher	25	-	44	69	2,100	3%
4	Filucy Bay	18	-	98	116	1,676	7%
5	Henderson Bay	1	-	-	1	1,306	0%
6	Herron	7	-	31	37	1,301	3%
7	Home	151	-	125	277	3,177	9%
8	Kingmans	5	-	19	23	1,307	2%
9	Lackey	53	-	26	79	1,856	4%
10	Mayo Cove	68	129	13	209	1,276	16%
11	Fork Muck	6	68	311	385	7,894	5%
12	Pitt	28	-	18	46	1,199	4%
13	Roberts	8	-	3	11	836	1%
14	Rocky	1	57	68	126	4,123	3%
15	Schoolhouse (KP)	43	-	19	62	1,199	5%
16	Taylor Bay	53	-	20	73	848	9%
17	Thomas	4	-	15	19	734	3%
18	Vaughn	14	22	72	108	4,009	3%
19	Whiteman	46	27	141	215	3,104	7%
20	Anderson Island East	11	158	21	190	1,720	11%
21	Anderson Island West	21	-	22	43	2,035	2%
22	Herron Island	4	-	2	6	267	2%
23	Ketron Island	13	-	-	13	221	6%
24	Raft & Cutts Islands	27	-	-	27	202	13%
25	Schoolhouse (AI)	37	-	46	82	1,342	6%
26	Burley	17	-	303	321	7,048	5%
27	Burley Lagoon	0	-	6	6	638	1%
28	Huge	-	-	116	116	4,709	2%
29	Minter	78	36	242	356	6,785	5%
30	Purdy	1	-	15	16	2,211	1%
31	Fox Island	30	-	12	42	3,222	1%
	TOTAL	**794**	**498**	**1,819**	**3,111**	**71,063**	**4%**

Note: NWI linear features are not included in the calculated areas.

*Estuarine systems consist of deepwater tidal habitats and adjacent tidal wetlands that are usually semienclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land (Cowardin, 1979).

**Lacustrine systems include wetlands and deepwater habitats with the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% aerial coverage; and (3) total area exceeds 8 ha (20 acres) (Cowardin, 1979).

***Palustrine systems include all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 o/oo (Cowardin, 1979).

Category III wetlands are regulated wetlands that do not contain features outlined in Category I, II, or IV. Category IV wetlands are hydrologically isolated regulated wetlands less than or equal to one acre in size which do not meet the criteria of a Category I or II wetland, contain only one wetland class, and have only one dominant plant species (monotypic vegetation).

4.2.6 Lakes

The KI Basin contains 28 lakes, ranging in size from 130 acres to less than 1 acre. According to the KGI Watershed Characterization and Action Plan (5), the majority of lakes are less than ten acres in size and most are shallow (<30 feet in depth). Nearly all of the lakes are used for recreational fishing, boating, and/or swimming. Some of the lakes are known to support cold water fish such as rainbow and cutthroat trout and some contain warm water species such as largemouth bass and bluegill. However, fish use of most of the lakes is unknown.

Other than size and use information, relatively little water quality or biological information exists for most of the lakes. The few lakes that have been studied were studied primarily due to problems with water quality or excessive plant growth. Invasive aquatic plants such as Eurasian milfoil have been identified as significant problems in several lakes.

Lake-shore residential development is occurring around a number of the lakes within the KI Basin and pressure for continued development within lake watersheds is likely to continue in the future. Unless carefully managed, development often results in additional surface runoff and nutrient loading. Excessive nutrient and sediment loading can lead to unacceptable algae blooms and emergent plant growth and can accelerate eutrophication. Detrimental effects on lake water quality can influence water quality and biotic conditions in outlet streams as well. Appropriate planning decisions for development around lakes requires an understanding of the sensitivity of these systems to additional nutrient and sediment loading.

Lake Minterwood, a man-made lake created by damming up an upstream tributary to Vaughn Creek, is located along Minterwood Drive, west of the Key Peninsula Highway. The outlet to the lake, which at one time drained southeast, to Vaughn Creek has been blocked and an overflow pipe constructed to drain east into Lackey Creek. The subbasin delineations on *Figure 4-1* have been redrawn to indicate that Lake Minterwood, and its watershed, are part of the Lackey Creek subbasin.

4.2.7 Surface Water Quality

The discussion of surface water quality contained in this section is a generalized overview of water quality conditions and issues of concern in the basin. Water quality characteristics observed in the field for individual streams and bays are described in sections 4.6 though 4.9, and a more detailed summary of sampling efforts and an assessment of sources and solutions is included in *chapters 5* and *7*.

There is limited historical data available on surface water quality in streams in the KI Basin prior to the 1990s. Data collected since the 1990s indicates that there are water quality problems in some of the streams in the KI Basin that need to be addressed. The results of various monitoring efforts indicate that levels of fecal coliform bacteria in streams and bays frequently exceed state water quality standards. Other water quality parameters of concern in certain streams include dissolved oxygen and turbidity. A full description of the water quality standards for surface waters in the state of Washington according to *WAC 173-201A* is included in *Chapter 5*.

Section 303(d) of the federal *Clean Water Act* (CWA) requires Washington State to periodically prepare a list of all surface waters in the state for which beneficial uses of the water (such as for drinking, recreation, aquatic habitat, and industrial use) are impaired by pollutants. These are water quality limited estuaries, lakes, and streams that fall short of state surface water quality standards, and are not expected to improve within the next two years.

The 303(d) status of streams in the KI Basin is shown as *Table 4-8*. As of 2005, there are four streams in the KI Basin that are listed on the 303(d) list as water quality limited for various parameters. The listed streams are: Burley, Huge, Little Minter, and Minter Creeks. Additional unnamed streams in the basin may also be water quality limited but it is not possible to distinguish unnamed streams on the list.

The Pierce Stream Team and Pierce County have coordinated the collection of surface water quality data by volunteers in the KI Basin since 1994. The results of the volunteer water quality monitoring for the basin are presented in *Table C-1* in *Appendix C*. The volunteer monitoring efforts are generally limited to water quality parameters that can be tested onsite, such as water temperature, dissolved oxygen (DO), pH, nitrate, and turbidity.

The Pierce Stream Team monitoring results for Rocky, Schoolhouse (KI), Minter, and Purdy Creeks do not show any consistent water quality problems at the monitoring sites for the parameters measured, with the exception of low DO readings seen several times in the East Fork of Rocky Creek (likely due to very low streamflow and stagnant water conditions).

As a part of the KI Basin Plan work, water quality sampling was also conducted on major streams in the basin on October 16, 2003, November 11, 2003, and October 20, 2004. The results of this monitoring are discussed later in *Chapter 5* and presented in *Table 5-2*.

Gauges have been installed on Minter, Rocky, and Vaughn Creeks that record stream temperature every 15 minutes. These gauges have been in operation since November 2003 (Minter and Vaughn) and February 2004 (Rocky), and comparison of these gauge results with the water quality standards are reported in *Chapter 5*.

Surface water quality is also being monitored by the Washington State Department of Health, Office of Shellfish Programs (WADOH) in estuaries and bays where shellfish are harvested commercially or recreationally. The primary pollutant of concern that is monitored at these locations is fecal coliform bacteria.

Concentrations of fecal coliform bacteria indicate the possible presence of pathogens and disease-causing organisms in the water due to contamination from agricultural runoff, livestock waste, sewage outfall sites, improperly functioning or failed sewage/septic tanks, stormwater runoff, boat waste, and/or wildlife.

The presence of pathogens and disease-causing organisms that are associated with fecal coliform bacteria in surface water pose a public health risk for harvested shellfish as well as for other forms of human contact with the water such as swimming. There are a number of commercial shellfish growing areas in the Basin including Burley Lagoon, Minter Bay, Filucy Bay, Rocky Bay, and Oro Bay.

Table 4-8

Water Quality Classification of Reaches in the KPI Basin (WRIA 15), Including Current TMDL and 303(d) Status

Subbasin	Stream	Stream Number	Category	Parameter	Number of Listings
Rocky	Rocky Creek	150015	2	Dissolved oxygen	1
Burley	Bear Creek	150057	2	Dissolved Oxygen	1
Burley	Bear Creek	150057	4B	Fecal Coliform	2
Burley*	Burley Creek	150056	5	Dissolved oxygen	1
Burley	Burley Creek	150056	4B	Fecal Coliform	3
Burley	Burley Creek	150056	2	Fecal Coliform	2
Burley	Burley Creek	150056	2	pH	1
Huge*	Huge Creek	150052	5	Dissolved oxygen	1
Huge	Huge Creek	150052	2	Fecal Coliform	1
Minter*	Little Minter Creek	150051	5	Fecal Coliform	2
Minter*	Minter Creek	150048	5	Dissolved oxygen	1
Minter*	Minter Creek	150048	5	Fecal Coliform	6
Purdy	Purdy Creek	150060	4B	Fecal Coliform	2
Purdy	Purdy Creek	150060	2	Dissolved oxygen	1

Notes:

1) A * indicates stream is 303(d) listed for specified parameter.
2) Category 2 indicates a water of concern for the specified parameter, and the stream will become 303(d) listed shortly.
3) Category 4B indicates a pollution control plan has been established for the stream and the parameter, but is not 303(d) listed.

The following commercial shellfish harvesting locations are monitored regularly for fecal coliform bacteria: Burley Lagoon, Drayton Passage, Dutcher Cove, Filucy Bay, Minter Bay, Oro Bay (Anderson Island), and Rocky Bay. The following recreational shellfish harvesting locations are also monitored for fecal coliform bacteria: Taylor Bay, South Oro Bay, Vaughn Bay, and Purdy Beach. Monitoring has occurred at some of these sites since the 1980's and repeated violations of water quality standards have been recorded at many of the sites, resulting in periodic or long-term shellfish bed downgrades or closures. Approximately 21 public beaches occur within the Key Peninsula, Islands, and Gig Harbor Peninsula region. Four of these beaches are closed to harvesting or are under a harvest advisory as of 2004. The remainders of the beaches are under no specific closures due to pollution. The status of commercial and recreational shellfish harvesting areas as of 2002 is summarized in *Table 4-9*.

4.2.8 Groundwater Hydrology

Precipitation that percolates into the ground enters a shallow unconfined aquifer within the permeable Vashon Drift Formation. Some of the water in the shallow aquifer continues to move downward into the Salmon Springs Drift through openings in the impermeable Kitsap Foundation. Some is discharged via springs and seeps to Puget Sound, either directly or via surface streams. Most of the water used for domestic purposes in the KI Basin is obtained from wells that penetrate the intermediate aquifer in the Salmon Springs Drift to a depth of 150 to 250 feet below the land surface. The intermediate aquifer is partially confined below the relatively impermeable Kitsap Formation and is thus better protected from contamination than the shallow aquifer.

4.2.9 Groundwater Quality

As water passes through the surface soils and percolates downward into the deeper aquifers it undergoes chemical changes as a result of natural processes and human influences. Groundwater in the shallow water aquifer has a low total dissolved solids content. Groundwater in the deeper aquifers exhibits higher total dissolved solids concentrations and higher concentrations of iron and manganese than shallow groundwater because it has been in contact with soils and rocks for longer periods of time. Shallow groundwater typically contains higher concentrations of nitrates than deeper groundwater because it is more influenced by human activities including the use of septic tanks for wastewater disposal, use of fertilizers, and domestic animal husbandry.

Groundwater quality for the Key Islands Peninsula is discussed in a *Draft Report on Kitsap Watershed Water Quality Technical Assessment* (7). The assessment focused on evaluating nitrates and chlorides to determine contamination levels and saline intrusion. General findings of the report indicate very good water quality overall in the public water system. Regulatory standards for water quality were only exceeded in two parameters, color and manganese. Both of these parameters are an aesthetic issue rather than a health concern.

Table 4-9

Status of Shellfish Harvesting Areas

Commercial Harvesting Water Body	Pollution Trend	Current Status	Comments
Burley Lagoon	Varies from southern to middle portion of lagoon.	South lagoon Approved (2001), middle lagoon Restricted (2004)	Southern end of lagoon shows improving water quality. Middle portion of lagoon shows deteriorating water quality.
Drayton Passage	Declining	Approved (1995)	Sample locations show increasing FC pollution.
Dutcher Cove	Stable	Approved (1997)	Sample locations have remained stable over the sampling period.
Filucy Bay	Declining	Conditionally Approved (1994) except for northern end - Restricted (2001), and Long-branch Marina – Closed (1994)	North end of bay and marina show poor water quality.
Minter Bay	Declining	Prohibited (1982)	Showing no water quality improvements since 1982.
Oro Bay:	Declining	Closed at marina, remainder is under review	Brief sampling period has shown some decline in water quality.
Rocky Bay	Stable	Approved (2002)	Rocky Bay has been classified as Approved since 2002.
Recreational Harvesting Water Body	**Pollution Trend**	**Current Status**	**Comments**
Taylor Bay	Information Unavailable	Closed	Beach is within area of sewage treatment plant outfall and is unsafe for recreational shellfish harvesting.
South Oro Bay	Information Unavailable	Closed	This beach lies within a marina closure zone.
Vaughn Bay, DNR Beach 18	Information Unavailable	Closed	Water quality for this beach does not meet Washington State standards for recreational shellfish harvesting.
Purdy Beach	Information Unavailable	Harvest Advisory	Shellfish harvesting should be avoided from the western reaches of the beach. This section of beach lies within a prohibited area for shellfish harvesting.
Other beaches in the KI Basin	Information Unavailable	Open	No specific closures due to pollution.

Residents of the Key Peninsula Islands obtain drinking water from private and community wells. Residents of the Islands, including Fox, Anderson, Raft, and Herron, obtain drinking water from mutual water associations. The Fox Island Mutual Water (FIMW) Association has grown from a 300-connection system in 1978 to a 946-connection system in 1998. The total well supply for FIMW is 975 gallons per minute and water storage is 735,000 gallons. All of FIMW water comes from underground aquifers. FIMW regularly draws water from nine wells. There are somewhat elevated levels of iron and manganese in the well water and this raw water is either blended with other sources to reduce the iron and manganese concentrations or treated for removal. FIMW has never had *E.Coli* or fecal coliform detected in their system.

There is a potential for serious groundwater quality problems in the basin as a result of seawater intrusion. Seawater intrusion can occur when wells that draw upon groundwater aquifers are pumped at a rate that exceeds the local recharge capacity. The resulting reduction in hydraulic pressure in the freshwater aquifers causes seawater to migrate landward. In severe cases, the salinity of water drawn from wells may increase to the point at which it is unusable for domestic or irrigation purposes.

Although there have not been any significant cases of seawater intrusion reported in the KI Basin, minor cases have been reported in the Taylor Bay area of the KI Basin. More significant cases have been reported in other coastal communities in the Puget Sound region. The *Draft Report on Kitsap Watershed Water Quality Technical Assessment* (7) indicates elevated chloride levels, an indication of saline intrusion, in wells within ½ to ¼ mile of seawater. The Washington State Department of Health monitors groundwater resources for seawater intrusion in locations where it is of concern.

4.3 BIOLOGICAL CHARACTERISTICS OF WATERSHED

4.3.1 Flora

Before the arrival of Euro-Americans, the KI Basin was primarily occupied by conifer forest dominated by western hemlock, western red cedar, and Douglas fir. Virtually all of the old growth forest in the basin was logged in the nineteenth and twentieth centuries. Now the basin is occupied by unvegetated surfaces and a mosaic of vegetation types including conifer forests of varying age, pasture, shrub-scrub, and non-native plantings around suburban and rural homes.

The remaining forest is dominated by stands of less-than one-hundred-year-old Douglas firs, which, if left undisturbed, will be gradually replaced by western hemlock and western red cedar. Hardwoods are common on recently disturbed sites and in riparian areas. They include red alder, bigleaf maple, and willows. Common shrub species include Douglas maple, vine maple, Indian plum, gooseberry, huckleberry, devil's club, and salmonberry. Salal, sword fern, deer fern, and Oregon grape are common low growing plant species.

4.3.2 Fauna

Mammals and birds

Most of the original fauna remains, although generally reduced in abundance except for those species that can tolerate or benefit from close association with humans and habitat fragmentation. Typical mammals are black bear, blacktail deer, coyote, raccoon, red fox, longtail weasel, deer mouse, and shrews. Common birds of the forest canopy include several species of flycatchers and wood warblers, black-capped and chestnut-backed chickadees, and red-breasted nuthatches. Song sparrows, fox sparrows, spotted towhees, American robins, and Swainson's thrushes are found in the shrub layer. House sparrows, house finches, European starlings, Brewer's blackbirds, and crows are found in open urban and suburban areas.

Salmonids

The Washington Conservation Commission recently assembled information on the presence of salmonid species in the streams of the KI Basin as part of an assessment of salmonid habitat in Water Resources Inventory Area (WRIA) 15. Salmonid distribution in streams in the KI Basin is summarized in *Table 4-10*. Partial and full fish passage barriers have been identified on many of the streams in the KI Basin. These barriers are described in the individual stream descriptions in *Section 4.6* through *4.9*, and are illustrated in *Figure 4-4*.

The Washington Department of Fish and Wildlife (WDFW) currently operates 91 fish hatcheries, of which 69 are dedicated to producing salmon and/or steelhead while the other 22 rear trout and other gamefish exclusively. There are two WDFW hatcheries in the KI Basin. The Minter Springs Hatchery is located on Minter Creek near its mouth and is a production facility that releases fall Chinook, coho, and chum.

The Minter Springs facility annually releases 1.8 million first year spring Chinook, 1.44 million first year coho, and 2.0 million first year chum per year. The Hupp Springs Hatchery, also located on Minter Creek, is a recovery facility releasing White River Spring Chinook stock at its location and on the White River. The Hupp Springs facility releases annually releases 250,000 first year and 90,000 yearlings (Popochok 2004(6)).

In addition to these two WDFW hatcheries in the KI Basin, a landowner on Herron Lake Creek is operating a remote site incubator, hatching eggs provided by the Minter Creek Hatchery. WDFW has permitted four years of chum plants and six years of coho plants (both beginning with the 2002 brood year) for Herron Lake Creek. Fifty thousand (50,000) eyed chum eggs and 25,000 eyed coho eggs are transferred each year from the hatchery. A goal of 50,000 chum and 25,000 coho released into Case Inlet each year has been set for this project (11).

Table 4-10: Salmonid Species Distribution in Key Peninsula-Islands Basin Streams

Creek	Sub-basin #	Salmonid Species Distribution	Comments
Dutcher	3	Coho[1], cutthroat[2]	Chum potential to road, but unknown presence; presumed cutthroat distribution to at least extent of other known salmonoids.
Herron Lake	8		Salmonid distribution unknown.
Huge	28	Coho[1], steelhead[1], cutthroat[1]	Coho distribution to headwaters; steelhead distribution to Pine Road; cutthroat distribution to headwaters.
Kingmans	8	Chum[1], coho[1]	
Knackstedt	6	Chum[1], coho[1], cutthroat[2]	Chum distribution to culvert, but steep gradient upstream; coho distribution to wetland in headwaters; presumed cutthroat distribution to at least etent of other known salmonoids.
Lackey	9	Chum[1], coho[1], cutthroat[2]	Coho distribution to Highway 302; presumed cutthroat distribution to at least extent of other known salmonoids.
Little Minter	29	Chinook[1], coho[1], steelhead[1], cutthroat[2]	Coho distribution to headwaters; steelhead distribution to headwaters; presumed cutthroat distribution to at least extent of other known salmonids.
Minter	29	Chinook[1], chum[1], coho[1], steelhead[1], cutthroat[1]	Coho distribution to Pine Road; steelhead distribution to Pine Road; cutthroat distribution to Pine Road.
East Fork Rocky	11	Chinook[1], chum[2], coho[1], steelhead[1], cutthroat[1]	Presumed presence of chum to 144th, potential to extend higher into watershed; distribution of coho to headwaters; distribution of steelhead to Wright-Bliss Road, likely to move farther upstream since bridge replaced; distribution of cutthroat to the headwaters.
Purdy	30	Chinook[2], chum[2], coho[1], steelhead[1], cutthroat[1]	Presumed Chinook distribution to Highway 3.

Table 4-10: Salmonid Species Distribution in Key Peninsula-Islands Basin Streams

Creek	Sub-basin #	Salmonid Species Distribution	Comments
Rocky	14	Chinook[1], chum[1], coho[1], steelhead[1], cutthroat[1]	
Rocky West Trib	14	Coho[1], cutthroat[2]	Presumed cutthroat distribution to at least extent of other known salmonoids.
Schoolhouse (Anderson Island)	25	Chum[1], coho[1], cutthroat[1]	Chum distribution to Powerline Road; coho distribution to Powerline Road; cutthroat distribution extending ~300 meters upstream of the uppermost Eckenstem/Johnson Road crossing.
Schoolhouse (Key Peninsula)	15	Chum[1], coho[1], cutthroat[1]	
Taylor Bay Creek	16	Coho[1], cutthroat[2]	Presumed cutthroat distribution to at least extent of other known salmonoids.
Vaughn	18	Chum[1], coho[1], cutthroat[2]	Distribution of chum to forks; distribution of coho to forks; presumed distribution of cutthroat to at least extent of other known salmonid.
Whiteman	19		Salmonid fish passage barrier at mouth.

[1] Known distribution in which observations have been made

[2] Presumed distribution in which little assessment work has been completed to verify the extent of distribution

4.4 Socioeconomic Characteristics of Watershed

4.4.1 Population

The 2000 U.S. Census recorded the population of the KI Basin as approximately 20,900 in six complete census tracts and 37 census blocks within three other census tracts. The Puget Sound Regional Council has made projections of future population in Pierce and Kitsap Counties (1). Records of past population and projections for the future are shown in *Table 4-11*.

The population of the KI Basin grew at a rapid rate of 45% from 1990 (when the population of the basin was near 14,400) to 2000. The rate of growth is expected to be considerably lower in the basin during the next 25 years. The Puget Sound Regional Council estimates that the Forecast Area Zone (FAZ) that encompasses the Key Peninsula and Islands area (FAZ 2940) will experience a growth rate of approximately 12.6% from 2000 to 2010, 3.8% from 2010 to 2020, and 6.1% from 2020 to 2030. Applying these growth rates to the 2000 population of the basin results in projections that the population of the basin will increase to approximately 23,500 in 2010, 24,400 in 2020, and 25,900 in 2030. It is important to note that some areas within the KI Basin, such as Fox Island, Purdy, Burley, and Rocky subbasins, are included partially in other Forecast Area Zones in the Puget Sound Regional Council projections (FAZ 2215, 2216, 9004, and 9016). Although the projections for these FAZs vary somewhat from the estimates for the Key Peninsula and Islands FAZ, for the purposes of this report it is assumed that the overall growth in the basin will follow the projections for the Key Peninsula and Islands area.

Factors that could influence future population growth include transportation-related changes in the area such as the current construction of a second bridge across the Tacoma Narrows and potential future changes such as additional ferry service to the islands or modifications to roads serving Key Peninsula. The new Tacoma Narrows Bridge, which is expected to open in 2007, will increase the capacity of State Route 16 to carry traffic between Tacoma and the Gig Harbor and Key Peninsula areas. The existing and new bridges in combination will provide four general-purpose lanes and two high-occupancy vehicle lanes.

At present, severe traffic congestion occurs on the existing bridge and its approach roads during commute hours. The new bridge is expected to reduce congestion and thus reduce the current disincentive, despite the toll costs for using the bridge, to live in the KI Basin and commute to Tacoma.

4.4.2 Land Use

The current and projected future land use in the KI Basin is shown in *Table 4-12*. Parcels identified as having urban land uses, such as residential, commercial, industrial, civic uses (including institutional and transportation uses) currently occupy 42% of the Basin. Current land use in the basin is illustrated in *Figure 4-5* and is also shown as the background to the individual

Table 4-11
Past and Projected Future Population of Key Peninsula-Islands Basin

Year	**1990**	**2000**	**2010**	**2020**	**2030**
Actual	14,389	20,856			
Projected		20,856	23,489	24,376	25,858

[a]The estimate for the 1990 census count was derived from GIS data for three census tracts, four census block groups and nine census blocks. These areas include:
Census Tracts: 726.00 and 727.00
Census Block Groups: 724.04 Groups 2 and 3; 725.01 Groups 1 and 2.
Census Blocks: 721.09 Blocks 123, 124, 125, 126, 127, 128, 129, 130 and 131.

[b]The estimate for the 2000 census count was derived from GIS data for six census tracts and 37 census blocks. These areas include:
Census Tracts:
724.10, 725.03, 726.01, 726.02, 726.03 and 727.00
Census Blocks:
· 725.04 Blocks 1012, 1011, 1010, 1004, 1001, 1009, 1005, 1008, 1002, 1006, 1003
· 721.9 Blocks 1043, 1044, 1045, 1046
· 725.05 Blocks 1013, 1009, 1010, 1012, 1011, 1007, 1014, 1008, 3037, 3031, 3032, 1006, 1015, 1005, 3034, 1020, 1018, 3035, 1016, 1017, 1019

[c] The population projections are based on the Puget Sound Regional Council estimate for population growth in the Forecast Area Zone (FAZ) that encompasses the Key Peninsula and Islands area (FAZ 2940). It is important to note that some areas within the KI Basin, such as Fox Island, Purdy, Burley, and Rocky subbasins, are included partially in other Forecast Area Zones in the Puget Sound Regional Council projections (FAZ 2215, 2216, 9004, and 9016). Although the projections for these FAZs vary somewhat from the estimates for the Key Peninsula and Islands FAZ, for the purposes of this report it is assumed that the overall growth in the basin will follow the projections for the Key Peninsula and Islands area. For more information on the Puget Sound Regional Council population projections, visit: http://psrc.org/datapubs/data/forecasts.htm

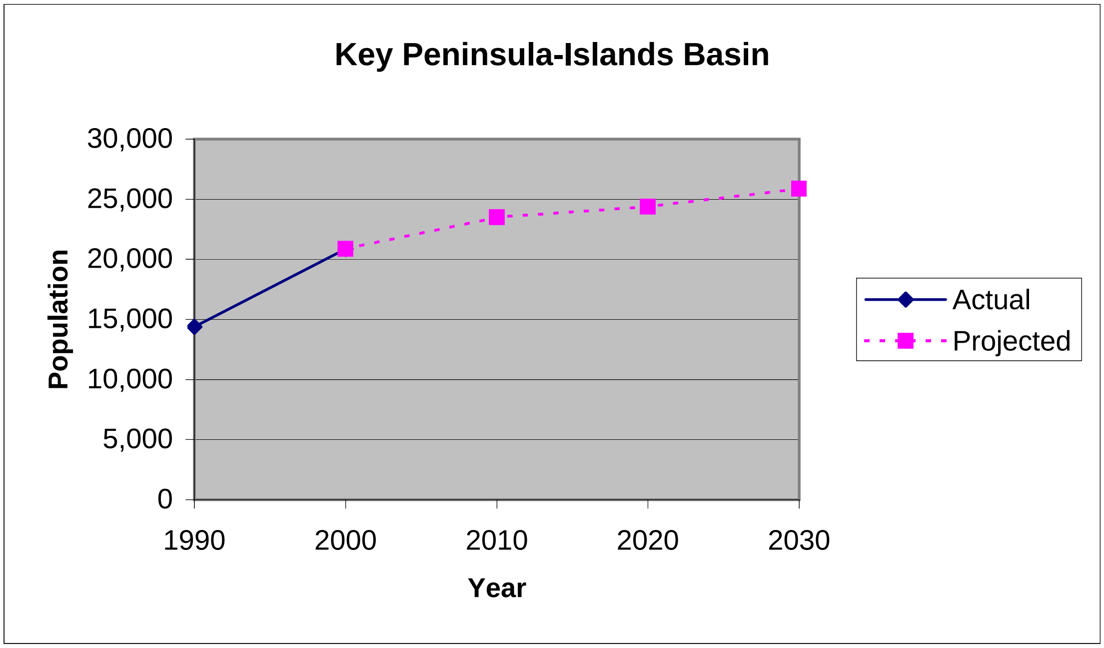

Key Peninsula-Islands Basin
30,000
25,000
20,000
15,000
10,000
5,000
0
Population
1990
2000
2010
2020
2030
Year
Actual
Projected

Table 4-12

KPI Basin Land Use Summary[1]

Land Use Type	Current % of Total Basin	Projected Future % of Total Basin[2]
Residential	35.6	63.6
Civic	3.5	3.5
Commercial	2.5	2.6
Industrial	0.0	0.1
Resource Use	19.2	19.7
Other[3]	10.0	9.9
Vacant	28.7	0.2
Water	0.2	0.2
Unknown	0.2	0.2

[1] Estimates of current and future land uses are based on Pierce and Kitsap County Tax Assessor Use Codes. See Appendix A for more information.

[2] The projected future condition of the basin is based on a full build-out scenario. This scenario is projected by assuming that vacant parcels identified by the County Tax Assessor will convert to the identified land uses of the parcels. For instance, parcels currently identified as “Residential Vacant Land” by the Tax Assessor (Use Code 9100) will convert from vacant land to low density residential land.

[3] Land uses classified as "other" include parcels identified by Pierce County as Commercial Land w/ SFR, Marine Craft Transportation, Communication, Utilities/Refuse, Drainfields, Well Sites, Cemetaries, Nursing Homes, Golf Courses, Resorts/Camps, Designated Forest Land RCW 84.33, and CU Open Space RCW 84.34 Current Use; and parcels identified by Kitsap County as Resorts/Group Camps, Water Systems, Communications, and O.S. General.

stream figures (*Figures 4-7* through *4-21*). The predominant land uses in the basin are residential and vacant land, with residential parcels currently estimated at 36% and vacant parcels estimated at 29% of the basin area. In the future (at full build-out of the basin[1]) parcels with urban uses are expected to occupy 70% of the Basin. It is expected that land use will become increasingly residential in the future, with residential parcels comprising 64% of the basin area at full build-out. The current and projected future land use characteristics of the basin were estimated based on Pierce and Kitsap County Tax Assessor Use Code descriptions of parcels. For detailed information on the land use analysis, see *Appendix B.*

As described earlier in *Section 4.2,* land use affects surface water hydrology by altering the landscape from its natural condition and changing water drainage, storage, and evaporation characteristics. The effect of various land uses on surface water hydrology is taken into consideration by estimating effective impervious surface within the basin. In order to conduct a detailed analysis of the current and projected future effective impervious surface within each subbasin, the basin was divided into more specific land use categories. The acres within each subbasin that are classified in these detailed land use categories under current and projected future conditions are shown in *Tables 4-5* and *4-6*. The current detailed land use categories for the percent impervious analysis are illustrated in *Figure 4-2*.

The current Pierce County and Kitsap County zoning for the KI Basin is summarized in *Table 4-13* and illustrated in *Figure 4-6*. The portion of the basin within Pierce County is almost entirely zoned Rural 10 (one dwelling per 10 acres). The portion of the basin within Kitsap County is predominantly zoned Rural Residential and Interim Rural Forest. Based on an analysis of zoning of parcels and the Pierce and Kitsap County Tax Assessor Use Codes for parcels, it is apparent that there are a variety of land uses existing within each zoning category in the basin. For instance, land zoned Agriculture contains parcels identified as fire stations, residential vacant land, utilities/refuse, street right of way, mobile home, and single-family dwelling. This discrepancy between zoning and land use in the basin reduces the value of using zoning as a tool for projecting future land use scenarios. For detailed information on the zoning analysis, see *Appendix B.*

4.5 CHARACTERIZATION OF STREAM CORRIDORS

The KI Basin is drained by a number of fairly small streams and a few larger streams with significant flow contributions from springs and wetlands. Most of the land close to the tops of the bluffs at the edges of the peninsula and the islands drains to small, unnamed, ephemeral streams. The larger streams are perennial. A summary of 57 streams in the KI Basin is provided in *Table 4-1*.

[1] Full build-out of the basin is projected by assuming that vacant parcels identified by the County Tax Assessor will convert to the identified land uses of the parcels. For instance, parcels currently identified as “Residential Vacant Land” by the Tax Assessor (Use Code 9100) will convert from vacant land to low density residential land.

Table 4-13
KPI Basin Zoning Summary

Zoning - Pierce County	**% of Basin Area**
Agriculture	2%
Activity Center	0%
Community Center	0%
Neighborhood Center	0%
Public Institutional	0%
Rural 10	96%
Rural Activity Center	0.3%
Rural Neighborhood Center	0.2%
Rural Sensitive Resource	1%
Reserve - 5	0.3%
Water	0.1%
Zoning - Kitsap County	
Industrial	2%
Iterim Rural Forest	35%
Lake	1%
Mineral Resource/Rural Residential	2%
Neighborhood Commercial	0%
Rural Protection	7%
Rural Residential	50%
Salt Water	0%
Urban Low Residential	0.2%
Urban Reserve	5%

The subbasins in the KI Basin range from 202 acres (0.3 square miles) to 7,895 acres (12.3 square miles) in size[2]. The catchment areas of the streams within each subbasin vary depending on the topographic configuration of the subbasin. Some streams, such as East Fork Rocky, Rocky, Huge, Minter, Burley, Purdy, and Schoolhouse (AI), have a catchment area equivalent to the respective subbasin area for those streams. Other streams including Vaughn, Dutcher, Kingmans, and Lackey, have a smaller catchment area than what comprises the total subbasin area due to the presence of additional small drainages within the subbasin that drain directly to Puget Sound.

To develop a surface water management plan for the KI Basin it is first necessary to obtain detailed information on the current condition of the streams. Information on the streams was obtained from a variety of sources but was primarily based on field surveys conducted by URS in October of 2003. Other important sources of information included the Key Peninsula-Gig Harbor-Islands Watershed Characterization and Action Plan (KGI Plan) (5) and products from the WRIA Salmon and Steelhead Limiting Factors Water Resources Inventory Area 15, prepared by the Washington Conservation Commission (3). The December 2000 Status Report of the Key Peninsula, Gig Harbor, and Island Watersheds Fish Passage Inventory and Assessment Project by Pierce Conservation District (PCD) (8) was used to supplement field survey information on barriers to fish passage. Several individuals provided information, including Dennis Popochok of the Minter Creek Hatchery, John Long of the WDFW, Monty Mahan of the Pierce Conservation District, and Pat Lowe of the Anderson Island Lakes Committee.

Sections 4.6 through 4.9 of this chapter describe the condition of the subbasins and surveyed streams in the KI Basin. Each section includes a description of the condition of fish habitat and the riparian corridor, barriers to fish passage, and a compilation of information on water quality and quantity. The general order in which the streams are presented is based on the basin number established by Pierce County. Table 4-1 lists the streams in each subbasin, including any alternative names by which streams are known, the survey status of the streams, the two-letter stream name abbreviations used in the KI Plan, and the Washington State stream catalog numbers.

For the KI Basin characterization, 17 streams were surveyed using the Tri-County Urban Stream Baseline Evaluation Method (USBEM). Of these 17 streams, seven streams were also surveyed using the Ecosystem Diagnosis and Treatment (EDT) method. Windshield surveys were performed for 15 additional streams. The remaining 24 streams or drainages in the KI Basin were not surveyed.

The 17 streams and subbasins desc*ribed in this section are:*

- Dutcher Creek (subbasin 3)
- Herron/Knackstedt Creek (subbasin 6)
- Herron Lake Creek (subbasin 8)

[2] There are several small islands in the KI Basin that have been grouped with larger adjacent islands in the subbasin delineation process. These include Cutts Island, 4.3 acres in size, which has been combined with Raft Island in Subbasin 24, and the small island next to Fox Island, 15.5 acres in size, which has been combined with Fox Island in Subbasin 31.

- Kingmans Creek (subbasin 8)
- Lackey Creek (subbasin 9)
- East Fork Rocky (subbasin 11)
- Rocky Creek (subbasin 14)
- Rocky West Tributary (subbasin 14)
- Schoolhouse Creek–KP (subbasin 15)
- Taylor Bay Creek (subbasin 16)
- Vaughn Creek (subbasin 18)
- Whiteman Creek (subbasin 19)
- Schoolhouse Creek–AI (subbasin 25)
- Huge Creek (subbasin 28)
- Minter Creek (subbasin 29)
- Little Minter Creek (subbasin 29)
- Purdy Creek (subbasin 30).

Figures 4-7 through *4-21* show detailed information for the streams that were surveyed for the KI Basin Plan. These individual basin maps show the quality of fish habitat and the riparian corridor in each reach and land use in the basi*n*. Locations where water quality monitoring and stream gauging has been conducted for the basin plan are also identified on the stream figures. During Phase 2 of the Basin Plan, these figures will be updated to identify features such as fish passage barriers, areas of water quality concern, and potential flooding problems. *Sections 4.6* through *4.9* are prefaced by a description of the survey methods used.

4.5.1 Stream Survey Methods

Two methods were used to assess the condition of the streams in the KI Basin. The primary method used for all streams surveyed in the KI Basin was a modified version of the Urban Stream Baseline Evaluation Method (USBEM), which is based on the method for evaluation of baseline conditions developed for the Tri-County Urban Issues Study. The Tri-County Group, which consists of King, Pierce, and Snohomish counties, is conducting the study as part of its effort to restore salmonid populations in the greater Puget Sound watershed. The application of the USBEM for the KI Basin Plan is summarized below. A detailed description of the USBEM evaluation method is contained in *Appendix D*.

The secondary method used to assess portions of major streams in the KI Basin (the main stems of Huge, Little Minter, Minter, Purdy, Rocky, Rocky West, and Vaughn Creeks) was the Ecosystem Diagnosis and Treatment (EDT) method, which is used to compile information for running the EDT model. The EDT method and model were developed by Mobrand Biometrics to provide an approach to salmonid conservation and recovery through watershed assessment and planning. The application of the EDT method for the KI Basin Plan is summarized below. A detailed description of the EDT evaluation method is contained in *Appendix D*.

Tri-County USBEM

The Tri-County USBEM employs a two-phase approach to freshwater stream habitat assessment. The purpose of the first phase of the work is to classify streams as "highly suitable habitat", "secondary habitat", or "negligible habitat" on the basis of existing data and without extensive field investigations. In the second phase, field investigations are undertaken to provide a more detailed assessment of habitat that falls within the first two classifications. Based on a review of existing data and a reconnaissance survey, URS concluded that 32 of the 57 streams in the KI Basin fell within the first two classifications and thus should be subject to detailed field investigations. Due to time, budget, and access constraints, 17 of these streams were surveyed using the Tri-County USBEM method and "windshield surveys" were performed for the remaining 15 streams. Windshield surveys consisted of aquatic habitat, riparian corridor, fish passage, and water quality observations made from cars and field observations performed at road crossings of the streams and other public access points.

The second phase of the USBEM method calls for the classification of streams by channel types and prescribes the habitat parameters that must be measured or evaluated for each channel type. Definitions of each stream classification and habitat parameter are provided that help standardize the evaluation. The definitions of stream classifications are included in *Appendix D*. The stream reaches in the KI Basin fall within four of the classifications defined in the USBEM method, "moderate gradient, mixed control", "moderate gradient, contained", "palustrine", and "estuarine". URS added a fourth stream classification "low gradient, mixed control".

Habitat parameters include riparian condition, substrate composition, embeddedness, bank condition, passage barriers, pool frequency, channel pattern/bedform, and large woody debris (LWD). The term "riparian condition" in this context means potential for recruitment of LWD. Evaluators rated stream reaches as "Good", "Fair", or "Poor" using the definitions developed in the Tri-County Urban Issues Study. In the case of two habitat parameters, URS modified the criteria to take account of the fact that the streams in the KI Basin are smaller than the streams the Tri-County Group had in mind when the evaluation method was designed. URS field teams made qualitative assessments of LWD and pool frequency rather than using the quantitative guidelines provided in the Tri-County method.

Because the goal of the Tri-County Urban Issues Study is preservation and enhancement of habitat for salmonids, the study's evaluation method is focused on fish habitat. To provide a more comprehensive assessment of stream health, URS developed additional habitat parameters used to evaluate the condition of the riparian corridor and its potential to support native plant species and the amphibians, birds, and mammals that use riparian environments. They include vegetated buffer width, streamside cover, canopy cover, structural diversity, invasive species, snags, and dead and down wood.

Definitions and ratings for parameters used in the fish habitat and riparian corridor evaluations based on stream channel type are shown in Tables 4-14, 4-15, and 4-16. They include the Tri-County habitat parameters and the parameters URS added to better evaluate habitat for species other than fish.

EDT Method and Model

The EDT method is a system for rating the quality, quantity, and diversity of habitat along a stream, relative to the needs of a focal species such as coho salmon. The EDT model organizes environmental information and rates the habitat elements with regard to the focal species, establishing a conceptual framework for decision-making. In effect, EDT describes how the fish would rate conditions in a stream based on our scientific understanding of their needs. The EDT model identifies the salmonid production potential for a stream under a set of conditions such as those that occur now or those that might occur in the future. The result is a scientifically based assessment of conditions and a prioritization of restoration needs.

The EDT model systematically examines conditions along a stream from the perspective of the fish, rating stream reaches individually based on data gathered in the field or assumptions made from research materials. In this way, the EDT model can be used to locate areas where conditions are particularly “Good” or “Bad” and identify habitat problems that need to be addressed. The EDT model identifies the “restoration potential” and the “protection value” of each reach of a stream. The EDT model results can be used to prioritize actions and focus on areas with identified problems where the potential for benefit is highest.

Pierce County is currently using the EDT model as a planning tool for watershed management and salmonid recovery. During the Fall 2003 field survey for the KI Basin Plan, URS rated 22 EDT attributes on seven major streams in the KI Basin in order to assist Pierce County with field verification of EDT model inputs. *Appendix D* contains descriptions and rating guidelines for the 22 attributes rated by URS during the Fall 2003 stream survey for the KI Basin Plan, as well as descriptions and rating guidelines for the 12 attributes not rated by URS during the Fall 2003 stream survey for the KI Basin Plan.

Field Application of USBEM and EDT method

The URS stream survey field team consisted of biologists specializing in fisheries, botany, and wetlands as well as an engineer specializing in hydrology and water quality. The field team’s goal was to develop a detailed and geographically extensive picture of habitat conditions along streams.

The field team walked the length of 17 streams in the basin and divided the streams into reaches with generally consistent aquatic habitat, confinement, gradient, and riparian corridor characteristics. Typical characteristics of each stream were then recorded using the expanded version of the Tri-County USBEM. EDT attributes were also rated on the main stems of seven major streams in the KI Basin (Huge, Little Minter, Minter, Purdy, Rocky, Rocky West, and Vaughn Creeks).

The field team surveyed approximately 110,000 feet of stream using USBEM. The downstream reaches of 17 streams were thoroughly surveyed. Some upstream reaches with little potential as fish habitat, for example reaches where flow was very low or nonexistent during Fall 2003, or reaches above barriers to fish passage, were not surveyed.

Table 4-14

USBEM Habitat Value Rating Criteria For

Moderate Gradient Mixed Control And Moderate Gradient Contained Channel Types

Habitat Parameter	**Good**	**Fair**	**Poor**
Recruitment Potential	High recruitment potential: Medium/Large Conifer (DBH > 12) or Medium/Large Mixed (DBH > 12); <30% of ground is exposed	Medium recruitment potential: Small/Large Conifer. Medium/Large Hardwood or Small Mixed vegetation type; <30% of ground is exposed	Low recruitment potential: Small Conifer (DBH<12) or Small/Large Hardwood; >30% of ground is exposed
Substrate Composition	Gravel or cobble is dominant. (Dominance = more than half of the surface area is composed of a single size class)	Gravel or cobble is subdominant	Sand or silt is dominant
Embeddedness	<20 % in riffle and pool tailout units	20-40% in riffle and pool tailout units	>40% in riffle and pool tailout units
Bank Condition	Perennial vegetation exists along >/=80% of banks; <20% of banks are exposed soil or artificially hardened	Perennial vegetation exists along >/=50% of banks; 20-50% of banks are exposed soil or artificially hardened	>50% of banks are exposed soil or artificially hardened
Pool Frequency	Qualitative assessment	Qualitative assessment	Qualitative assessment
Channel Pattern and Bedform	Sinuous pattern with intact connections to adjacent wetlands or side-channels	Sinuous pattern and with few connections to adjacent wetlands or side-channels	Straightened pattern; channel is disconnected from adjacent wetlands or side-channels
Large Woody Debris	Qualitative assessment	Qualitative assessment	Qualitative assessment
Riparian Buffer Width	Greater than 80 ft on each bank	25 to 80 feet on each bank	Less than 25 feet on each bank
Riparian Cover	Shrubs are the dominant (>50%)	Trees are the dominant (>50%)	Grass or forbs are the dominant

Table 4-14 (continued)

USBEM Habitat Value Rating Criteria For

Moderate Gradient Mixed Control And Moderate Gradient Contained Channel Types

Habitat Parameter	Good	Fair	Poor
	streamside vegetation	streamside vegetation	(>50%) streamside vegetation
Canopy Cover	>75% of water surface shaded	20-75% of water surface shaded	<20% of water surface shaded
Structural Diversity	4-5 vegetation layers are present	2-3 vegetation layers are present	1-2 vegetation layers are present
Invasive Species	<10% cover by invasive species	10% to 25% cover by invasive species	>25% cover by invasive species
Snags	>3 per acre	1-3 per acre	<1 per acre
Dead and Down	Abundant dead and down material, some large (>20”), various stages of decay	Limited dead and down material, typically small (<20”) and fresh	No dead and down material
Percent of Reach as Riffle	< 10% of reach as riffle	10% to 30% of reach as riffle	> 30% of reach as riffle
Distance Between Holding Areas	< 40 feet between pools	40 ft to 60 ft between pools	> 60 feet between pools
Storm Refuge	> 2 refuge areas (offstream channel or pools/ponds)	1 - 2 refuge areas (offstream channel or pools/ponds)	No refuge areas (offstream channel or pools/ponds)
Coho Pools	< 40 feet between pools	40 ft to 60 ft between pools	> 60 feet between pools

CW = Channel width at bankfull flows.

Table 4-15

USBEM Habitat Value Rating Criteria For

Palustrine Channel Type

Habitat Parameter	Good	Fair	Poor
Recruitment Potential	Riparian vegetation is continuous and dominated by native species typical of the channel type	Riparian vegetation is discontinuous or <50% are native species typical of the channel type	Riparian area is dominated by land use alterations or invasive non-native species
Bank Condition	Undercut areas frequent; >80% of banks with dense vegetation and not artificially hardened	Undercut areas sparse; 50-80% of banks with dense vegetation and not artificially hardened	>50% of banks are exposed soil or artificially hardened
Channel Pattern and Bedform	Sinuous pattern with intact connections to adjacent wetlands or side-channels	Sinuous pattern and with few connections to adjacent wetlands or side-channels	Straightened pattern; channel is disconnected from adjacent wetlands or side-channels
Riparian Buffer Width	Natural vegetation extends at least two active channel widths on each side	Natural vegetation extends one third to two active channel widths on each side	Natural vegetation extends less than a third of the active channel width on each side
Riparian Cover	Shrubs are the dominant (>50%) streamside vegetation	Trees are the dominant (>50%) streamside vegetation	Grass or forbs are the dominant (>50%) streamside vegetation
Structural Diversity	4-5 vegetation layers are present	2-3 vegetation layers are present	1-2 vegetation layers are present
Invasive Species	<10% cover by invasive species	10% to 25% cover by invasive species	>25% cover by invasive species
Snags	>3 per acre	1-3 per acre	<1 per acre
Dead and Down	Abundant dead and down material, some large (>20"), various stages of decay	Limited dead and down material, typically small (<20") and fresh	No dead and down material

Table 4-16

USBEM Habitat Value Rating Criteria For

Estuarine Channel Type

Habitat Parameter	Good	Fair	Poor
Recruitment Potential	Riparian vegetation is continuous and dominated by native species typical of the channel type	Riparian vegetation is discontinuous or <50% are native species typical of the channel type	Riparian area is dominated by land use alterations or invasive non-native species
Channel Pattern and Bedform	Complex network of distributaries with intact connections to adjacent wetlands or open saltwater	Some distributary channels connected to adjacent wetlands or open saltwater	Single thread channel; channel is disconnected from adjacent wetlands or open saltwater
Riparian Buffer Width	Natural vegetation extends at least two active channel widths on each side	Natural vegetation extends one third to two active channel widths on each side	Natural vegetation extends less than a third of the active channel width on each side
Riparian Cover	Shrubs are the dominant (>50%) streamside vegetation	Trees are the dominant (>50%) streamside vegetation	Grass or forbs are the dominant (>50%) streamside vegetation
Structural Diversity	4-5 vegetation layers are present	2-3 vegetation layers are present	1-2 vegetation layers are present
Invasive Species	<10% cover by invasive species	10% to 25% cover by invasive species	>25% cover by invasive species
Snags	>3 per acre	1-3 per acre	<1 per acre
Dead and Down	Abundant dead and down material, some large (>20”), various stages of decay	Limited dead and down material, typically small (<20”) and fresh	No dead and down material

Identification of Fish Passage Barriers

The field team identified potential barriers to fish passage during the stream surveys. Information from the Washington State Salmon and Steelhead Habitat Inventory Assessment Program (SSHIAP), the Pierce Conservation District (PCD) *Status Report of the Key-Peninsula Gig-Harbor - Island Watershed Fish Passage Inventory and Assessment Project*, and WDFW's *Fish Passage and Diversion Screening Inventory Database* was also used to identify fish passage barriers in the KI Basin.

The PCD assessment of fish passage barriers was based on the WDFW *Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual* (9). This manual provides guidance on how to locate, assess, and prioritize fish passage problems (culverts, dams, and fishways) and surface water diversion screening problems. An initial method for determining barrier status is outlined in the manual, known as a Level A analysis. This analysis utilizes culvert dimensions and stream characteristics to determine if a culvert is a barrier to fish passage.

In some cases, particularly when a culvert is in a tidally influenced area or there is a slope break in the culvert, the Level A analysis may not be sufficient to determine the culvert status. Potential barriers such as these require a further level of analysis, known as a Level B analysis.

Management and Presentation of Stream Survey Data

The results of the stream surveys are included in full in *Appendix E*. To facilitate understanding, a summary of the results is provided in this chapter. Summary tables for a stream were prepared by condensing the multiple ratings of stream reaches with respect to fourteen habitat parameters into single ratings of the condition of fish habitat and the riparian corridor.

The method used to summarize has the drawback that it gives equal weight to all of the habitat parameters. Because the habitat parameters are not all of equal importance, the method may distort the results of the evaluation somewhat. Attempts by the Tri-County Urban Issues Study to agree on weighting of habitat parameters were unsuccessful, so no attempt to do so was made here.

Water Quality Measurement and Assessment

Water quality information was compiled from published sources and supplemented by field studies. As a part of the KI Basin Plan work, URS conducted water quality monitoring on 10 major streams in the basin on October 16, 2003, November 11, 2003, and October 20, 2004. The results of this monitoring are presented in *Chapter 5*. Grab samples were taken from all major streams and analyzed for water temperature, pH, turbidity, dissolved oxygen, nutrients, and fecal coliform content. Analytical procedures were conducted in accordance with *Standard Methods for the Examination of Water and Wastewater* (10).

Gauges have been installed on Minter, Rocky, and Vaughn Creeks that record stream temperature every 15 minutes. These gauges have been in operation since November 2003 (Minter and Vaughn) and February 2004 (Rocky), and thus far have shown water temperatures to be meeting state standards. The data from these gauges will become increasingly useful once it has been collected over several summers and can be evaluated against state water temperature standards.

Assessment of water quality conditions was done by comparing grab sample field results with applicable in-stream water quality standards. *Section 303* of the CWA requires that states establish standards to protect the quality of the waters of the United States. The State of Washington's water quality standards are contained in *Chapter 173-201A* of the Washington Administrative Code (WAC). All water bodies in the state have been assigned classification based on freshwater or marine standards. Freshwater standards are further classified according to support of core or noncore salmonid rearing. A full description of the water quality standards is contained in *Chapter 5*.

Water Quantity Measurement

Stream discharge information was compiled from published sources and supplemented by field studies. Historic information on stream discharge is very limited for basin streams, with the exception of Huge Creek where an active U.S. Geological Society (USGS) gauging station (station 12073500) has been in operation from 1947 to 1969 and from 1977 to the present at 144th Street NW. This is the only USGS gauging station in the KI Basin with long-term record. A gauging station (station 12072800) was operated by the USGS between 1960-1962 on Purdy Creek. It was first located at the downstream end of the culvert under 144th Street NW and then moved above the upstream end of the culvert. There is also a USGS record for Burley Creek (station 12073000) on the upstream side of Spruce Road from 1947 through 1965.

Devices that measure water level (also known as "stage") every 15 minutes were installed at stations on Minter, Rocky, and Vaughn Creeks by River Measurement, Ltd., a subcontractor to URS. These gauges have been in operation since November 2003 (Minter and Vaughn) and February 2004 (Rocky). The data from the gauging devices was collected and stage and discharge measurements were taken approximately once every two months, and rating tables were created for each stream using the stage and discharge measurements taken. The rating tables were used to compute 15-minute stream discharge.

All data collection was done using USGS approved methods and equipment. Data computation was performed using Kisters Water Management Information System licensed software. Data computation and analysis methods are compatible with those used by USGS. Detailed descriptions of the methods utilized by River Measurement, Ltd. for the data collection and analysis can be found in *Appendix F*.

4.6 KEY PENINSULA BASIN (#10)

4.6.1 Dutcher Creek

Dutcher Creek (15.0026), located in Dutcher subbasin (Subbasin 3), is approximately 2.5 miles long including tributary 15.0027 and an unnumbered tributary. It enters Dutcher Cove on the east side of Case Inlet. The stream supports coho to the headwaters on the main stem and to an impassable culvert on tributary 15.0027; chum use is unknown. Salmon and Steelhead Stock

Inventory (SASSI) indicates the presence of steelhead in Dutcher Creek, although presence was not identified in the SASSI steelhead distribution map.

The culvert at the Lackey Road crossing of Dutcher Creek is failing and PCD has identified it as a fish passage barrier. Coho passage is precluded upstream of a dam at the end of Reach DU01. Construction of a six step wooden weir-pool fishway fed by an 18 inch pipe through a dam into the top pool was built by the current owners to bypass the dam in 1982 with WDFW consent. Downstream of the dam, habitat and riparian corridor conditions are “Good”, with adequate LWD and dense vegetation.

Upstream of the dam, in Reaches DU03 and DU05, riparian condition has been degraded where the creek flows through agricultural areas. A South Puget Sound Salmon Enhancement Group (SPSSEG) volunteer who rears coho eggs annually reported that overall habitat in Dutcher Creek is very “Good”, with “Good” canopy cover and low volumes of stormwater runoff (Manning and Manning, personal communication 1996, as referenced in KGI DRAFT 1999).

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors walked approximately 5,300 feet of stream corridor along Dutcher Creek. The stream was divided into five reaches as shown in *Figure 4-7*. The characteristics of aquatic habitat and the riparian corridor are shown in *Table 4-17* and *Figure 4-7*. One-hundred percent of the aquatic habitat surveyed is in “Good” condition. Forty-nine percent of the riparian corridor surveyed is in “Fair” condition, and 51% is in “Good” condition. The results of the Pierce County Nearshore Habitat Survey are also displayed in *Figure 4-7*. Dutcher Cove is rated in “Good” condition while the shoreline area north and south of Dutcher Cove is rated in “Poor” and “Fair” condition.

The most downstream reach of Dutcher Creek begins at the end of the tidal influence upstream of a large tidal mudflat in Dutcher Cove. Reach DU01 is a contained channel type with moderate gradient (See Appendix E for a description of channel types). Aquatic habitat and riparian conditions in this reach were rated “Good”. There is excellent riparian cover and structural complexity as well as adequate LWD and pool frequency. Bank condition and channel pattern and bedform are also “Good”, but substrate composition, and embeddedness are “Poor”. Upstream is an approximately 400-foot reach consisting of an unnamed lake. This reach (DU02) is unrated due to the unsuitability of the rating criteria for lakes. Reach DU03 is a palustrine channel type extending approximately 895 feet upstream of the lake. Aquatic habitat in this reach is “Good” and the riparian corridor is rated as “Fair”, primarily due to the characteristics common in palustrine reaches. Reach DU03 has “Poor” riparian cover, low recruitment potential for LWD, low structural diversity, and a high proportion of the invasive species of reed canary grass.

Reach DU04 extends from the end of the palustrine conditions to the Lackey Road crossing of Dutcher Creek. Aquatic habitat in Reach DU04 is rated as “Good” overall, although embeddedness is “Poor” and substrate composition is “Fair”. Riparian corridor in Reach DU04 is also rated as “Good”, but improvements could be made to increase structural diversity and reduce invasive species. Reach DU05 is a moderate gradient mixed control channel type extending 1,510 feet upstream from the Lackey Road crossing to approximately 170th

Table 4-17

Dutcher Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
DU01	End of tidal influence to unnamed lake	1,696	Moderate gradient contained	Good	Good
DU02	Unnamed lake	400	N/A	N/A	N/A
DU03	End of unnamed lake to end of palustrine influence	895	Palustrine	Good	Fair
DU04	End of palustrine influence to Lackey Road	761	Moderate gradient mixed control	Good	Good
DU05	Lackey Road to 170th Avenue/68th Street Court	1,510	Moderate gradient mixed control	Good	Fair

Avenue/68th Street Court. There is a home on the south side of the stream upstream of the Lackey Road crossing that is closely situated to the stream and may be a potential flood hazard.

Aquatic habitat in Reach DU05 is "Good" and riparian corridor conditions are "Fair". Embeddedness, channel pattern and bedform, and pool frequency received "Fair" ratings in Reach DU05. The riparian corridor in Reach DU05 contains fewer mature trees than desirable, resulting in "Poor" ratings for snags and "Fair" ratings for recruitment potential, structural diversity, and dead and down wood. Photograph 1 illustrates the typical conditions in Reach DU05.

Dutcher Creek was not surveyed upstream of Reach DU05 due to time constraints and access issues. Aerial photograph analysis of the unsurveyed upper reaches of Dutcher Creek indicates that the riparian corridor is intact and in "Fair" to "Good" condition in the area immediately surrounding the creek as well as in the larger catchment area for the headwaters. The aquatic habitat conditions in the unsurveyed upper reaches are not known, but based on land use and riparian corridor conditions it is likely that the habitat is in "Fair" to "Good" condition.

Barriers to Fish Passage

Coho passage is precluded upstream of a dam at the end of Reach DU01 (Barrier 105K101820a), shown in Photograph 2. PCD indicates this dam was built in 1982 with WDFW consent. The associated fish ladder is composed of a concrete foundation and wood weirs. There is a metal grate debris collector at the upstream end of the inlet that may become periodically clogged and forms a fish passage barrier.

At the upstream end of Reach DU04, the 5-ft diameter, 76-feet long concrete culvert (Barrier 105K042518b) at the Lackey Road crossing of Dutcher Creek is failing and has been identified as a fish passage barrier by PCD (Barrier K042518b). The lower end of the culvert has fallen off and the culvert has a 1.5 feet (0.5 meter) drop at the outlet. The culvert failure and high water velocities through the culvert at peak flows has resulted in scouring and the formation of a large plunge pool.

PCD identified a 2-feet diameter, 33-feet long galvanized steel private driveway culvert that is a fish passage barrier off 68th Street in Reach DU05 (Barrier 105K080918a). Upstream of Reach DU05 approximately 0.2 miles east of 170th Avenue, PCD identified two 12-inch diameter, 16-feet long round concrete private driveway culverts that are potentially blocking fish passage (Barrier 105L072530a).

Water Quality

The results of the water quality sampling effort conducted for this stream are shown and described in Chapter 5.

Water Quantity

Dutcher Creek and tributaries have been closed to new water rights since 1954 (WAC 173-515-040).

4.6.2 Herron/Knackstedt Creek

Knackstedt Creek (15.0029), located in the Herron subbasin (subbasin 6), is sometimes referred to as Herron Creek. The main stem of Knackstedt Creek is about one and a half miles long. Its gradient is shallow. The headwaters of the stream originate in a functioning beaver dam complex near 32nd Street and Jackson Lake Road. Knackstedt Creek flows into Case Inlet east of the north end of Herron Island adjacent to the ferry dock to Herron Island. The limiting factor analysis notes that development of five-acre residential housing lots has increased in recent years in the upper reaches of the stream. The stream supports chum and coho to a culvert located at 202nd Avenue. Cutthroat distribution is presumed to at least the extent of the other salmonids.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors walked approximately 7,500 feet of stream corridor along Knackstedt Creek. The stream was divided into five reaches as shown in *Figure 4-8*. The characteristics of aquatic habitat and the riparian corridor are shown in *Table 4-18* and *Figure 4-8*. Overall the stream is in excellent condition, containing 96% “Good” aquatic habitat and 4% “Fair” aquatic habitat. 100% of the riparian corridor is in “Good” condition. The results of the Pierce County Nearshore Habitat Survey are also displayed in *Figure 4-8*. The estuary at the mouth of Knackstedt Creek is rated in “Fair” condition. The shoreline area south of the estuary is rated in “Poor” condition and the shoreline area north of the estuary is rated in “Fair” condition.

The first reach of Knackstedt Creek begins at the end of the tidal influence approximately 1,500 feet from the estuary outlet. Reach HE01 is an alluvial fan channel type as evidenced by the channel migrating across the fan as a result of deposition. Riparian conditions of this reach were rated “Good”, while the aquatic conditions were rated “Fair”. Upstream is an 850-foot reach extending between a channel type change from alluvial fan at the end of Reach HE01 to moderate gradient mixed control channel type. Within this reach is a woody debris complex that has been artificially notched, to improve flows, a factor that has the potential to limit salmonid habitat. Reach HE03 extends up the main stem approximately 4,200 feet. Overall this reach is in “Good” condition consisting of many LWD complexes, including adequate amounts of recent coniferous recruitment. The greatest number of pools was located in this section of the stream due to the high ratio of LWD to channel width.

HE04 shows signs of recent high flows throughout the length of the reach including compressed vegetation and sediment deposition beyond the ordinary high water mark. A possible beaver dam breach upstream within the wetlands complex was later determined to be the cause of the high water flows. The stream channel becomes less confined within this reach and a significant change in riparian vegetation and channel type defines the end of the reach. The last reach, HE05, was characterized by a beaver dam and wetlands complex. Further evidence of a dam breach was observed and a new dam had recently been constructed. Several lodges were located throughout the wetlands, along with sizeable amounts of downed wood. There was also evidence of a historical fire. Reach HE05 is unrated due to the unsuitability of the rating criteria for beaver pond and wetlands complexes. *Photograph 3* illustrates the beaver dam complex at the mouth of Knackstedt Creek.

Barriers to Fish Passage

In Reach HE02 under 202nd Avenue is a 7-foot diameter arch plate culvert (Barrier 105K020719a), shown in *Photograph 4*. Two improperly placed culverts that prevented fish passage by frequently becoming clogged with debris were replaced in July 1999. Although this culvert is adequately sized for the dimensions of the stream, there is a misalignment of the culvert with the stream channel on the upstream side resulting in a probable fish passage barrier. As a result of the misalignment of the culvert there is potential for road failure due to erosion of the roadbed. The culvert is also slightly undersized for the passage of LWD. There is an indication of high stream power evidenced by the sediment deposition patterns and the high water lines marked by debris, indicating that there is a possibility for culvert failure.

The Washington Conservation Commission indicates that there is also a culvert located at the mouth of a right-bank tributary just south of the Herron Beach Community Club that connects to Knackstedt Creek. This culvert was replaced in 1999 in order to allow total fish passage to upstream habitat. However, in 2000 the culvert was evaluated as still blocking fish passage.

Water Quality

The results of the water quality sampling effort conducted for this stream are shown and described in *Chapter 5*.

4.6.3 Herron Lake Creek

Herron Lake Creek (15.0030) in Kingmans' subbasin (subbasin 8) has been significantly altered from its natural condition. The original flow of Herron Lake Creek was just under one mile in length, originating from Herron Lake and discharging into Case Inlet across from the southern end of Herron Island. A series of 11 impounded manmade ponds have replaced the natural channel along Herron Lake Creek. The current landowner of parcels surrounding Herron Lake Creek runs a remote site incubator, hatching eggs provided by the Minter Creek Hatchery. WDFW has permitted four years of chum plants and six years of coho plants (both beginning with the 2002 brood year) for Herron Lake Creek. 50,000 eyed chum eggs and 25,000 eyed coho eggs are transferred each year from the hatchery. A goal of 50,000 chum and 25,000 coho released into Case Inlet each year has been set for this project (John Long 2004).

Characteristics of Aquatic Habitat and the Riparian Corridor

Herron Lake Creek was surveyed, although the rating criteria for aquatic habitat were somewhat unsuitable for the pond-like conditions of the stream. Surveyors walked approximately 2,100 feet of stream corridor along Herron Lake Creek. The stream was evaluated in a single reach as shown in *Figure 4-9*. The characteristics of aquatic habitat and the riparian corridor are shown in *Table 4-19* and *Figure 4-9*. The results of the Pierce County Nearshore Habitat Survey are also displayed in *Figure 4-9*. The shoreline area south of the discharge point of Herron Lake Creek is rated in "Fair" condition and the shoreline area to the north is rated in "Poor" condition. Reach HL01 extends from the outlet of the stream at Case Inlet through a series of 11 impounded manmade ponds that have replaced the natural channel along Herron Lake Creek. Most of the ponds are connected by PVC pipes, and there is no surface flow connecting the ponds to allow

Table 4-18

Knackstedt Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
HE01	End of tidal influence to 325 feet upstream of end of tidal influence	325	Alluvial fan	Fair	Good
HE02	325 feet upstream of end of tidal influence to 225 feet upstream of culvert under 202nd Avenue	850	Moderate gradient mixed control	Good	Good
HE03	225 feet upstream of culvert under 202nd Avenue to 5,425 feet upstream of stream survey start	4,250	Moderate gradient mixed control	Good	Good
HE04	5,425 feet upstream of stream survey start to beaver pond complex	2,015	Moderate gradient contained	Good	Good
HE05	Beaver pond complex	N/A	N/A	N/A	N/A

for fish passage. The pools average 1.3-1.6 feet in depth and 100 feet wide by 200 feet long in size. Algae blooms were present throughout the length of the stream due to the shallow nature of the ponds and lack of surface flow. An artificial holding pond connects to the stream during high flows, providing the upper limit of the hatchery coho. This pond, as well as two other holding ponds, are stocked with rainbow trout. There is some groundwater seepage into the ponds. At approximately 2,100 feet from the outlet of the stream, the natural Herron Lake corridor begins. Herron Lake Creek was not surveyed upstream of Reach HL01 due to time constraints.

Barriers to Fish Passage

A bulkhead has been constructed at the outlet of Herron Lake Creek, as shown in *Photograph 5*. The landowner indicates that at the highest tides, water surface flow exceeds the bulkhead allowing for fish passage. An example of the additional artificial impoundments along Herron Lake Creek is shown in *Photograph 6*.

Water Quality

Algae blooms were present throughout the length of the stream surveyed due to the shallow nature of the artificial ponds and lack of surface flow. The algae blooms result in extremely poor water clarity, with visibility in most areas being less than two to four inches. Water quality sampling was not conducted on this creek.

4.6.4 Kingmans Creek

Kingmans Creek (15.0031), located in Kingmans subbasin (subbasin 8), is just under one mile in length. Its gradient is shallow. The stream supports coho and chum and in addition, 10,000 Chinook are released annually. The stream flows southwest before discharging into a lake at a summer camp located at the mouth of the stream, shown in *Photograph 7*. Presumably the stream eventually flows into Case Inlet southeast of the southern end of Herron Island, although this was not confirmed during the field survey. Approximately 500 acres at the headwaters of the stream were clearcut in 1991 and 1992 and converted to housing and vacant land. Conditions in the upper reaches of the stream were not surveyed due to barriers to access and lack of stream flow, but the Washington Conservation Commission indicates that the resulting effects of the clearcuts have subsequently degraded the riparian and aquatic habitat throughout the stream. Due to the associated erosion issues, increased amounts of fine sediments have eroded into the stream and landslide incidents have increased.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors walked approximately 1,340 feet of stream corridor along Kingmans Creek. The surveyed section of the stream was divided into the two reaches shown in *Figure 4-9*. The characteristics of aquatic habitat and riparian corridor are shown in *Table 4-20* and *Figure 4-9*. The surveyed reaches of the stream contain 100% “Good” aquatic habitat and 100% “Good” riparian habitat.

The results of the Pierce County Nearshore Habitat Survey are also displayed in Figure 4-9. The area at the mouth of Kingmans Creek is rated in “Fair” and “Poor” condition and the shoreline area north and south of the mouth is rated in “Fair” condition.

Table 4-19

Herron Lake Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
HL01	Estuary to 2,100 feet upstream	2,100	Moderate gradient mixed control	Poor	Fair

Table 4-20

Kingmans Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
KG01	Upstream end of wetland above lake to 620 feet upstream of wetland	620	Floodplain	Good	Good
KG02	620 feet upstream of wetland to 1,340 feet upstream of wetland	720	Moderate gradient mixed control	Good	Good

The lower reaches of Kingmans Creek flow through a steep canyon that appears to be well protected. Reach KG01, starting just upstream of a small wetland extending about 200-feet from the lake, runs just over 600 feet. The substrate is composed of sand mixed with small gravel and the canopy is primarily characterized by mature, deciduous vegetation. Upstream is a 700-foot reach that begins where the stream channel becomes more confined and the banks are steeper and runs to where the stream's flow became significantly diminished. An example of the dense riparian vegetation along Kingmans Creek is shown in *Photograph 8*.

Barriers to Fish Passage

A pond formed by a levee (Barrier 105K0802218a) adjacent to a summer camp at the mouth of Kingmans Creek appears to be a fish passage barrier, although no investigation could be made during the survey. The upper portions of Kingmans Creek may not be accessible to anadromous fish. WDFW noted WRIA #150360 as a cascade barrier on the middle reaches of the main stem of the stream.

Water Quality and Quantity

No water quality data or records of measured discharge were found for Kingmans Creek. In October 2003, URS surveyors estimated the flow in both reaches KG01 and KG02 to be approximately 1 cubic foot per second. Water quality sampling was not conducted on this creek.

4.6.5 Lackey Creek

Lackey Creek (15.0046), located in Lackey subbasin (subbasin 9), is about two and a half miles long flowing south between the Key Peninsula Highway and Cramer Road. The stream crosses Cramer Road before emptying into the north end of Glen Cove. Lackey Creek's gradient is shallow. The stream supports coho to Highway 302. Cutthroat distribution is presumed to be similar to the other salmonids.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors walked approximately 2,500 feet of stream corridor along Lackey Creek before the survey was terminated because the stream became intermittent and eventually dry. The stream was divided into four reaches as shown in *Figure 4-10*. The characteristics of aquatic habitat and the riparian corridor are shown in *Table 4-21* and *Figure 4-10*. Overall the surveyed reaches of the stream are in excellent condition, with 100% of the aquatic habitat and the riparian corridor rated as "Good". The results of the Pierce County Nearshore Habitat Survey are also displayed in *Figure 4-10*. Glen Cove, at the mouth of Lackey Creek, is rated mostly "Fair" with a few "Poor" condition areas.

Reaches LA01 and LA02 were short reaches defined as moderate gradient contained channel types since the stream is located in a naturally confined valley as seen in *Photograph 9*. Both reaches contain generally "Good" habitat conditions that have potential to support natural assemblages of salmonid species. LA03 and LA04 are defined as moderate gradient mixed control. Both reaches have "Good" aquatic habitat and riparian habitat and clear water in the stream. LA03 has adequate amounts of LWD, multiple channels, and cobbles upstream. Some scour is evident. Toward the upper end of the reach, the riparian area has been logged to within

Table 4-21

Lackey Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
LA01	Upstream extent of tidal influence to right bank tributary at 285 feet	285	Moderate gradient contained	Good	Good
LA02	Right bank tributary at 285 feet to 885 feet upstream of beginning of stream survey	600	Moderate gradient contained	Good	Good
LA03	885 feet upstream of beginning of stream survey to logged area 1,800 feet upstream of the start of the stream survey	920	Moderate gradient mixed control	Good	Good
LA04	1,800 feet upstream of the start of the stream survey to end of to end of flow	655	Moderate gradient mixed control	Good	Good

20 feet of the stream. At this location there are no conifers, only salmonberry is located in the riparian area. At the beginning of LA04, the banks are logged on both sides and open canopy that extends for 100 feet. Himalayan blackberry and salmonberry are the dominant riparian cover toward the upstream area of this reach. *Photograph 10* shows the end of flow on LA04.

Barriers to Fish Passage

No fish passage barriers were noted during the 2003 field survey or in other existing documents.

Water Quality

Field observations indicate that general water quality in the reach is good. There are no water quality impairments or 303(d) listings for Lackey Creek. Water quality sampling was not conducted on this creek.

Water Quantity

Lackey Creek has been closed to new water rights by *WAC 173-515-040* due to surface water source limitations. Lackey Creek exhibits low summer flows and has a potential for drying up or inhibiting anadromous fish passage during critical life stages. Stream Team volunteers have been monitoring a site located below the confluence of Lackey Creek and a tributary below Cramer Road. The results of the monitoring indicate that this site has flow during the summer months.

4.6.6 East Fork Rocky (Fork Muck Creek)

East Fork Rocky (15.0016), a tributary of Rocky Creek in Fork Muck subbasin (subbasin 11), is sometimes referred to as Fork Muck Creek. East Fork Rocky Creek has the longest drainage channel in the KI Basin, over 7.5 miles in length, although much of the channel does not exhibit perennial flow.

East Fork Rocky Creek enters mainstem Rocky Creek approximately a quarter-mile above where State Route 302 crosses Rocky Creek. The headwaters of East Fork Rocky Creek are located near Lake Flora Road in Kitsap County. The drainage flows south for most of its length before turning westward near its confluence with Rocky Creek. The stream supports chum to 144th Street and there is potential to extend access higher into the watershed. In addition, there is distribution of coho to headwaters; distribution of steelhead to Wright-Bliss Road, which is likely to move farther upstream since the bridge was replaced; and distribution of cutthroat to the headwaters.

Historically there have been significant logging operations of riparian vegetation along East Fork Rocky Creek as well as a large harvest in the headwaters. In 1998, 240-acres along East Fork Rocky Creek were transferred to the Peninsula Park Board. The area, now known as the Rocky Creek Conservation Area, will be protected from future development.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors walked approximately 4,500 feet of stream corridor along East Fork Rocky Creek. The stream was divided into four reaches, as shown in *Figure 4-11*. The characteristics of aquatic habitat and the riparian corridor are shown in *Table 4-22* and *Figure 4-11*.

Table 4-22

East Fork Rocky Creek (Fork Muck Creek) - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
EF01	Mouth of Muck Creek to Winter Snow Creek confluence	1,720	Moderate gradient contained	Good	Good
EF02	Confluence of Winter Snow Creek to 1,250 feet upstream of confluence	1,250	Moderate gradient mixed control	Good	Good
EF03	1,250 feet upstream of confluence of Winter Snow Creek to 1,575 feet downstream of Wright-Bliss Road	1,515	Moderate gradient mixed control	Good	Good
EF04	1,575 feet downstream of Wright-Bliss Road to Wright-Bliss Road	N/A	N/A	N/A	N/A

The surveyed portions of East Fork Rocky Creek are in excellent condition, with 100% of the aquatic habitat and the riparian corridor rated as “Good”.

EF01 begins at the confluence of East Fork Rocky Creek with Rocky Creek and ends at the confluence of Winter Creek with East Fork Rocky Creek. At the beginning of the reach, there is an opening in the canopy and a resulting loss of cover as a result of forestry operations. Depositional patterns of cobble, gravel, and debris provide evidence of very high water flows throughout the reach as seen in *Photograph 11*.

Embeddedness in this reach is considered “Fair” with greater than 20% sediment in riffle and pool tailout units. There was also a presence of algae blooms during the fall 2003 field survey. In Reach EF02 the flow becomes diminished developing a pocket pool pattern. Deciduous trees dominate the riparian corridor and there is a lack of downed wood. The embeddedness is decreased from EF01, although there were still algae blooms present. The pools became disconnected by surface water flows mid-way through the reach and eventually the stream became dry, ending the reach.

In the last two surveyed reaches the flow was interstitial with some sheet flow and residual pools present in places. There was a lot less LWD present and there were several lawns and pastures situated at the edge of the stream bank. EF03 contained several historical bank stabilization efforts. There are also actively managed forest lands subject to logging at regular intervals. Based on the stream surveys, management on some parcels of land adjacent to the stream corridor have proven to retain the “Good” rating for the habitat parameters. *Photograph 12* shows erosion issues under a private driveway bridge in EF03. The parameters in Reach EF04 were not evaluated due to the stream becoming completely dry with no pools or surface water flow. Observations included an increase in non-native, invasive species in the shrub layer, as well as “Poor” riparian conditions and associated bank erosion issues. The aquatic habitat becomes degraded as a result of reduced sinuosity and the presence of armoring on both banks.

Barriers to Fish Passage

In 2000, the culvert at Wright-Bliss Road, a long-standing barrier to fish passage along the stream, was replaced with a bridge allowing for unrestricted fish passage upstream toward the headwaters.

Water Quality

The Washington Conservation Commission indicates that the powerline access road at 144th Street has resulted in stream bank erosion of fine sediments and bank failure due to use by four-wheel drive vehicles. Algae blooms observed on EF01 and EF02 also contributed to reduced water clarity. Water quality sampling was not conducted on this creek.

Water Quantity

The Department of Ecology indicates that East Fork Rocky Creek has low summer flows and has a potential for drying up thereby inhibiting anadromous fish passage during critical life stages. As a result, the stream has been closed to new water rights by *WAC 173-515-040*.

4.6.7 Rocky Creek

Rocky Creek (15.0015), located in the Rocky subbasin (subbasin 14), is approximately five miles long with two major tributaries and several minor tributaries adding 10-12 miles of channel length. The headwaters of Rocky Creek are located in Kitsap County just south of Wye Lake. The stream flows into Rocky Bay and eventually into Case Inlet. The rural basin is characterized by low-density residential housing. In order to protect the basin from further growth, a 1995 Pierce County Council mandate limits development to one dwelling per 20 acres. The stream supports runs of Chinook, coho, steelhead, cutthroat, and chum salmon. Stream team volunteers have voiced concern regarding salmon productivity in the Rocky Creek watershed due to poaching at the mouth of the stream.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors walked approximately 19,000 feet of stream corridor along Rocky Creek. The surveyed section of the stream corridor was divided into seven reaches as shown in *Figure 4-12*. The characteristics of aquatic habitat and the riparian corridor are shown in *Table 4-23*. The stream contains 4% "Fair" and 96% "Good" aquatic and riparian habitat. The conditions of the stream reaches are shown in *Figure 4-12*.

With the exception of Reach RC06, the aquatic and riparian habitat conditions on Rocky Creek were all rated "Good". Off-channel habitat, well-developed sinuous channel lengths, and an abundance of LWD characterized the aquatic habitat of the surveyed reaches. Throughout the stream, juvenile salmonids were observed. The stream is located in a vegetated ravine through much of its channel length.

Reaches RC01 – RC05 were moderate gradient mixed control channel types. The lowest reach of Rocky Creek begins at Highway 302 and extends 1,430 feet upstream to the confluence with Winter Snow Creek. RC02 was a long reach, extending almost 5,000 feet. The reach was generally more confined than RC01 with a mixed canopy layer. A redd and several larger salmonids in holding pools were observed on RC02. RC03 ends at the culvert under 144th Street. Minor stands of reed canary grass were noted, as well as, fewer LWD. Conditions in RC04 and RC05 degraded slightly, although both reaches maintained a "Good" rating. Sections of the reaches contained increased algae growth, increased embeddedness, and had a lack of canopy cover or immature stands as seen in *Photograph 13*.

RC06 was rated "Fair" for both aquatic and riparian conditions. The substrate was highly embedded relative to the other reaches on Rocky Creek. A bridge located on 176th Street at the end of the reach had the potential to constrict flow. The riparian habitat was mostly open and contained a high percentage of invasive species, one of which was reed canary grass. The recruitment potential for LWD was low.

The last reach, RC07, was a 2,000-foot palustrine reach with improved habitat conditions. A remnant beaver pond was observed at the beginning of the reach and also approximately 400 feet upstream from the beginning of the reach. The second remnant pond was over 200 feet wide with buried logs and over 100 pieces of LWD. Some algae growth causing decreased clarity was observed most likely due to an open canopy present in some sections of the reach. The structural diversity was the only parameter that did not receive a "Good" rating for the riparian habitat.

Table 4-23

Rocky Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
RC01	Hwy 302 to junction with tributary 1,430 feet upstream	1,430	Moderate gradient mixed control	Good	Good
RC02	1,430 feet upstream to 132nd Street	4,875	Moderate gradient mixed control	Good	Good
RC03	132nd Street to 144th Street	4,195	Moderate gradient contained	Good	Good
RC04	144th Street to 3,780 upstream of 144th Street	3,780	Moderate gradient mixed control	Good	Good
RC05	3,780 feet upstream of 144th Street to 700 feet downstream of 157th Street	2,100	Moderate gradient mixed control	Good	Good
RC06	700 feet downstream of 157th Street to 157th Street	700	Floodplain	Fair	Fair
RC07	157th Street to end of palustrine influence	2,000	Palustrine	Good	Good

Barriers to Fish Passage

In Reach RC03, west of Wright-Bliss Road under 144th Street is an oval corrugated metal pipe culvert (Barrier 105K042717b) that is a partial fish passage barrier for fry due to velocities during high flows as seen in *Photograph 14*. Spawners move only to find available habitat, but quiet water is available just downstream on the culvert, so replacement or modification of the culvert is a low priority.

Water Quality

The results of the water quality sampling effort conducted for this stream are shown and described in *Chapter 5*.

Water Quantity

Rocky Creek exhibits low summer flows creating potential for inhibiting fish passage during critical life stages. As a result, the stream is governed by *WAC 173-515-040* prohibiting water availability for new water rights from June 1 – October 31. Applications for new water rights outside of this time frame are subject to required instream flow quantities.

A water level measuring device was installed in Rocky Creek by River Measurement, Ltd., a subcontractor to URS. The device measures water level (also known as “stage”) in the creek every 15 minutes. This gauge has been in operation since February 2004. Data from the gauging device is collected and stage and discharge measurements taken approximately once a month. A rating table was created using the stage and discharge measurements taken. The rating table was used to correlate the 15-minute stage readings with stream discharge estimates.

Measurements made during the year ranged in discharge from 2.66 to 22.1 cfs. Computed discharges during the water year ranged from 2.64 to 41.3 cfs.

4.6.8 Rocky West Tributary

Stream 15.0021, located in the Rocky subbasin (subbasin 14), is an unnamed western tributary of Rocky Creek that is sometimes called Rocky West Creek. The main stem of Rocky West Creek is about two miles long. Its gradient is shallow. The headwaters of the stream originate just west of Fern Lake. Rocky West Creek flows in a southerly direction for 1.5 miles before turning east and entering Rocky Creek near 144th Street. The stream supports coho and cutthroat.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors walked approximately 5,000 feet of stream corridor along Rocky West Creek. The stream was divided into four reaches as shown in *Figure 4-12*. The characteristics of aquatic habitat and the riparian corridor are shown in *Table 4-24*. The stream contains 16% “Poor”, 46% “Fair”, and 38% “Good” aquatic habitat. Sixteen percent of the riparian corridor is in “Poor” condition, 9% “Fair”, and 75% “Good”. The conditions of the stream reaches are show in *Figure 4-12*.

Reach RW01 begins at 144th Street and extends 1,510 feet upstream to a canopy opening and canopy change from the predominance of conifers to a more deciduous forest. This reach was rated as having the best habitat conditions on Rocky West Creek with a “Good” rating for both the aquatic and riparian habitat conditions. The channel was sinuous with multiple side channels. Juvenile lampreys were observed. Although the riparian habitat was rated “Good”, there were some clearcuts and openings in the canopy.

RW02 was given a rating of “Poor” for both the aquatic and riparian conditions. There was increased fine sediment and the substrate was heavily embedded. There was almost no LWD for the initial 500 feet of the stream reach and trash was observed in all sections of the reach. There was no riparian corridor in several locations in the reach and stands of Japanese knotweed were noted.

RW03 is a palustrine channel type that began at a beaver dam complex and extended to the beginning of a conifer canopy. Historical forestry operations logged to the edge of the stream, leaving no canopy cover. The reach contained a “Good” native shrub layer with douglas spiraea, sedge species, and rush species. The last reach, RW04, was over 2,000 feet long with “Fair” aquatic habitat and “Good” riparian habitat. Several small tributaries entered the stream throughout RW04. This section of the stream was characterized by brushy vegetation that prohibited stream access for hundreds of feet.

Barriers to Fish Passage

A culvert located on RW01 is a potential fish passage barrier due to the outfall and slope conditions, as shown in *Photograph 15*. *Photograph 16* shows a private driveway bridge along RW02 that has a potential to be a velocity limitation during high flows.

Water Quality

No water quality data is available for Rocky Creek West. During the stream surveys it was noted the stream was quite silty, possibly from logging operations upstream. Water quality sampling was not conducted on this creek.

Water Quantity

Rocky West Creek exhibits low summer flows creating potential for inhibiting fish passage during critical life stages. As a result, the stream is governed by *WAC 173-515-040* prohibiting water availability for new water rights from June 1 – October 31. Applications for new water rights water outside of this time frame are subject to required instream flow quantities.

4.6.9 Schoolhouse Creek- KP

Schoolhouse Creek (15.0039), located in the Schoolhouse (KP) subbasin (subbasin 15), on Key Peninsula, is approximately 1 mile long and enters the northernmost end of Filucy Bay. Coho, cutthroat, and chum salmon, have been observed in the stream. The stream has a variable gradient. Starting out at a low gradient of less than 1%, the stream steepens to 8% gradient, requiring weirs for fish passage. In the third reach the stream returns to a gradient of 1% before accessibility limited further field work.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors walked approximately 2,000 feet of stream corridor along Schoolhouse Creek. The stream was divided into three reaches, as shown in *Figure 4-13*. The characteristics of aquatic habitat and the riparian corridor are shown in *Table 4-25*. The stream contains 100% “Poor”

Table 4-24

Rocky West Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
RW01	144th Street to 1,510 feet upstream	1,510	Moderate gradient mixed control	Good	Good
RW02	1,510 feet upstream of 144th St to beaver dam complex	840	Moderate gradient mixed control	Poor	Poor
RW03	Beaver dam complex to end of complex at beginning of conifer canopy	450	Palustrine	Good	Fair
RW04	Beginning of conifer canopy to pond	2,345	Moderate gradient mixed control	Fair	Good

Table 4-25

Schoolhouse Creek (KP)- Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
SC01	Estuary to Reeves Road culvert	440	Moderate gradient contained	Poor	Fair
SC02	Reeves Road culvert to open pasture at 890 feet upstream of Reeves Road	890	Moderate gradient mixed control	Poor	Good
SC03	Open pasture at 890 feet upstream of Reeves Road to end of access at 1,440 feet upstream of Reeves Road	550	Floodplain	Poor	Poor

aquatic habitat and conditions of the riparian corridor are a mixture of “Poor” (29%), “Good” (47%), and “Fair” (23%). The conditions of the stream reaches are shown in *Figure 4-13*. SC01 begins at an estuary and ends at the culvert on Reeves Road, a distance of 440 feet. This first reach includes a moderate gradient contained channel type. Aquatic habitat was rated “Poor” and riparian habitat was rated “Fair” for this reach. Downcutting was evident throughout this reach, particularly downstream of the lowest weir in the stream as seen in *Photograph 17*.

A high degree of embeddedness is evident in the channel. Starting with a less than 1% gradient, the slope increases to 3% at 250 feet and rises to 8% at a series of four manmade weirs between 370 and 410 feet, immediately downstream of the Reeves Road culvert. Two of the weirs, the first two downstream weirs, have 18 – 24 inch drops and are potential barriers to fish passage. The riparian corridor contains a partly open canopy with a mixture of coniferous and deciduous trees. The right bank is an open canopy providing no shade for the stream. Riparian vegetation includes the invasive species blackberry and holly.

Reach SC02, the middle reach, is the longest reach surveyed, at 890 feet. Aquatic habitat is rated “Poor” due to embeddedness and the low number of pools in this reach. The riparian corridor, however, is in “Good” condition, with “Good” cover for the water and along the stream buffer. Flows are very slow and the channel is quite turbid. Downcutting of the channel occurs at high flows.

The Reeves Road culvert in SC01 is undersized causing increased water velocity during high flows and potentially contributing to the downcutting and subsequent turbid flows in the channel of this reach. Scattered large boulders were observed in this reach. The riparian cover consists of a mixed canopy including deciduous trees and some mature conifers on the right bank. At 560 feet the field crew crossed a property line. The right bank changed to young alders adjacent to a mowed field, a potential contributor of turbidity to the stream. Small unidentified fish, less than three inches long were observed in this reach.

At 890 feet, at the start of reach SC03, the field crew encountered an open pasture with no tree canopy. Most of the reach has no canopy. The left bank has canopy cover at 300 feet and the right back at 550 feet, which is the end of the reach. The channel is a floodplain, which has a gradient of 1%. Both aquatic habitat and the riparian corridor are “Poor” for this reach. A drain tile is visible at 20 feet and a small pedestrian bridge is located at 270 feet. A small tributary enters on the left bank at 280 feet. At the time of the field survey, October 10, 2003, the water in this reach was at a very low flow and velocity. The low flow and the lack of canopy are likely contributors to the algae noted in the stream.

Brush in the riparian area and fences prevented further access for this stream.

Barriers to Fish Passage

The culvert (Barrier 105K040519a) on Reeves Road is a barrier due to outfall and slope. Four weirs located downstream of Reeves Road were initially installed to assist with fish passage, but have turned into likely fish barriers over time as seen in *Photograph 18*. Downcutting of the channel creates larger drops and bigger hurdles for the fish to pass through, particularly during low flows.

Water Quality

The results of the water quality sampling effort conducted for this stream are shown and described in *Chapter 5*. WRIA Salmon and Steelhead Habitat Limiting Factors WRIA15 (3) indicates an ostrich farm is located along Reach SC02. This is a potential source of bacteria that could be investigated further.

Field observations on October 10, 2003 noted "Poor" water clarity at the pools of the manmade weirs. As noted earlier, algae was observed in reach SC03, likely a result of the lack of canopy and slow-moving water.

4.6.10 Taylor Bay Creek (subbasin 16)

Taylor Bay Creek (15.0034), located in the Taylor Bay subbasin (subbasin 16), also known locally as Twin Creek, is about 0.5 miles long. The stream supports coho and cutthroat distribution is presumed, to at least the extent of coho. A spawning adult salmon of unknown species was observed at the mouth of stream during the October 2004 field survey.

Characteristics of Fish Habitat and the Riparian Corridor

Surveyors walked approximately 2,100 feet of stream corridor along Taylor Bay Creek. The section of the stream beginning at the end of estuarine influences and extending to the end of the riparian corridor located at Twin Creek Farm was designated as one reach as shown in *Figure 4-14*. The characteristics of the aquatic habitat and the riparian corridor are shown in *Table 4-26*. The stream contains 100% "Fair" aquatic habitat due to low scores for turbidity and embeddedness. One-hundred percent of the riparian corridor is in "Good" condition. The conditions of the stream reaches are show in *Figure 4-14*.

TB01 is a moderate gradient contained channel type. The riparian buffer vegetation is a mixed mid-successional canopy with a well-developed shrub layer. Undercut banks suggest higher flows in winter months. At the end of the reach at the northeastern edge of the farm's property, an electric fence crosses the stream, thus allowing cattle access to Taylor Bay Creek upstream of this point. The last hundred feet of the reach have a limited tree canopy cover and the shrub and herb layer ends at the fence line. The stream beyond the culvert does not have a riparian corridor and is channelized into a straight stream through the surrounding agricultural lands as seen in *Photograph 19*.

Barriers to Fish Passage

No fish passage barriers were noted during the fall 2003 field survey or are reported in other existing documents.

Water Quality

The results of the water quality sampling effort conducted for this stream are shown and described in *Chapter 5*.

Water Quantity

No records of measured discharge were found for Taylor Bay Creek.

Table 4-26

Taylor Bay Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
TB01	End of estuary influence to Twin Creek Farm driveway at 7012 Key Peninsula Highway	2,100	Moderate gradient contained	Fair	Good

4.6.11 Vaughn Creek (subbasin 18)

Vaughn Creek (15.0023A), located in the Vaughn subbasin (subbasin 18), is an independent tributary to Vaughn Bay, located on the western end of Key Peninsula. The stream flows generally southwest and is approximately one mile in length with several smaller connecting tributaries and wetlands. Surveys performed measured the stream at approximately three-quarters of a mile to the upstream-most point of surface water flow where its headwaters originate in a forested wetland complex. Variance in stream length is likely due to seasonal fluctuations in the water table. Vaughn Creek is a low gradient stream, varying from one to two percent throughout its length. Chum, coho, and cutthroat trout are known to occupy Vaughn Creek for all or part of the year. Surveys were performed to the upstream most point of flowing water, approximately 2,000 feet upstream of Olson Road at the time of the survey. The stream extended to a large forested wetland where the stream channel and flow were no longer distinct.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors assessed approximately 4,100 feet of stream corridor along Vaughn Creek. The stream was divided into the five reaches as shown in *Figure 4-15*. The characteristics of aquatic habitat and the riparian corridor are shown in *Table 4-27*. Fifty-four percent of the aquatic habitat was rated as “Good” and 46% was rated “Fair”. The riparian conditions were rated the same as the aquatic conditions. The conditions of the stream reaches are shown in *Figure 4-15*.

VA01, the first or downstream-most reach of Vaughn Creek, begins at its estuary in Vaughn Bay, just behind the Civic Center, to a distance of 300 feet to the end of tidal influence. It is classified as moderate gradient/contained. In this steep wooded ravine, both aquatic and riparian habitat conditions in Reach VA01 were rated as “Fair”. Several parameters in the riparian corridor were compromised throughout the reach including riparian buffer width and snags, although overall canopy cover remained high. Some concrete bank armor was noted within this reach and the substrate was heavily silted. The reach ends at a pair of concrete culverts under a private road as shown in *Photograph 21*.

Reach VA02, classified as moderate gradient/mixed controlled, is rated as being in “Fair” condition. Trees are the dominant streamside vegetation in this reach and the structural diversity comprises two to three vegetation layers. Himalayan blackberry and English ivy are present in some stretches of the reach. There are no snags located in this reach and there is a limited amount of dead and down material. Greater than 75 percent of the water surface is shaded, however, natural vegetation on the right bank does not extend at least two channel widths, compromising the riparian buffer width and recruitment potential. The banks have a small section of artificial hardening and several sideslope failures that are not revegetatated. Several sections of the reach have good substrate composition with gravel as the dominant substrate, but overall silt is the dominant substrate. There is a lack of in-stream cover and large woody debris resulting in a lack of a pool riffle pattern throughout this 1,100-foot stretch of Vaughn Creek.

Reach VA03 as a whole was rated “Good”. It is comprised entirely of a series of active and inactive beaver dams over the 700-foot length of the reach. This reach and those upstream of it are classified as palustrine. The riparian corridor is in “Good” condition with riparian cover, structural diversity, and the presence of snags, although a moderate amount of non-native vegetation was noted. Most aquatic conditions could not be rated due to the significant ponding caused by the beaver dams as seen in *Photograph 22*.

Table 4-27

Vaughn Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
VA01	Civic center to culverts at private driveway 300 feet upstream	300	Moderate gradient contained	Fair	Fair
VA02	Culverts at private driveway 300 feet upstream of survey start to beaver dam complex 140 feet upstream of Olson Road	1,100	Moderate gradient mixed control	Poor	Poor
VA03	Beaver dam complex 140 feet upstream of Olson Road to end of complex	700	Palustrine	Good	Good
VA04	End of beaver dam complex to 700 feet upstream of Olson Road culvert	500	Palustrine	Fair	Fair
VA05	700 feet upstream of Olson Road culvert to end of stream flow	1,500	Palustrine	Good	Good

Reach VA04 was rated “Fair”. This 500-foot reach appears to have been influenced by active beaver dams that have been removed within the last 10 to20 years. Heavy substrate siltation was present and algae growth was noted growing on the surface in areas of slower water. The riparian buffer width and cover are noted in relatively good condition and the channel is sinuous and unconfined. At least one property on McFadden Drive contains an artificial pond that may drain into Vaughn Creek and may contribute pollutants to the waterway.

The upstream most reach of Vaughn Creek, VA05, is the longest reach and is rated in “Good” condition. This reach is comprised of a network of shallow braided channels that meander freely through a wide and diversely vegetated mature western red-cedar and Sitka spruce wetland/riparian complex. There is little evidence of human impacts within this relatively undisturbed reach. The reach also appears to have been formerly influenced by beaver dams.

Barriers to Fish Passage

There is one documented barrier to fish passage located along Vaughn Creek and several unlisted culverts that are potential barriers. The first culvert located along the stream was not documented in any existing data sources. The culvert is a double culvert at the end of VA01 (see *Photograph 21*) under a private, unnamed dirt road. These concrete culverts are perched above the stream with a 1.5-foot drop and may pose a significant barrier to adult and juvenile passage. The second culvert (Barrier 105K042520a) is located at Olson Road, also a double concrete culvert. The third culvert is located along the stream was also not documented in any existing data sources. The double concrete culvert is located under a private driveway in VA04.

Water Quality

The results of the water quality sampling effort conducted for this stream are shown and described in *Chapter 5*.

Water quality conditions in the lower reaches of Vaughn Creek have been potentially affected by residential homes in close proximity to the stream, lack of riparian cover in some reaches, unvegetated banks, and possible runoff from residential lawns. Algae is abundant in some areas.

Water Quantity

The total natural flow of Vaughn Creek and tributaries is required for protection and preservation of instream resources. These waters are closed year-round to further water appropriation (*WAC 173-515-040*). There was no evidence of water withdrawals.

A water level measuring device was installed in Vaughn Creek by River Measurement, Ltd., a subcontractor to URS. The device measures water level (also known as “stage”) every 15 minutes. This gauge has been in operation since November 2003. Data from the gauging device was collected and stage and discharge measurements taken approximately once a month. A rating table was created using the stage and discharge measurements taken. The rating table was used to correlate the 15-minute stage readings with stream discharge estimates.

4.6.12 Whiteman Creek (subbasin 19)

Whiteman Creek (15.0032), located in the Whiteman subbasin (subbasin 19) is less than one mile long, entering Whiteman Cove on Case Inlet, south of Joemma Beach State Park. Its gradient is shallow. A salmonid fish passage barrier at the mouth precludes the use of Whiteman

Creek by anadromous fish. The estuarine function of the stream has been eliminated by the conversion of the mouth to a freshwater lake. The lakeshore is lightly developed. Camp Coleman, an outdoor YMCA environmental camp, is located on 96 acres adjacent to the mouth of Whiteman Creek.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors walked approximately 1,400 feet of stream corridor along the main stem of Whiteman Creek. Two reaches were delineated as shown in *Figure 4-16*. The characteristics of aquatic habitat and riparian habitat are shown in *Table 4-28*. One-hundred percent of the aquatic habitat was rated "Poor". Fifty-eight percent of the riparian corridor was rated "Fair" and 42% was rated "Poor".

Reach WH01's riparian corridor is rated "Poor" and consists of a non-native shrub layer composed of Himalayan blackberry, reed canary grass, and English ivy as seen in *Photograph 23*. The substrate is predominantly a silt and sand substrate. The water clarity quickly degrades adjacent to the lawns situated on both banks of the stream. Reach WH02 showed a slight improvement along the riparian corridor due to the older age class and the more diverse composition of the forest community, although the width and density were still compromised and invasives were present. The aquatic habitat is degraded by channelization, downcutting, and abutment failure, and the presence of oil drums in the stream channel. The reach ended at the Whiteman Road culvert where the stream became dry.

Barriers to Fish Passage

The outlet of Whiteman Cove located at Whiteman Cove Lake is regulated by two weir-flow structures as seen in Photograph 24. The structures regulate flow through culverts (Barriers 105K041717a and 105K041717b) that flow under the road that spans the cove excluding anadromous fish passage to the stream. The outfall from the dam is creating significant foaming at the outlet cascade.

A culvert located on Whitman Cove Road (Barrier 105K041118a) is a barrier due to slope. The area is a slow flowing wetland and may be a barrier itself. Upstream of the unsurveyed reaches just south of Whiteman Road Cove Road on Whiteman Road is a culvert (Barrier 105K041718a) that is a barrier due to outfall and slope.

Water Quality

The results of the water quality sampling effort conducted for this stream are shown and described in *Chapter 5*.

Water Quantity

No records of measured discharge were found for Whiteman Creek.

Table 4-28

Whiteman Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
WH01	194th Ave to 19220 Whiteman Cove Road driveway	595	Moderate gradient mixed control	Poor	Poor
WH02	19220 Whiteman Cove Road driveway to Whiteman Road culvert	805	Moderate gradient mixed control	Poor	Fair

4.7 Islands Basin (#17)

4.7.1 Schoolhouse Creek- AI

Schoolhouse Creek (15.0089), located on Anderson Island (subbasin 25), is less than a mile long. The stream enters Oro Bay on the southeast side of the island. Its gradient is shallow. Schoolhouse Creek is the only stream on Anderson Island known to support anadromous salmonids.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors walked approximately 5,000 feet of stream corridor along Schoolhouse Creek. The stream was divided into nine reaches as shown in *Figure 4-17*. The characteristics of aquatic habitat and the riparian corridor are shown in *Table 4-29*. The stream contains 13% “Poor”, 9% “Fair”, and 71% “Good” riparian habitat. The aquatic habitat is 13% “Poor”, 15% “Fair”, and 65% “Good”. The conditions of the stream reaches are show in *Figure 4-17*.

The lowest reach of Schoolhouse Creek begins at the start of the canopy cover, approximately 2,500 feet from the mouth of the stream. Reach AI01 is an estuarine channel type with a glide pattern flowing over siltstone. It is characterized by an immature mixed riparian forest. Invasive species, including holly saplings, are located throughout the riparian. Aquatic and riparian conditions of this reach were rated “Good”. The reach break was determined by the transition from the tidal influence to freshwater, 60 feet downstream of Andy's Park trail as seen in *Photograph 25*.

Upstream is a short reach extending between a change of channel type at the end of Reach AI01 to a culvert at Oro Bay Road. This reach is a moderate gradient mixed control channel type that was rated as “Fair” aquatic habitat due to the lack of LWD and a low frequency of pools; the riparian habitat was rated “Good”. Reach AI03 extends up the main stem 1,200 feet to an opening in the canopy. Overall this reach is in “Good” condition with a sinuous channel pattern.

Reach AI04 begins at the canopy opening at Sandberg Road. Both the aquatic habitat and riparian habitat were rated “Poor”. The beginning of the reach appears straightened and down-cutting is occurring as a result of stream channel modifications. Several invasive species are present including Himalayan blackberry, creeping buttercup, and bull thistle. The end of the reach contains an historical wetland that has been filled with sediment and gravel as seen in *Photograph 26*. Also at this location, the stream is backed up behind a log weir, a cause of stream bank erosion. The next reach, AI05, begins at the culvert and extends to the start of the naturalized section of the stream about 500 feet upstream. This reach is in “Fair” condition with a large thicket of Himalayan blackberry and sections of the reach containing mowed lawn adjacent to the stream bank. AI06 is a short reach in “Good” condition extending to a section of the stream that had no in-stream access for survey work. As a result, AI07 is a section of the stream that was not rated. Access was regained for AI08 and AI09, reaches that both contained overall “Good” habitat conditions. Reach AI08 was characterized by an increase in channel complexity with side channels. The end of the reach contains evidence of in-stream restoration, including four large root wads just downstream of the culvert and a hatch box, for fry, just 50 feet downstream of the end of the reach. The beginning of reach AI09 has evidence of

Table 4-29

Schoolhouse Creek (AI)- Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
AI01	At start of canopy cover, about 2,500 feet from mouth of stream to 60 feet downstream of Andy's Park trail	360	Estuarine	Good	Good
AI02	60 feet downstream of Andy's Park trail to Eckenstam-Johnson Road and Oro Bay Road culvert	270	Moderate gradient mixed control	Fair	Good
AI03	Eckenstam-Johnson Road and Oro Bay Road culvert to canopy opening	1,200	Palustrine	Good	Good
AI04	Canopy opening to culvert at Sandberg Road	640	Palustrine	Poor	Poor
AI05	Culvert at Sandberg Road to start of naturalized section of the stream	470	Moderate gradient mixed control	Fair	Fair
AI06	Start of the naturalized section of the stream to canopy opening	350	Moderate gradient contained	Good	Good
AI07	N/A	350	N/A	N/A	N/A
AI08	Upstream of Sandberg Road 1,170 feet to culvert at 108th Street	650	Moderate gradient contained	Good	Good
AI09	Culvert at 108th Street to 680 feet upstream of 108th Street	680	Moderate gradient mixed control	Good	Good

backwater at the culvert inlet. Several groundwater inputs were observed and the LWD was predominantly coniferous.

Barriers to Fish Passage

There are several barriers to fish passage located along Schoolhouse Creek. Three culverts need further evaluation to determine if they are barriers to fish passage. Three culverts have been identified as fish passage barriers along Schoolhouse Creek. The most downstream culvert is located in AI01 on Ekenstam-Johnson Road at the mouth of Schoolhouse Creek. This culvert requires further evaluation. The structure is submerged at high tides, but is thought to be passable otherwise.

Water Quality

On Anderson Island, pollution from residential development, especially nutrients and pesticides from the many small home lots on the lakeshores, the golf course, and parks, are likely. Also, failing septic tanks and construction impacts are probable causes of degraded water quality. Impacts due to local logging operations are also a potential source of pollution. Seawater intrusion is a known concern for the whole southwestern portion of the island. Water quality sampling was not conducted on this creek.

Salmonid Presence

As reported by the School House Creek Stream Steward (Steward), there are established runs of sea-run cutthroat Coho and Chum salmon in Schoolhouse Creek. Fry are found in all stream reaches from AI09 to salt water. The culverts up-stream to the culvert at stream reach AI08 are passable by fish, according to the Steward. Careful placement of rocks to keep pooling water in the culverts allows this. The Steward further reports that CR-08 is too steep to create a durable pool backing into the culvert. The stumps observed in the stream are placed there to attempt to create a pool in culvert CR-08. Culvert CR-09 was blocked to create a pool which is stocked annually to allow fry to grow in the upper stream.

4.8 Burley – Minter Basin (#25)

4.8.1 Huge Creek

Huge Creek (15.0052), located in Huge subbasin (subbasin 28), is 4.7 miles in length based on Pierce County GIS information. Other documents have reported the length of the stream to be from 3.7 to 5.2 miles long, most likely due to the seasonal flow of the creek. Several tributaries of unknown length are located along Huge Creek. The shallow gradient stream is a tributary of Minter Creek flowing southeast into Minter Creek just north of 140th Street Court. Huge Creek supports coho and cutthroat to the headwaters, and steelhead to Pine Road. Surveys were performed to the Pierce County/Kitsap County line. Conditions in the upper reaches of the stream were not evaluated.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors walked approximately 8,600 feet of stream corridor along Huge Creek. The surveyed section of the stream was divided into the six reaches as shown in *Figure 4-18*. The characteristics of aquatic habitat and riparian corridor are shown in *Table 4-30*. Eighty-three percent of the aquatic habitat was rated "Good", 11% was rated "Poor", and 6% was rated "Fair". Fifty five percent of the riparian habitat was rated "Good", 34% was rated "Fair", and 11% was rated "Poor". The conditions of the stream reaches are shown in *Figure 4-18*.

The lowest reach of Huge Creek is located at the confluence of Minter Creek and Huge Creek extending approximately 2,500 feet upstream. Aquatic habitat conditions in Reach HG01 were rated "Good", while riparian conditions were rated "Fair". Several parameters in the riparian corridor, including riparian buffer width, snags, and riparian cover, were compromised throughout the reach. Also, numerous artificial in-stream structures and modifications for bank stabilization and significant stretches of armoring were noted in this reach.

Overall Reach HG02 and HG03 are in "Good" condition. Although there is an insufficient number of conifers in the canopy cover and a few expanses of degraded or minimal riparian corridor, the riparian conditions are an improvement from Reach HG01. Aquatic habitat is healthy, containing several coho pools as seen in *Photograph 27*. Algae and increased embeddedness was also noted in Reach HG03.

Aquatic habitat in Reach HG04 is still "Good", however the reach is comprised of larger cobbles, intermittent boulders, more silt and sand, and a lack of new recruitment of large woody debris. The riparian corridor vegetation is mid-successional mixed conifer and deciduous. The last two surveyed reaches of Huge Creek were shorter in length and the conditions began to deteriorate rapidly. Lawns and pastures adjacent to the bank became characteristic of the riparian corridor and the remaining cover is more open and lacked structural diversity. Pool frequency became inadequate, and, as a result of the riparian conditions, large woody debris was also scarce.

Barriers to Fish Passage

A broken concrete culvert located under a private driveway bridge at 153rd Street Court warrants further investigation as a potential barrier to fish passage (see *Photograph 28*). The steep slope in Reach HG06 generates high water velocities that make fish passage difficult.

Water Quality

Water quality conditions in the lower reaches of Huge Creek have potentially been affected by several access points for livestock along the stream corridor. The lack of fencing and lack of utilizing best management practices have contributed to high levels of fecal coliform on Huge Creek. Huge Creek has been identified on the 2002/2004 303d list as a water of concern. Specifically, Category 2, for fecal coliform levels, and Category 5, for dissolved oxygen. Water quality sampling was not conducted on this creek.

Water Quantity

Huge Creek has been closed to new water rights since 1973 by *WAC 173-515-040* due to surface water source limitations. Huge Creek exhibits low summer flows and has a potential for drying up or inhibiting anadromous fish passage during critical life stages. Historic flow regimes indicate that no water is available for additional appropriation.

Table 4-30

Huge Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
HG01	Mouth of Huge Creek to 2,435 feet upstream	2,435	Moderate gradient mixed control	Good	Fair
HG02	2,435 feet upstream to 153rd Street Court	2,820	Moderate gradient mixed control	Good	Good
HG03	153rd Street Court to 1,000 feet upstream of 153rd Street Court	1,000	Moderate gradient mixed control	Good	Good
HG04	1,000 feet upstream of 153rd Street Court to 880 feet upstream of 153rd bridge	880	Moderate gradient mixed control	Good	Good
HG05	880 feet upstream of 153rd bridge to log jam 1,410 feet upstream of 153rd	530	Moderate gradient mixed control	Fair	Fair
HG06	Log jam 1,410 feet upstream of 153rd to culvert at 160th Street/County Line Road	950	Moderate gradient mixed control	Poor	Poor

4.8.2 Minter Creek

Minter Creek (15.0051), located in the Minter subbasin (subbasin 29), is approximately 6.3 miles long with two major tributaries (Huge and Little Minter Creeks) and several minor tributaries. In total, the watershed drains approximately 8.5 square miles and rises from sea level to approximately 1,312 feet. The headwaters of Minter Creek are located in Kitsap County north of Pine Road. The stream flows into Minter Bay and eventually into Case Inlet. The basin is largely rural and is characterized by low-density residential housing and agriculture. Approximately two-thirds of the watershed is forested. The stream supports runs of Chinook, coho, steelhead, cutthroat, and chum salmon.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors walked approximately 17,000 feet of stream corridor along Minter Creek, upstream to the Kitsap/Pierce County line. The surveyed section of the stream corridor was divided into twelve reaches as shown in *Figure 4-19*. The characteristics of aquatic habitat and the riparian corridor are shown in Table 4-31. The stream contains 9% “Poor”, 5% “Fair”, and 85% “Good” aquatic habitat, and 26% “Poor”, 3% “Fair”, and 71% “Good” riparian habitat. The condition of the stream reaches is shown in *Figure 4-19*.

Aquatic and riparian habitat conditions on Minter Creek were mixed, with the majority of both habitat types rated as “Good”. Generally, Minter Creek scores higher in aquatic habitats than in riparian habitats. Only reaches MN01 and MN09 scored “Poor” in aquatic habitat, while reaches MN01, MN05, MN07 through MN09, and MN11 scored “Poor” for riparian habitat. Off-channel habitat, well-developed sinuous channel lengths, and an abundance of LWD characterized the aquatic habitat of the reaches surveyed with “Good” characteristics. Reaches with “Poor” or “Fair” characteristics were generally either lacking in complexity, had a modified riparian buffer area, or were directly affected by roads within the riparian or floodplain areas. Throughout the stream, juvenile salmonids and redds were observed, and adult Chinook were observed in the lower reaches.

WDFW operates Minter Creek Hatchery, a major feature of the Minter Creek Basin. The hatchery adversely affects habitat conditions such as passage and riparian conditions in reach MN01, while providing important regional fisheries enhancement. The hatchery operates the Hupp Springs rearing ponds in Reach MN03, and draws artesian well water to operate the ponds, then releases water through a small “tributary” outfall channel (observed to be clean and cold). Annually, the hatchery removes migrating fall Chinook, coho, and chum salmon as broodstock, and releases outmigrant fingerlings and smolts into Minter Creek and other Puget Sound streams. In 2002-2003, approximately 9,300 fall Chinook, 52,000 chum salmon, and 14,700 coho salmon spawners were trapped from Minter Creek. Approximately 9,500 chum and 602 coho smolts were later released into Minter Creek. No Chinook smolts were released into Minter Creek. The hatchery also provides some outplants and eggs for nearby Puget Sound hatcheries and streams.

Reaches MN01- MN04 were very shallow gradient palustrine and floodplain channel types. The lowest reach of Minter Creek (MN01) begins at the estuary outfall at Creviston Drive and extends upstream 1,200 feet to outfall pipes from the Minter Creek Hatchery. Reach MN01 is heavily influenced by the presence of the hatchery, which affects active floodplain width, fish passage, and to some extent water quality in the reach. Water diversions, intake, and outfall structures alter natural habitat forming processes in the reach, and the facilities limit riparian buffer width and quality. Evidence of nutrient enrichment was observed at the hatchery outfall pipes. This reach scored "Poor" in both aquatic and riparian condition.

Reaches MN02 and MN03 are floodplain channel types with unconfined channels and wide active floodplains. They provide significant off-channel and holding pool habitats. LWD and coho holding pool tallies were among the highest surveyed in the Key Peninsula area. Together MN02 and MN03 extend almost 5,350 feet, and are separated by the State Route 302 crossing. This box culvert may constrict flows, but does not constitute an impediment to fish passage. A redd and several larger salmonids in holding pools were observed in both reaches. Some bank armor was observed in two locations in MN02, and a right-bank livestock access point was observed in MN03, 1,000 feet upstream of State Route 302, which may be a point source of turbidity and/or fecal coliform.

MN04 is a slightly higher gradient floodplain channel with abundant deep pools, well-established side channels, and "Good" cover. Bankfull widths ranged from 20 to 40 feet. This reach also scored high in LWD and riparian function, though riparian vegetation was primarily deciduous. Minter Creek Hatchery operates the Hupp Springs rearing ponds in this reach, with water withdrawals and an outfall that does not appear to affect water quality. Riprap reinforcement had been placed around the west bank abutment for a footbridge crossing to the Hupp Springs facilities at 640 feet upstream of the MN03/MN04 reach break. An east bank slump of natural origin was observed at 1,865 feet and was contributing both sediment and LWD to the system. MN04 ends at the confluence with Huge Creek.

Reaches MN05 through MN09 are moderate gradient mixed control channel types, with slightly more confinement and higher gradients than the lower reaches. Aquatic habitat and riparian conditions ratings were mixed through all the reaches. Reach MN05 is 1,000 feet long and ends at a west bank failure area. A water withdrawal was observed at 330 feet, and a private bridge crossing at about 640 feet may restrict the channel. Deep holding pools were less frequent than in the lower reaches, but pools and in-stream complexity were well distributed. Riparian buffer widths were narrow and riparian vegetation had been removed from several locations. Riparian canopy cover was adequate throughout MN05. Reach MN 06 is 450 feet long and ends at a box culvert at 144th Street. This reach had characteristics similar to MN05, but riparian conditions had degraded further, with frequent gaps in vegetative cover and influence of roadways. Despite "Poor" riparian conditions, both MN05 and MN06 have "Good" aquatic habitat scores.

MN07 begins at 144th Street and extends 1,027 feet upstream. This reach also has "Good" aquatic habitat conditions and "Poor" riparian buffer width and is influenced by both 144th Street and 188th Avenue NW. A concrete box culvert under 144th Street is not a fish passage impediment, but likely constrains high flows and limits stream channel migration.

MN08 parallels 118th Avenue NW and scored "Fair" in aquatic habitat and "Poor" in riparian condition. Stream bank erosion is evident at 288 feet and the stream crosses under 118th Avenue NW at 350 feet through a concrete box culvert.

Table 4-31

Minter Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
MN01	Creviston Road at the Minter Creek Hatchery road to 1,200 feet upstream	1,200	Palustrine	Poor	Poor
MN02	1,200 feet upstream of the hatchery road to culvert at SR 302	4,100	Floodplain	Good	Good
MN03	Culvert at SR 302 to tributary 1,250 feet upstream of SR 302	1,250	Floodplain	Good	Good
MN04	Tributary 1,250 feet upstream of SR 302 to confluence with Huge Creek	2,055	Floodplain	Good	Good
MN05	Confluence with Huge Creek to 1,000 feet upstream of the confluence with Huge Creek	1,000	Moderate gradient mixed control	Good	Poor
MN06	1,000 feet upstream of the confluence with Huge Creek to 144th Street	450	Moderate gradient mixed control	Good	Fair
MN07	144th Street to vegetation change 1,027 feet upstream of 144th Street	1,027	Moderate gradient mixed control	Good	Poor
MN08	1,027 feet upstream of 144th Street to culvert at 149th Street	703	Moderate gradient mixed control	Fair	Poor
MN09	Culvert at 149th Street to 118th Avenue	2,900	Moderate gradient mixed control	Poor	Poor
MN10	118th Avenue to 2,020 feet upstream of 155th Street	2,020	Floodplain	Good	Good
MN11	2,020 feet upstream of 155th Street to 1,300 ft upstream of 118th/155th	200	Floodplain	Fair	Poor
MN12	1,300 ft upstream of 118th/155th to Pierce County/Kitsap County Line	2,680	Moderate gradient mixed control	Good	Good

Reach MN09 scored poorly for both aquatic habitat and riparian conditions, due primarily to stream bank and channel alterations and lack of riparian function. The stream flows through several agricultural fields and under 118th Avenue NW at 380 feet. From approximately 850 feet to 1500 feet, the stream flows through a series of residential lots and has been extensively altered for aesthetics and, presumably, flood protection. Riparian vegetation consists of lawn grass and few isolated large trees. Footbridges cross the stream in several locations and rock armoring is frequent as seen in *Photograph 30*. The reach generally lacks cover and complexity and has little LWD.

In some locations, homeowners have placed anchored rootwads and logs as bank stabilization, providing nominal cover. Algae blooms are evident through this section, possibly the result of lawn fertilizer entering the stream channel. At about 1,800 feet, the stream enters an agricultural field and continues to lack mature riparian cover. Dense shrubs provide canopy cover over the channel, but comprise a narrow riparian buffer with no LWD and recruitment potential; otherwise riparian vegetation is primarily grass throughout. A sixty-foot-long side channel is evident at 2,210 feet and provides "Good" off-channel refugia and rearing habitats. The reach ends at 118th Avenue NW.

Reach MN10 is a floodplain channel type and is 2,020 feet in length beginning at a concrete box culvert under 118th Avenue NW. This culvert is not a passage impediment. Though this reach parallels 118th Avenue NW, it remains generally unconfined. MN10 received high scores for both aquatic habitat and riparian conditions and consisted of braided and complex channels for approximately 1,000 feet to a culvert crossing at 155th Street Court. From 1,100 to 1,400 feet riparian cover becomes slightly thinner, with more reed canary grass and less LWD in the channel. A private bridge is present over the stream at 1,700 feet, but does not constrict flow or limit passage.

Reach MN11 is a floodplain channel type, and extends only 200 feet through a rural residential property. Riparian vegetation is non-existent through this reach and LWD is scarce. Aquatic habitat has a "Poor" rating and riparian conditions rate "Fair" in this reach. Reach MN12 extends 2,680 feet upstream from reach MN11 to the Kitsap/Pierce county line.

MN12 has a mixed control moderate gradient channel type. Aquatic habitat and riparian conditions both received "Good" ratings, though LWD was slightly scarcer than in the lower reaches. Riparian vegetation provided "Good" canopy cover throughout, but in two locations consisted primarily of brush rather than trees. Between 700 and 1,900 feet, riparian conditions were excellent, consisting of mature conifer forest and complete canopy closure. An uncontrolled horse/off road vehicle trail crosses the stream channel at 2,300 feet and is a point source of turbidity.

Barriers to Fish Passage

There are numerous potential impediments to fish passage in the mainstem of Minter Creek. Diversion and intake structures for the Minter Creek Hatchery have historically presented passage barriers. One culvert in Kitsap County upstream of the surveyed reaches east of Glenwood Road on Minterbrook Road is a partial barrier due to being undersized. Two culverts (105K050817a and 105K050416b) have been designated for replacement by the South Puget Sound Salmon Enhancement Group (SPSSEG) along Minter Creek. They are in reach MN10 and in Kitsap County, respectively. In addition, 118th Avenue NW crosses the stream in at least four locations with concrete box culverts. While these are not designated as barriers, they may present seasonal low flow impediments for some species.

Water Quality

Several minor point sources of turbidity were noted during the surveys as described above. The results of the water quality sampling effort conducted for this stream are shown and described in *Chapter 5*.

Water Quantity

Minter Creek exhibits low summer flows creating potential for inhibiting fish passage during critical life stages. As a result, the stream is governed by *WAC 173-515-040* prohibiting water availability for new water rights from June 1 – October 31. Applications for new water rights outside of this time frame are subject to required instream flow quantities.

A water level measuring device was installed on Minter Creek by River Measurement, Ltd., a subcontractor to URS. The device records water levels (also known as “stage”) in the creek every 15 minutes. This gauge has been in operation since November 2003. Data from the gauging device was collected and stage and discharge measurements taken approximately once a month. A rating table was created using the stage and discharge measurements taken. The rating table was used to correlate the 15-minute stage readings with stream discharge estimates.

Measurements made in Minter Creek ranged in discharge from 15.7 to 183 cfs. The rating curves were used to compute discharges ranging from 14 to 268 cfs during the water year.

4.8.3 Little Minter Creek

Little Minter Creek (15.0049), located in the Minter subbasin (subbasin 29), is a tributary of Minter Creek and about three miles long. The headwaters are located in a wetlands complex near 82nd Avenue NW and the Kitsap-Pierce County line. Little Minter Creek flows southwesterly to Minter Creek. Its gradient is shallow. Little Minter is a small system with a channel width that is generally less than three feet. The stream supports coho, cutthroat, and steelhead to Pine Road.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors walked approximately 13,000 feet of stream corridor along Little Minter Creek. The stream was divided into nine reaches as shown in *Figure 4-19*. The characteristics of aquatic habitat and the riparian corridor are shown in *Table 4-32*. The stream contains 29% “Poor”, 11% “Fair”, and 60% “Good” aquatic habitat. Twenty-nine percent of the riparian corridor is in “Poor” condition and 71% is in “Good” condition. The conditions of the stream reaches are show in *Figure 4-19*.

The lowest reaches of Little Minter Creek were moderate gradient mixed control channel types. Riparian and aquatic conditions of LM01 and LM02 were rated “Poor”. The riparian habitat of LM01 was characterized by the presence of invasive species, including large stands of Japanese knotweed, English ivy, and reed canary grass. “Good” aquatic conditions in this reach were lacking due to small, infrequent, and mainly deciduous LWD, stretches of armoring, channelization, and the presence of several weirs in the stream channel that were causing erosion. LM02’s riparian vegetation consisted mainly of Himalayan blackberry and the canopy layer was absent for most of the reach. Several large, vacant buildings that are probably situated in the floodplain were located in this reach. Two nonfunctioning concrete weirs approximately ten feet wide with a four feet gap between the weirs were also present in this reach as seen in *Photograph 31*. Flow was observed to be going under the upstream weir and a large plunge pool was noted.

Approximately 1,120 feet upstream of the lower two reaches, LM03 contained improved conditions. The aquatic conditions were rated “Fair”, while riparian conditions were rated “Good”. LM04 is also an improved reach with both the aquatic and riparian conditions rated “Good”. The channel appears to be more sinuous in the upper reaches than in the lower reaches and the riparian was comprised of a mature coniferous canopy.

Reaches LM05-LM07 were consistently rated “Good” for both aquatic and riparian habitat conditions. Reach LM08, located approximately 3,000 feet upstream of 144th was rated “Poor” for aquatic and riparian habitat conditions. A pasture and manicured lawns were located adjacent to the stream banks allowing for minimal to no riparian buffer. The gravel was observed to be embedded with approximately six inches of fines. Reach LM09, extending from the end of LM08 to 94th Avenue, returned to “Good” habitat conditions. This reach meanders through a herb/shrub wetland that appears to be an old beaver pond. The stream flows through and around willow root masses creating pools. In some areas, flow fans out through emergent vegetation. Dense areas of sedges, Douglas spirea, and willows dominate the wetland complex. The substrate is primarily sand/silt. There is abundant fish presence with significant off-channel rearing habitat.

Barriers to Fish Passage

A culvert (Barrier 105K050121a) located at 118th and State Route 302 in Reach LM02 is a barrier to fish passage due to failure. The culvert bottom is rusted, allowing the flow to pass underneath the culvert, rather than through the culvert. A slope break approximately 15 feet from the downstream end has created a rapid drop. The culvert is currently scheduled to be replaced in 2005. In Reach LM03, old in-stream LWD has been undermined allowing the flow to pass below and between the logs. The weir forms a plunge pool, causing sedimentation upstream. The structure is likely a passage barrier at low flows. In LM09 under 94th Avenue, a culvert (Barrier 105K050416a) needs further evaluation to determine its barrier status.

Water Quality

The results of the water quality sampling effort conducted for this stream are shown and described in *Chapter 5*. Historically, the highest levels of fecal coliform have been documented on the upper sections of Little Minter Creek. The pollution source has been identified as poor livestock management. Road run-off and other non-point sources of pollution were also noted to cause degradation of water clarity throughout the stream, particularly in the lower reaches of Little Minter Creek.

Table 4-32

Little Minter Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
LM01	Mouth of stream to 118th Avenue	1,860	Moderate gradient mixed control	Poor	Poor
LM02	118th Avenue to 1,120 feet upstream of 118th Avenue at improved canopy cover	1,120	Moderate gradient mixed control	Poor	Poor
LM03	1,120 feet upstream of 118th Avenue at improved canopy cover to 950 feet upstream of 115th.	1,350	Moderate gradient mixed control	Fair	Good
LM04	950 feet upstream of 115th Avenue to 1,670 feet upstream of 115th Avenue	820	Moderate gradient contained	Good	Good
LM05	1,670 feet upstream of 115th Avenue to 144th Street	1,980	Moderate gradient mixed control	Good	Good
LM06	144th Street to 860 feet upstream of 144th Street	860	Moderate gradient contained	Good	Good
LM07	860 feet upstream of 144th Street to 2,860 feet upstream of 144th Street	2,000	Floodplain	Good	Good
LM08	2,860 feet upstream of 144th Street to 3,640 feet upstream of 144th Street	750	Moderate gradient mixed control	Poor	Poor
LM09	3,640 feet upstream of 144th Street to 94th Avenue	2,000	Paulstrine	Good	Good

4.8.4 Purdy Creek (subbasin 30)

Purdy Creek

Purdy Creek is an independent tributary that flows into the southeast corner of Burley Lagoon. The stream flows generally southwest and is approximately 3.5 miles long, with 1.4 miles within Pierce County. Its gradient is shallow, varying from 2-3% throughout the surveyed area. Chinook, chum, coho, steelhead, and cutthroat trout are known to occupy Purdy Creek for all or part of the year (WRIA 15, 2000). The portion of Purdy Creek north of 160th St NW (the Pierce/Kitsap County line) was initially surveyed beyond the County line to approximately 200' downstream of Bandix Road, for a total of 2.8 miles of stream assessed. Barrier and culvert assessments continued to 500 feet upstream of Bandix Road. This report only describes those reaches assessed within Pierce County.

Characteristics of Aquatic Habitat and the Riparian Corridor

Surveyors assessed approximately 1.4 miles of stream corridor along Purdy Creek within Pierce County. The portion of Purdy Creek within Pierce County was divided into seven reaches as shown in *Figure 4-20*. The characteristics of aquatic habitat and the riparian corridor are shown in *Table 4-33*. Of the 7,290 feet of stream length in Pierce County, 12% of the aquatic habitat was rated as “Good”, 79% was rated “Fair”, and 9% was rated as “Poor”. 56% of the riparian habitat was rated “Good”, 16% was rated “Fair”, and 28% was rated “Poor”. The conditions of the stream reaches are shown in *Figure 4-20*.

Reaches PR01 and PR02 are tidally influenced and are classified as estuarine. The remaining reaches are classified as moderate gradient/mixed controlled. The first, or downstream-most reach of Purdy Creek, PR01, begins in Burley Lagoon within the estuary and extends to the 144th St NW culvert for a length of 300 feet. The aquatic conditions within this reach were rated as “Fair” and the riparian conditions were rated as “Poor”. The lack of vegetation coverage and presence of invasive plant species associated with Purdy Drive NW account for the low riparian ratings.

PR02 is tidally influenced and was rated in “Fair” condition for both aquatic and riparian conditions. The left bank consists of the Purdy Road NW road grade. Reed canary grass, undercut banks, and channel erosion are present within this 320-foot reach as seen in *Photograph 33*.

PR03 is the longest reach within Purdy Creek, measuring approximately 3,300 feet. Aquatic conditions were rated as “Fair” and riparian conditions were rated as “Good”. Residential homes are scattered within the riparian zone. Livestock access and evidence of recent streamside herbicide use, as seen in Photograph 34, were noted within this reach. LWD is not abundant and is limited to deciduous pieces. This low gradient reach allows for some floodplain connectivity and off-channel/storm refuge. Canopy cover was generally rated as “Good”, although non-native species associated with the streamside residential homes have encroached in the riparian zone. Several smaller tributaries are noted within this reach.

Table 4-33

Purdy Creek - Condition of Aquatic Habitat and Riparian Corridor

Reach Designation	Reach Description	Reach Length (ft)	Channel Type	Aquatic Habitat	Riparian Corridor
PR01	300 feet downstream of culvert under Hwy 302 to culvert under Hwy 302	300	Estuarine	Fair	Poor
PR02	Upstream of culvert under Hwy 302 to 144th Street culvert	320	Estuarine	Fair	Fair
PR03	144th Street culvert to SR 16	3,300	Moderate gradient mixed control	Fair	Good
PR04	SR 16 to 840 feet upstream	840	Moderate gradient mixed control	Good	Fair
PR05	840 feet upstream of SR 16 to 1,530 feet upstream of SR 16	690	Moderate gradient mixed control	Poor	Poor
PR06	1,530 feet upstream of SR 16 to 2,600 feet upstream of SR 16	1,070	Moderate gradient mixed control	Fair	Poor
PR07	2,600 feet upstream of SR 16 to 3,370 feet upstream of SR 16	770	Moderate gradient mixed control	Fair	Good
PR08, Kitsap Cty	3,370 feet upstream of SR 16 to 160th Street	600	Moderate gradient mixed control	Poor	Poor
PR09, Kitsap Cty	160th Street to 600 feet upstream of 160th Street	830	Moderate gradient mixed control	Good	Fair
PR10, Kitsap Cty	600 feet upstream of 160th Street to 1,430 feet upstream of 160th Street	800	Moderate gradient mixed control	Good	Good
PR11, Kitsap Cty	1,430 feet upstream of 160th Street to 2,230 feet upstream of 160th Street	400	Moderate gradient mixed control	Good	Good

Table 4-33

Purdy Creek - Condition of Aquatic Habitat and Riparian Corridor

PR12, Kitsap Cty	2,230 feet upstream of 160th Street to tributary 200 feet downstream of Bandix Road	N/A	N/A	N/A	N/A
PR13, Kitsap Cty	200 feet downstream of Bandix Road to 800 feet upstream of Bandix Road	N/A	Estuarine	N/A	Poor
PR14, Kitsap Cty	800 feet upstream of Bandix Road	570	N/A	N/A	N/A

PR04 extends from State Route 16 to 840 feet beyond State Route 16. This reach was rated as "Good" for aquatic habitat and "Fair" for riparian habitat. Most of the reach is buffered by mature mixed coniferous riparian vegetation that becomes less abundant at the upper ends of this reach. LWD is abundant and most in-stream features rate relatively high within this reach.

PR05 is 690 feet in length and was rated as the poorest quality reach for both aquatic and riparian features. Significant concrete bank armor lines the left bank and residential homes are built close to the top of the steep stream banks. Riparian vegetation is compromised and LWD and pools are absent.

PR06 is the second longest reach within Purdy Creek, measuring 1,070 feet. Aquatic conditions were rated as "Fair" and riparian conditions were rated as "Poor". An agricultural drainage ditch enters Purdy Creek within this reach and uncontrolled livestock watering occurs. The riparian corridor is narrow and non-native species are present.

The final reach of Purdy Creek within Pierce County is PR07, approximately 770 feet in length. Aquatic conditions are rated as "Fair" and riparian conditions are rated as "Good". A wide and diverse riparian zone has protected the banks from erosion. Lack of LWD and infrequent pools contributed to the lower aquatic habitat rating.

Barriers to Fish Passage

There are four barriers or potential barriers to fish passage along Purdy Creek. PR02 contains a box culvert of undetermined length (Barrier 105K051515b). PR03 contains a corrugated metal pipe culvert under SR 16 (Barrier 105K051122a). PR04 contains a three-foot diameter concrete culvert (Barrier 105K102520a) which appears to be partially failing. PR07 contains a concrete culvert and weir (105K050920c).

Water Quality

The results of the water quality sampling effort conducted for this stream are shown and described in *Chapter 5*. Water quality conditions in all surveyed reaches of Purdy Creek has been potentially affected by residential homes in close proximity to the stream, lack of riparian cover in some reaches, unvegetated banks, possible runoff from residential lawns, and small pipes contributing water to the stream of an undetermined source.

Water Quantity

An unscreened water withdrawal was observed on the left bank from a small pumphouse in reach PR03.

4.9 Fox Island Basin (#26)

Fox Island is approximately 5 miles long with about 12-miles of shoreline. The south end and southwest side of Fox Island are characterized by high bluffs between 200 and 300 feet high. The northeast side has more gentle slopes. Fox Island has six unnamed streams. These streams are minor drainages that have been routed to culverts. As a result, they are unable to support salmon. For purposes of characterizing the streams, the following descriptions identify the unnamed individual streams as FI01-FI06.

Characteristics of Fish Habitat and the Riparian Corridor

The conditions of the stream reaches are shown in *Figure 4-21*. FI01 was observed at 12th Avenue. The aquatic habitat on FI01 is deeply incised, channelized, and highly embedded. The flow width was approximately 3 feet with a bankfull width of approximately 7 feet. The riparian corridor was composed of greater than 25% invasive species, including English Ivy and Himalayan Blackberry.

FI02 was a very small channel and no flow was observed from Hyak Drive during the survey visit. FI03 was observed from 10th Court. The stream was more natural than the other streams on Fox Island and had a “Good” gravel/cobble substrate. The riparian habitat was composed of mostly invasive species including English Ivy. The riparian corridor was narrow, averaging approximately 20 feet in width. The overall habitat appeared to be “Fair” downstream of Hyak Drive and “Poor” upstream of Hyak Drive.

FI04 was observed at Gway Drive. The overall aquatic and riparian habitat was observed to be “Poor”. FI05 was observed from Fox Drive and had almost no flow. A flow was observed on FI06, but only a small percentage of the flow was going through the culvert, likely due to road damage.

Barriers to Fish Passage

It is not known whether there are salmonid passage barriers on this stream on Fox Island.

Water Quality

No records of water quality were found for the streams located on Fox Island. No water quality sampling was conducted for this creek.

Water Quantity

No records of measured discharge were found for the streams located on Fox Island.

4.10 Raft and Ketron Islands (#17)

Raft and Ketron Islands are both small islands within the Key Peninsula Basin. Ketron Island drains a total of 150 acres, while Raft Island drains 200 acres. These islands weren’t surveyed due to the combination of factors of small basins, very short streams that drain directly to Puget Sound, and the lack of reports of problems in these areas.

4.11 Results of Benthic Invertebrate Survey

The analysis of benthic macroinvertebrate community structure, when integrated with physical habitat data, offers an approach for assessing impacts of multiple stressors to surface waters. Benthic macroinvertebrate samples were collected, by Pierce County, in three locations: Rocky Creek on September 12, 2003, Little Minter Creek on October 5, 2004, and Minter Creek on September 6, 2004. These samples provide additional information on water quality for Rocky, Little Minter and Minter Creeks.

The Benthic Index of Biological Integrity (B-IBI) is a measure of a stream's biological health. The B-IBI is composed of 10 different biological metrics that are sensitive to changes in biological condition caused by human activities. Each of the individual metrics reflect the condition of important biological components. These components provide insight and clues about the types of degradation responsible for changes within the biological community of benthic macroinvertebrates.

Each of the 10 metrics receives a rank of 1, 3, or 5, with higher numbers indicating better biological integrity. Overall B-IBI values can be interpreted qualitatively by using the following classes of biological condition:

B-IBI Biological Condition

Score	Grade	Definition
50-46	Healthy	Ecologically intact, supporting the most sensitive life-forms.
44-36	Compromised	Showing signs of ecological degradation. Impacts expected to one or more salmon life-stages.
34-28	Impaired	Healthy ecosystem functions demonstrably impaired. Cannot support self-sustaining salmon populations.
26-18	Highly impaired	Highly adverse to salmon and various other life-forms.
16-10	Critically impaired	Unable to support a large proportion of once-native life-forms.

A value close to 50 indicates that the stream's biology is equivalent to what would be found in a "natural" stream of that area. A value close to 10 indicates a poor biotic condition within the stream. As in the case for the samples in Rocky and Little Minter Creeks, the score is usually somewhere in between these two extremes.

It is important to not only look at the final B-IBI score, but to look at the individual metric scores for clues to the types of impacts affecting the final score. For example, is there a high percentage of pollution tolerant taxa?, were long lived taxa present?, were sediment tolerant taxa present?. The individual metrics, the original data set, and notes on the land uses surrounding the site will help to understand the processes occurring within and around the sampling site.

The ten 10 biological metrics include:

- Total number of taxa
- Number of Ephemeroptera (mayflies) taxa
- Number of Plecoptera (stoneflies) taxa
- Number of Trichoptera (caddisflies) taxa
- Number of Long-lived taxa
- Number of Intolerant taxa
- % of individuals in tolerant taxa
- % of predator individuals
- Clinger taxa
- % dominance (3 taxa)

Total number of taxa, the number of distinct taxa, or taxa richness, represents the diversity within a sample. The expected response to increasing perturbation is a decrease in taxa richness. A decrease in taxa represents a decrease in overall diversity and results from human disruptions to the stream system.

The orders *Ephemeroptera (*mayflies*)*, *Plecoptera (*stoneflies*)*, and *Trichoptera (*caddisflies*)*, generally contain organisms sensitive to effects of perturbation. Therefore, the number of families in these three orders would be expected to decrease with increasing perturbation. Stoneflies are the first to disappear in response to human disturbances while the diversity of mayflies decreases with increasing human influence. Caddisfly taxa decrease with decreasing habitat complexity.

Long-lived taxa are invertebrates that complete their cycles in excess of one year. As such, they are exposed to all of the human induces activities that occur in a stream over the course of one or more years. Varying water flows, for example, and other cyclical activities cause impacts to these invertebrates.

As the name suggests, the *number of Intolerant taxa* are those that are very sensitive to human induced disturbances. The percentage of intolerant taxa would be expected to decrease with increasing perturbation. In the opposite direction, *% of individuals in tolerant taxa* is the percentage of the invertebrates sampled that are tolerant to disturbance. The percentage of tolerant taxa would be expected to increase with increasing perturbation.

The percentage of the invertebrate community that consists of predators, *% of predator individuals*, is a measure of the complexity of the system. The larger the number of predators the less disturbed a site due to the indication of a large amount of prey and a variety of habitats to support the prey.

Clinger taxa are physically adapted to be able to hold on to smooth surfaces in rapid water. Clinger taxa are very sensitive to fine sediments as this removes their habitat between bottom rocks of a stream.

A final indication of disturbance is the metric *% dominance*, a measure of the quantity of the three most plentiful taxa in the sample. A high value for this metric indicates a system out of balance and disturbance to the stream and it's invertebrate community.

The metric values for Rocky Creek, Little Minter Creek, and Minter Creek, surveyed in September, 2003, October, 2004, and September, 2004, respectively, are found in Table 4-34. All three creeks had similar values for total taxa. Likewise, the number of intolerant taxa received a high score, of 5, for the three streams. Tolerant taxa were also high in the streams. Moderate values for mayflies, stoneflies, and caddisflies, with the exception of a low value for caddisflies in Rocky Creek, brought down the overall score for the streams. Total scores of 30 for Rocky Creek and 34 for both Minter and Little Minter Creeks, indicate aquatic systems of moderate biological integrity. Activities in these rural basins, despite the low residential density, appear to be having an impact on the ecosystem.

From these three samples, it appears that the streams have been impacted to some extent by human perturbations in their watersheds. However, the streams were found to support at least some taxa that are relatively intolerant to pollution. This indicates that general water quality in the streams is still relatively good.

Invertebrate sampling is an excellent tool to determine long term impacts of activities on streams and to determine the general health of a stream and thus, its watershed. A sample of all of the streams would provide invaluable information for identifying baseline conditions and trends in the basin. Resampling streams every three years would provide notice of major changes to the ecosystem.

NOTES:

(1) *2003 Sub-County (Small Area) Forecasts of Population and Employment, Central Puget Sound Region,* Puget Sound Regional Council, http://psrc.org/datapubs/data/forecasts.htm, accessed April 20, 2004.

(2) The information on geology and soils was obtained from *Soil Survey of Pierce County Area*, Washington, February 1970, USDA Soil Conservation Service; *Salmon and Steelhead Habitat Limiting Factors Water Resources Inventory Area 15*, November 2000, Washington State Conservation Commission; and *Draft Environmental Impact Statement for Update of Kitsap Basin Water Pollution Control and Abatement Plan for Gig Harbor Peninsula Planning Area*, prepared for Pierce County Utilities Department by Brown and Caldwell Consulting Engineers, 1986.

(3) *WRIA Salmon and Steelhead Habitat Limiting Factors Water Resources Inventory Area 15*, November 2000, Washington State Conservation Commission

(4) *Guidance for Basin Planning*, June 2000, Pierce County Water Programs.

(5) *Key Peninsula, Gig Harbor and Island Watershed Characterization and Action Plan,* July 1999, KGI Watershed Council, Pierce County Water Programs.

(6) Popochok, Dennis. Hatchery Complex Manager for Minter Creek/Hood Canal Complex. Personal communication with Nicki Newman. June 23, 3004.

(7) *Draft Report on Kitsap Watershed (WRIA 15) Water Quality Technical Assessment*, June 30, 2003, Golder Associates Inc.

(8) *Status Report of the Key Peninsula, Gig Harbor, and Islands Watersheds Fish Passage Inventory and Assessment Project,* December 2000, Pierce Conservation District.

(9) *Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual,* Washington Department of Fish and Wildlife, August 2000, http://www.wa.gov/wdfw/hab/engineer/mnl2000.pdf.

(10) Standard Methods for the Examination of Water and Wastewater

(11) Long, John, Washington Department of Fish and Wildlife, Personal Communication with Nicki Newman, June 16, 2004.

Table 4-34
Benthic Invertebrate Sample Results for
Rocky Creek, Minter Creek, and Little Minter Creek

Scoring Biometrics						
Site Rocky Creek	**Rep.** Composite		**Date Collected**		12 Sep. 2003	
Metric	**No./%**		**Score**		**Total**	
Total no. of taxa	25		3		30	
No. of Ephemeroptera taxa	4.33		3			
No. of Plecoptera taxa	4.66		3			
No. of Trichoptera taxa	4.33		1			
No. of Long-lived taxa	1		1			
No. of Intolerant taxa	3.33		5			
% of individuals in tolerant taxa	12.75		5			
% of predator individuals	8.82		1			
Clinger taxa	9.66		3			
% dominance (3 taxa)	54.66		5			

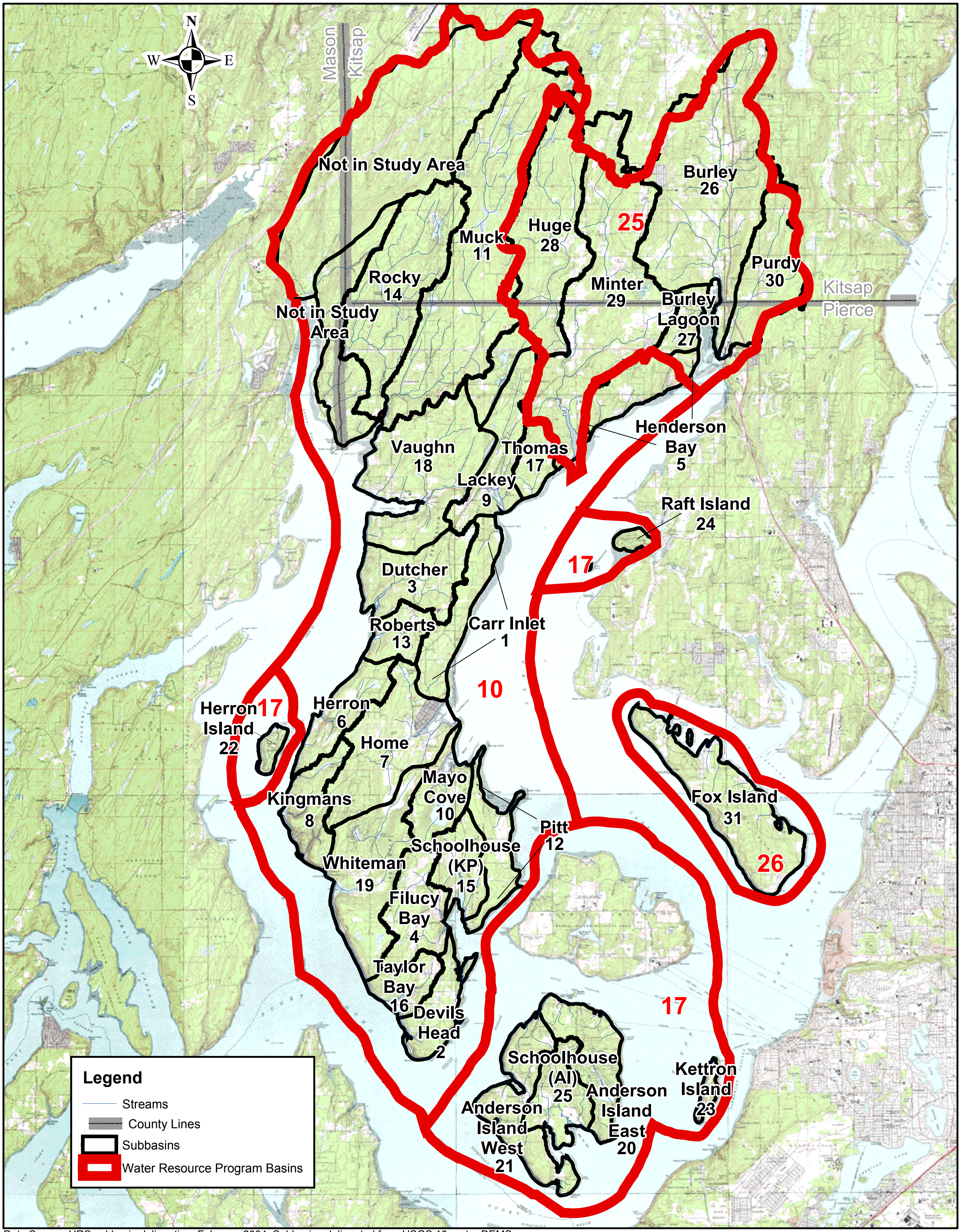
Scoring Biometrics						
Site Minter Creek	**Rep.** Composite		**Date Collected**		16 Sep. 2004	
Metric	**No./%**		**Score**		**Total**	
Total no. of taxa	28.33		5		34	
No. of Ephemeroptera taxa	4.67		3			
No. of Plecoptera taxa	5.33		3			
No. of Trichoptera taxa	5.33		3			
No. of Long-lived taxa	0.33		1			
No. of Intolerant taxa	4.33		5			
% of individuals in tolerant taxa	3.58		5			
% of predator individuals	6.77		1			
Clinger taxa	10.67		3			
% dominance (3 taxa)	52.33		5			

Scoring Biometrics						
Site Little Minter Creek	**Rep.** Composite		**Date Collected**		5 Oct. 2004	
Metric	**No./%**		**Score**		**Total**	
Total no. of taxa	24.33		3		34	
No. of Ephemeroptera taxa	4.67		3			
No. of Plecoptera taxa	4.67		3			
No. of Trichoptera taxa	5		3			
No. of Long-lived taxa	1		1			
No. of Intolerant taxa	4		5			
% of individuals in tolerant taxa	11.12		5			
% of predator individuals	25.42		5			
Clinger taxa	7.67		1			
% dominance (3 taxa)	47.33		5			

Metric - Each of the metrics (see table above) receives a rank of 1, 3 or 5, with higher numbers indicating better biological integrity. Overall B-IBI values can be interpreted qualitatively by using the following classes of biological condition:

B-IBI Biological Condition:

46-50 Excellent
38-44 Good
28-36 Fair
18-26 Poor
10-16 Very Poor



Print date: June 2004

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Data Source: URS subbasin delineation, February 2004. Subbasins delineated from USGS 10-meter DEMS.
See Appendix A for detailed description of delineation.

1 inch equals 15,000 feet

0 5,000 10,000 20,000 30,000 Feet

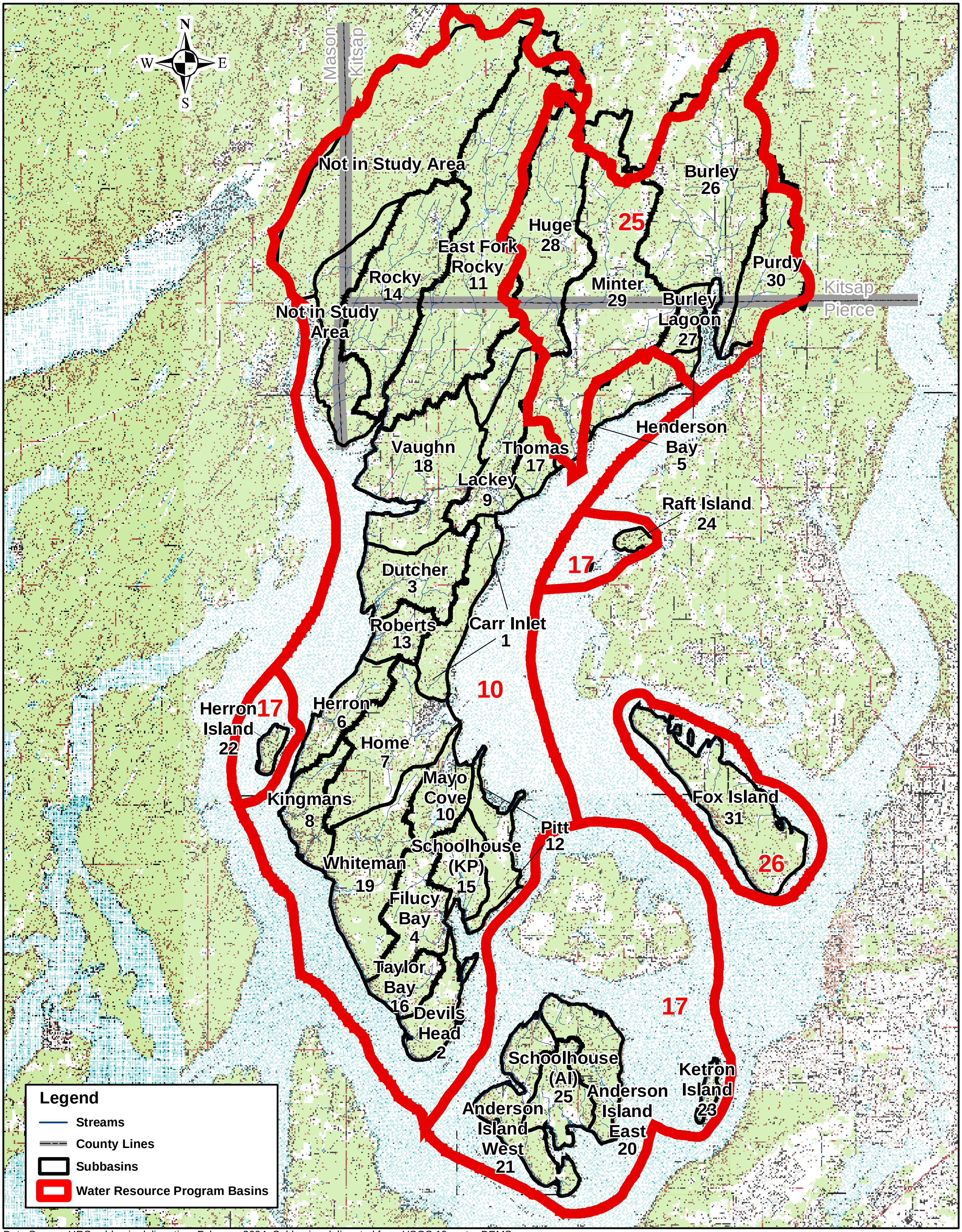
0 1,250 2,500 5,000 7,500 Meters

Pierce County
Water Programs

DRAFT

FIGURE 4-1
SUBBASIN INDEX

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON



Data Source: URS subbasin delineation, February 2004. Subbasins delineated from USGS 10-meter DEMS.
See Appendix A for detailed description of delineation.

1 inch equals 15,000 feet

0 5,000 10,000 20,000 30,000 Feet

0 1,250 2,500 5,000 7,500 Meters

Pierce County
Water Programs

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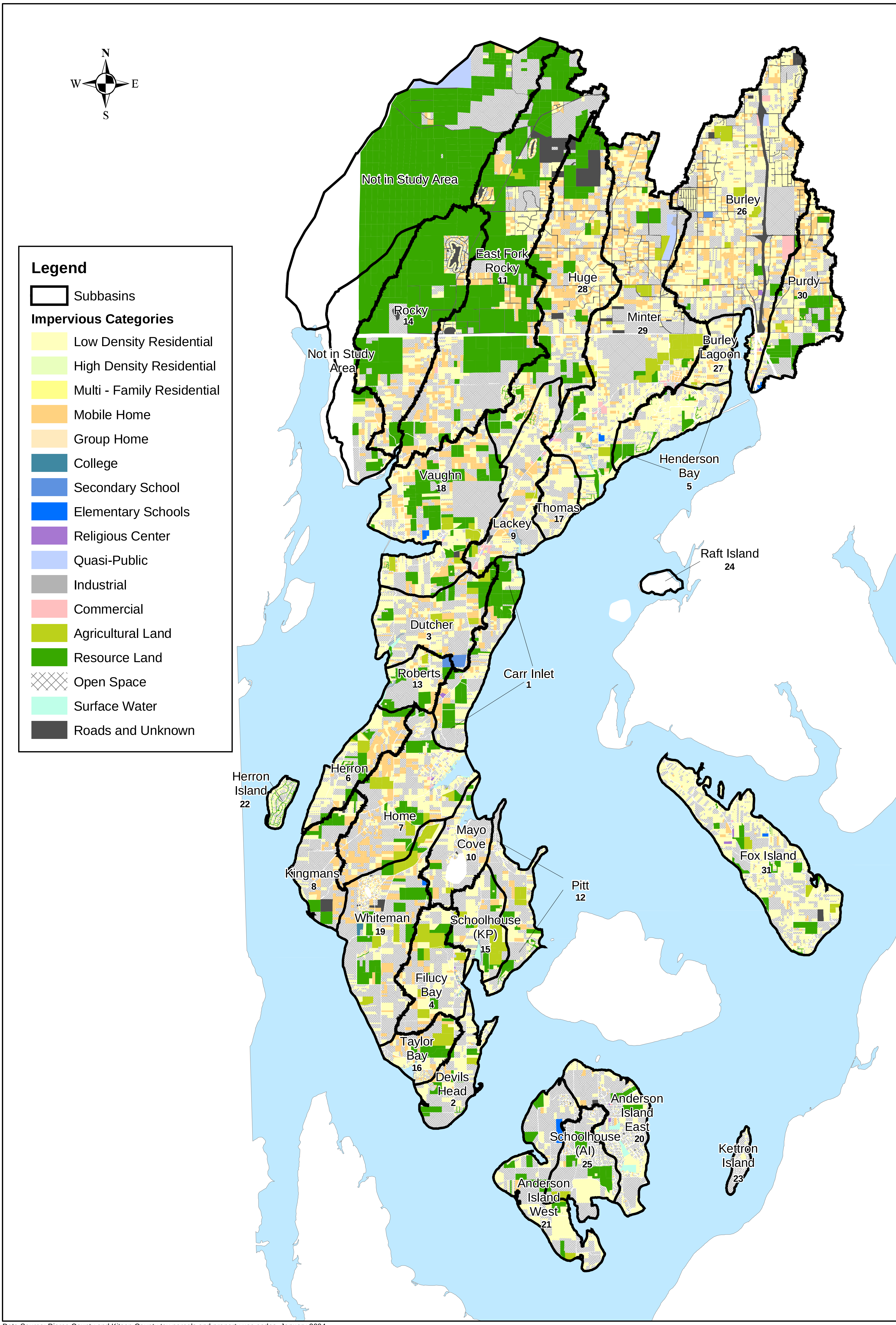
FIGURE 4-1
SUBBASIN INDEX

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON



Data Source: Pierce County and Kitsap County tax parcels and property use codes, January 2004.
See Appendix B for property use codes aggregated into impervious categories.

1 inch equals 10,000 feet

0 2,500 5,000 10,000 15,000 20,000 Feet

0 1,000 2,000 3,000 4,000 5,000 Meters

Pierce County
Water Programs

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FIGURE 4-2
IMPERVIOUS CATEGORIES

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

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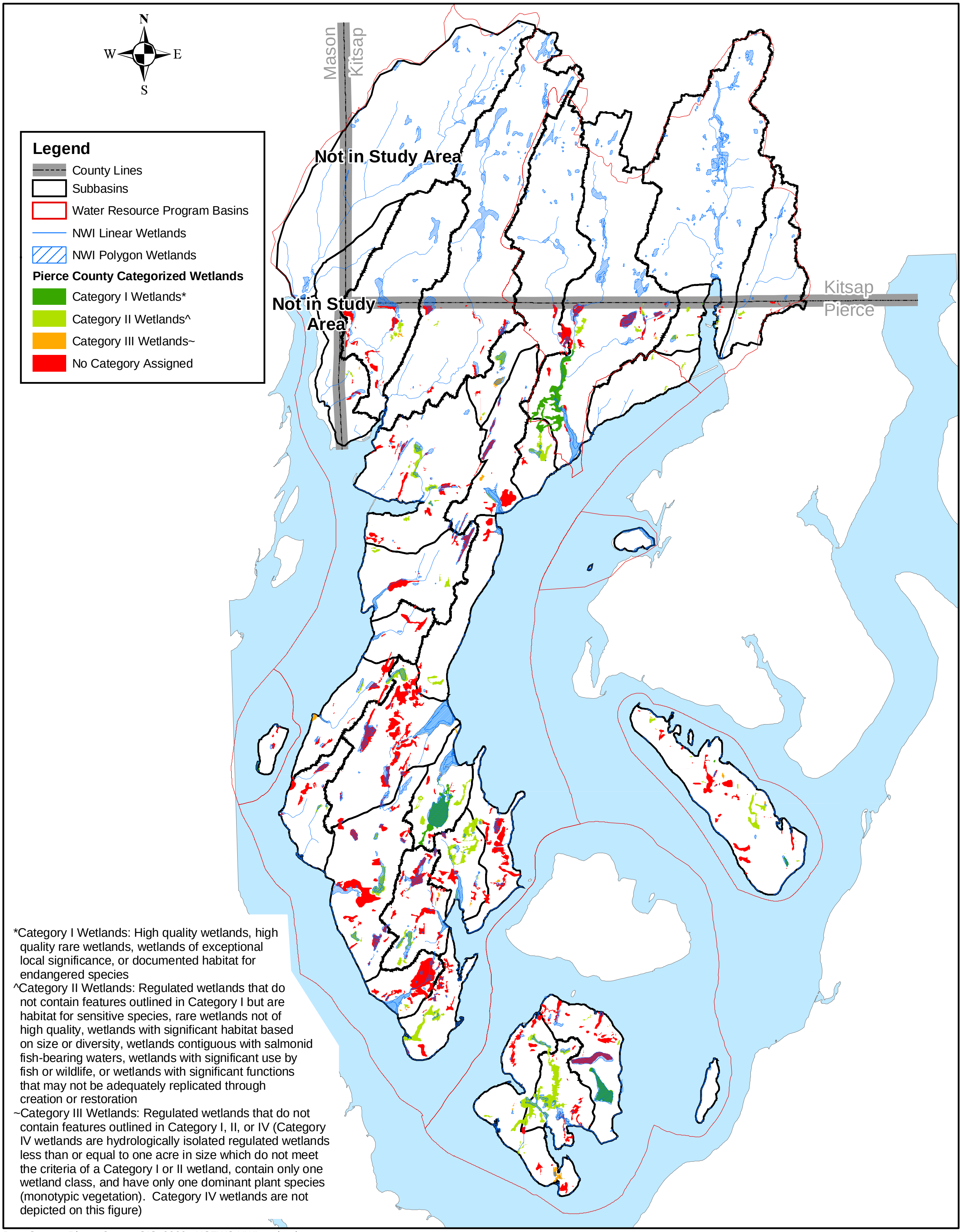

*Category I Wetlands: High quality wetlands, high quality rare wetlands, wetlands of exceptional local significance, or documented habitat for endangered species

^Category II Wetlands: Regulated wetlands that do not contain features outlined in Category I but are habitat for sensitive species, rare wetlands not of high quality, wetlands with significant habitat based on size or diversity, wetlands contiguous with salmonid fish-bearing waters, wetlands with significant use by fish or wildlife, or wetlands with significant functions that may not be adequately replicated through creation or restoration

~Category III Wetlands: Regulated wetlands that do not contain features outlined in Category I, II, or IV (Category IV wetlands are hydrologically isolated regulated wetlands less than or equal to one acre in size which do not meet the criteria of a Category I or II wetland, contain only one wetland class, and have only one dominant plant species (monotypic vegetation). Category IV wetlands are not depicted on this figure)

Print date: August 2005

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Data Source: Pierce County GIS, 2003. USFWS NWI wetlands.

Pierce County Water Programs

1 inch equals 15,000 feet

0 5,000 10,000 20,000 30,000 Feet

0 1,250 2,500 5,000 7,500 Meters

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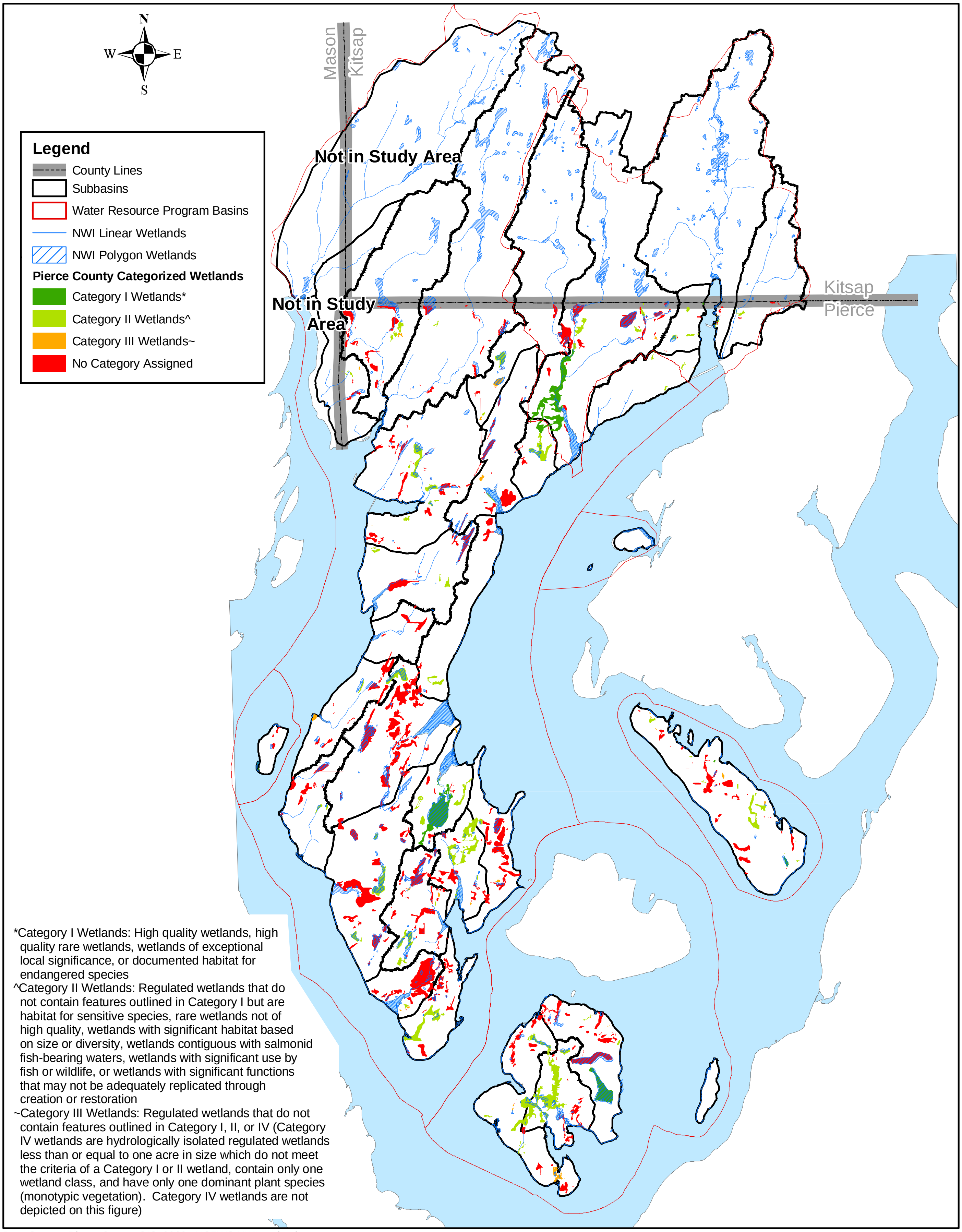
FIGURE 4-3
WETLANDS

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON



*Category I Wetlands: High quality wetlands, high quality rare wetlands, wetlands of exceptional local significance, or documented habitat for endangered species

^Category II Wetlands: Regulated wetlands that do not contain features outlined in Category I but are habitat for sensitive species, rare wetlands not of high quality, wetlands with significant habitat based on size or diversity, wetlands contiguous with salmonid fish-bearing waters, wetlands with significant use by fish or wildlife, or wetlands with significant functions that may not be adequately replicated through creation or restoration

~Category III Wetlands: Regulated wetlands that do not contain features outlined in Category I, II, or IV (Category IV wetlands are hydrologically isolated regulated wetlands less than or equal to one acre in size which do not meet the criteria of a Category I or II wetland, contain only one wetland class, and have only one dominant plant species (monotypic vegetation). Category IV wetlands are not depicted on this figure)

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Data Source: Pierce County GIS, 2003. USFWS NWI wetlands.

Pierce County Water Programs

1 inch equals 15,000 feet

0 5,000 10,000 20,000 30,000 Feet

0 1,250 2,500 5,000 7,500 Meters

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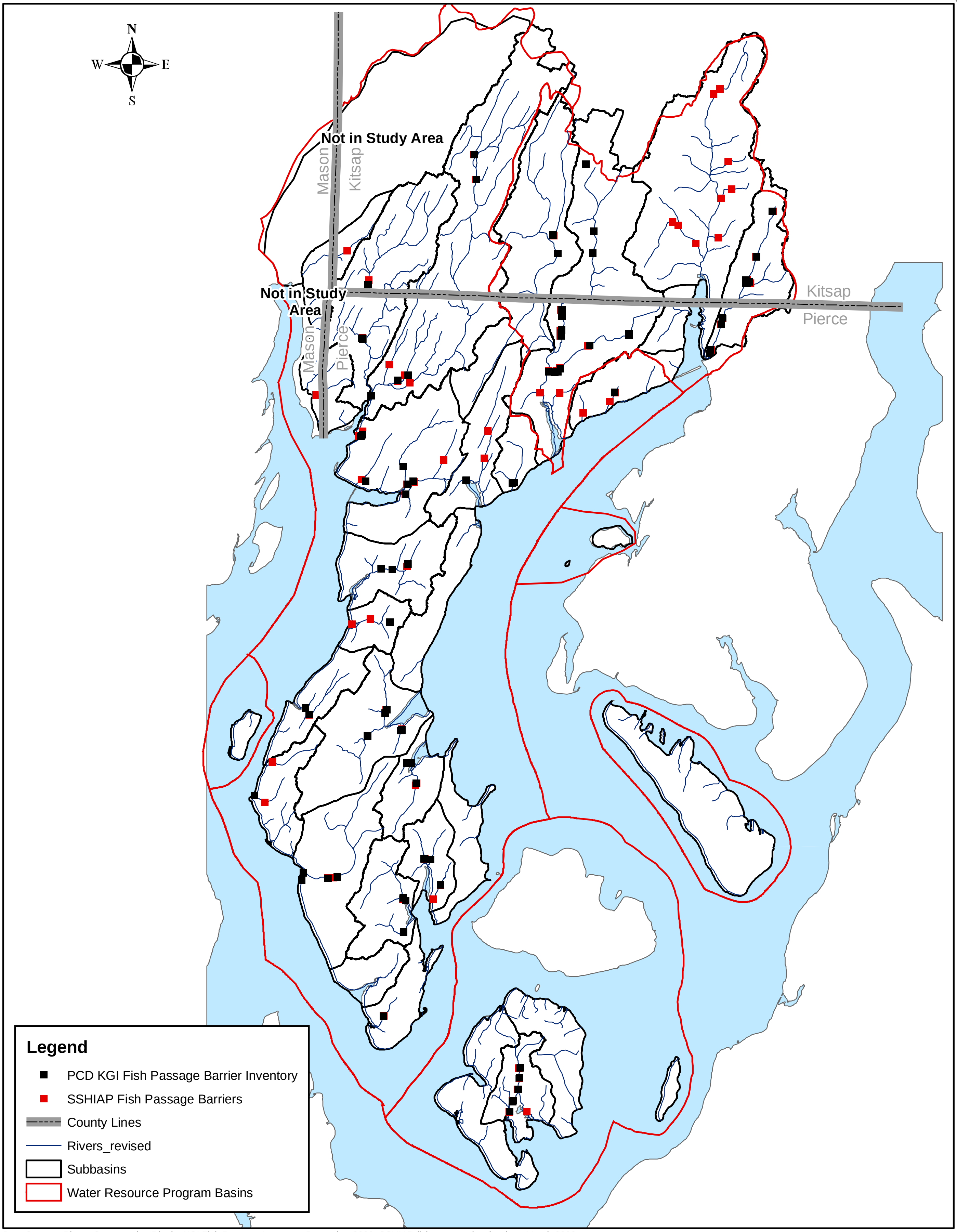
FIGURE 4-3
WETLANDS

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON



Data Source: Pierce Conservation District KGI Fish Passage Inventory, December 2000; SSHIAP fish passage barrier data, March 2002.

Pierce County Water Programs

1 inch equals 15,000 feet

0 5,000 10,000 20,000 30,000 Feet

0 1,250 2,500 5,000 7,500 Meters

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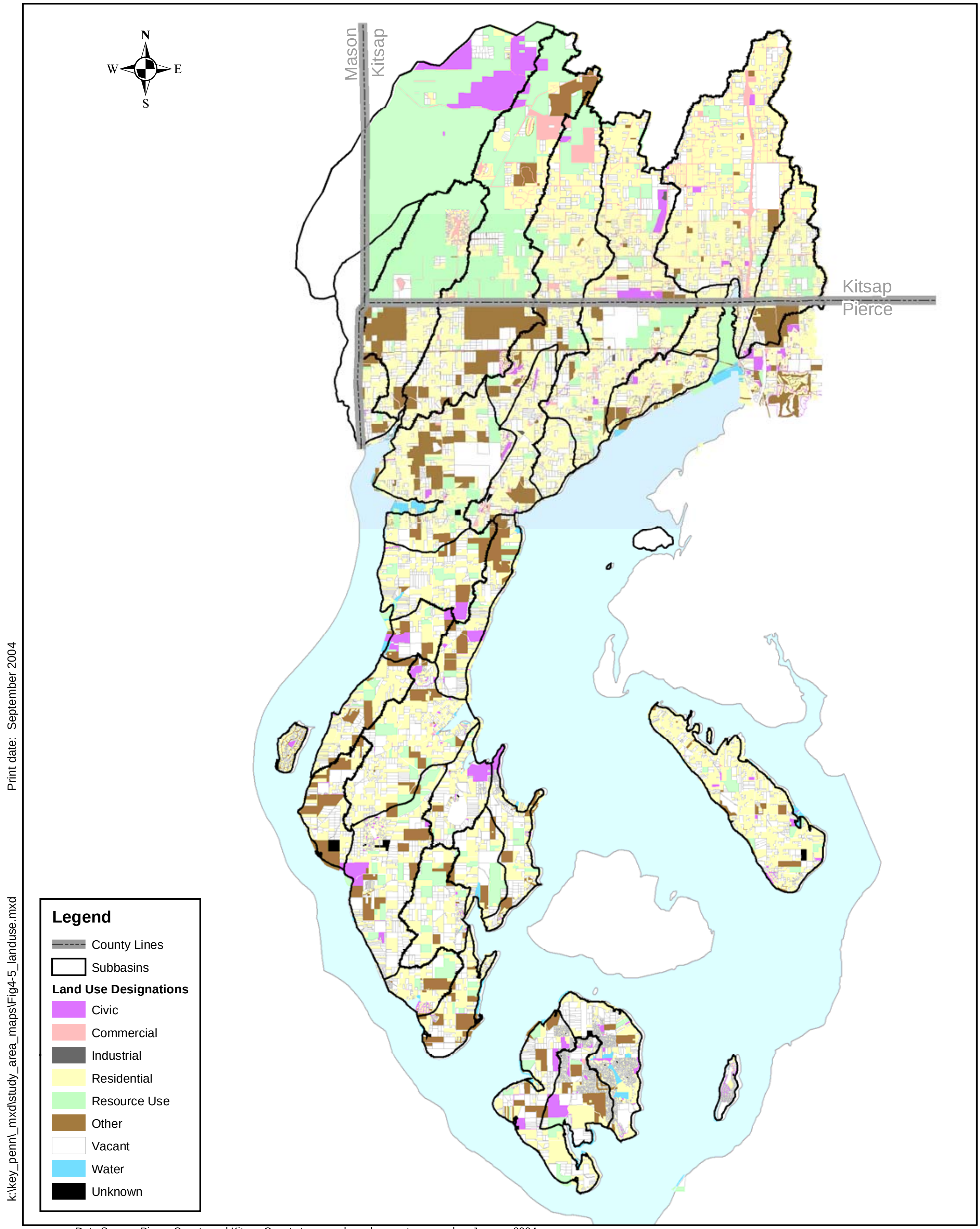
FIGURE 4-4
FISH PASSAGE BARRIERS

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON



Data Source: Pierce County and Kitsap County tax parcels and property use codes, January 2004.
See Appendix B for property use codes aggregated into land use categories.

1 inch equals 15,000 feet

0 5,000 10,000 20,000 30,000 Feet

0 1,250 2,500 5,000 7,500 Meters

Pierce County
Water Programs

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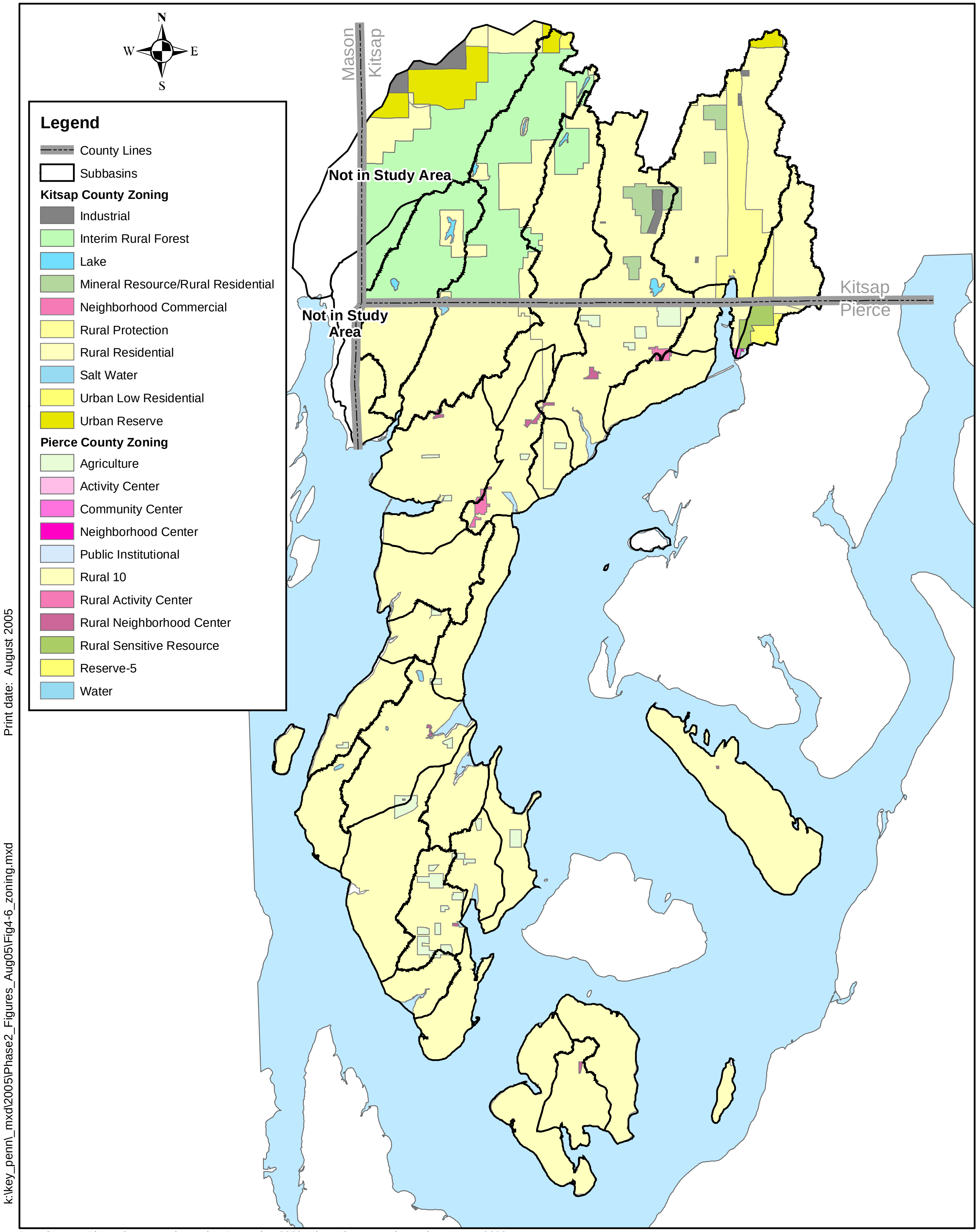
FIGURE 4-5
CURRENT LAND USE

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON



Data Source: Pierce County zoning codes, December 2003; Kitsap County zoning codes, August 2003.

Pierce County Water Programs

1 inch equals 15,000 feet

0 5,000 10,000 20,000 30,000 Feet

0 1,250 2,500 5,000 7,500 Meters

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FIGURE 4-6
CURRENT ZONING

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

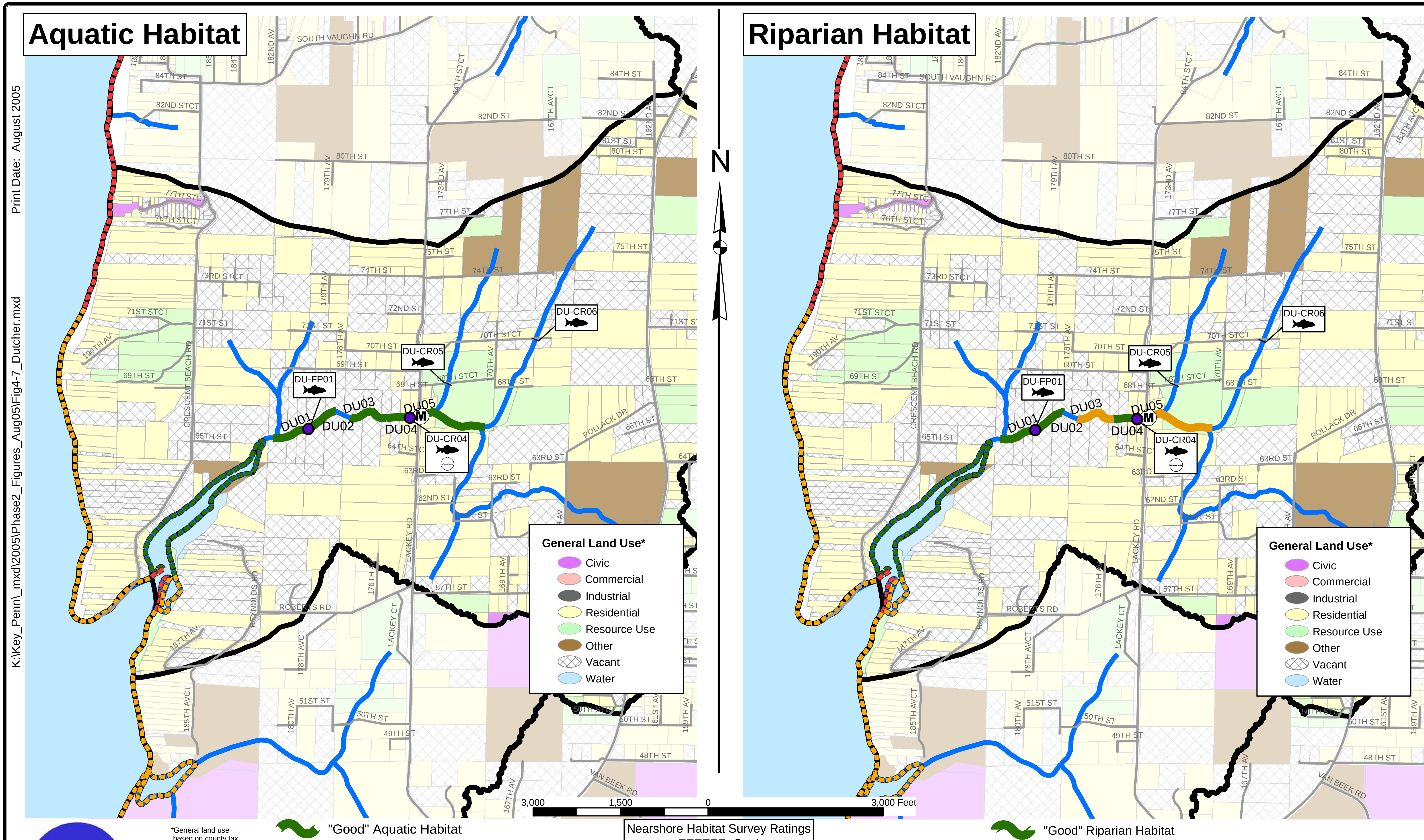

FIGURE 4-7
DUTCHER CREEK

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

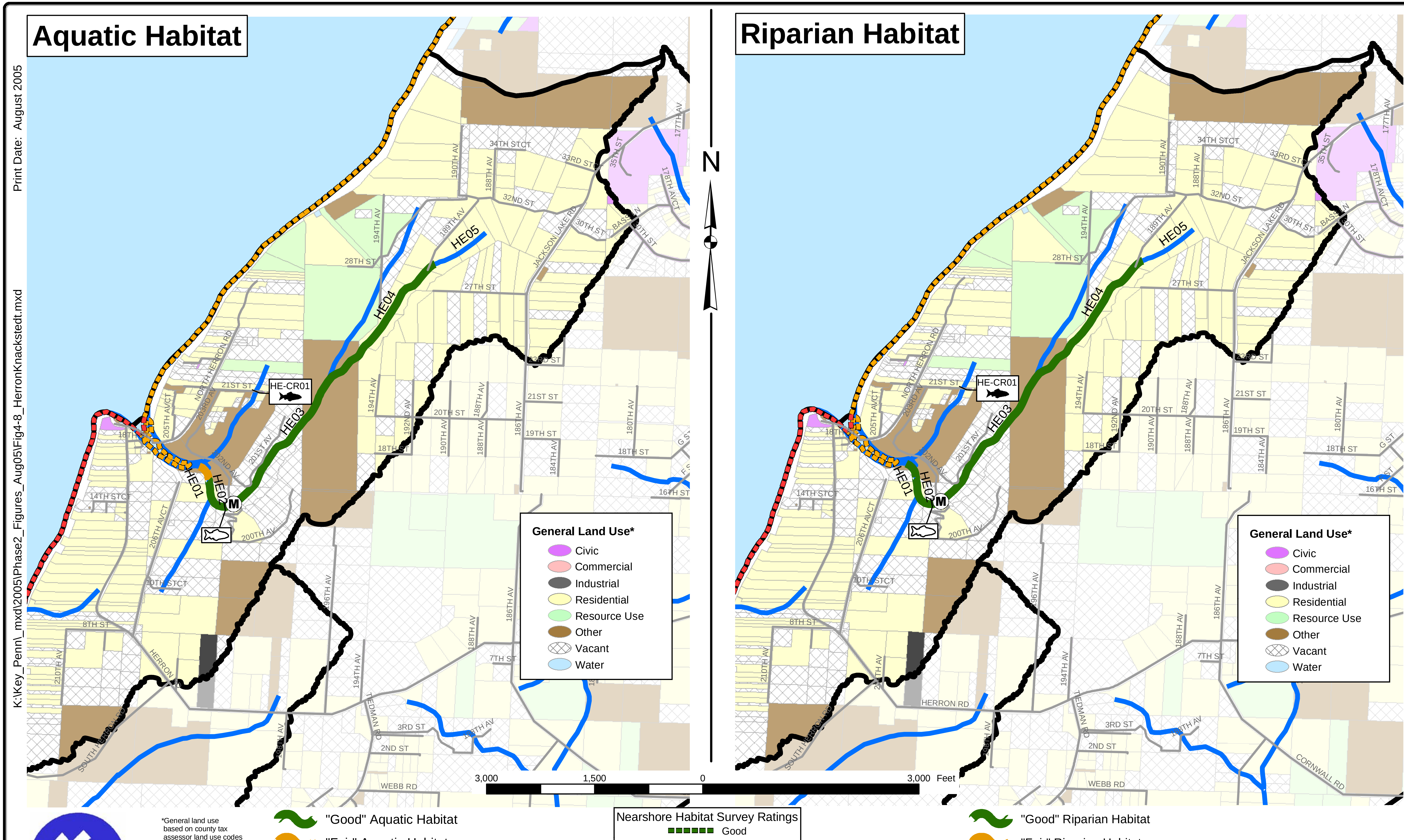

FIGURE 4-8
HERRON/KNACKSTEDT CREEK

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

Print Date: August 2005

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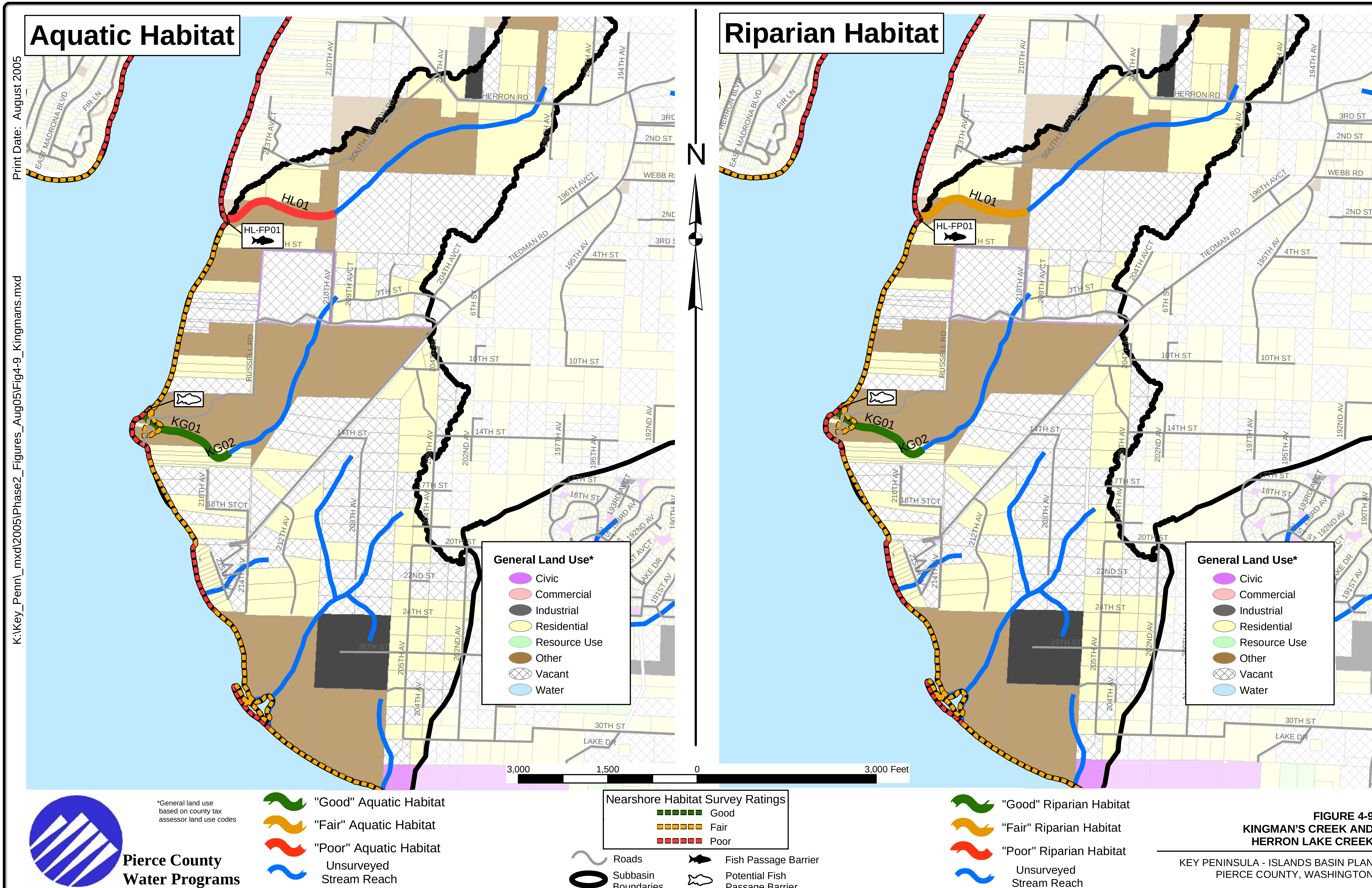


FIGURE 4-9
KINGMAN'S CREEK AND HERRON LAKE CREEK

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

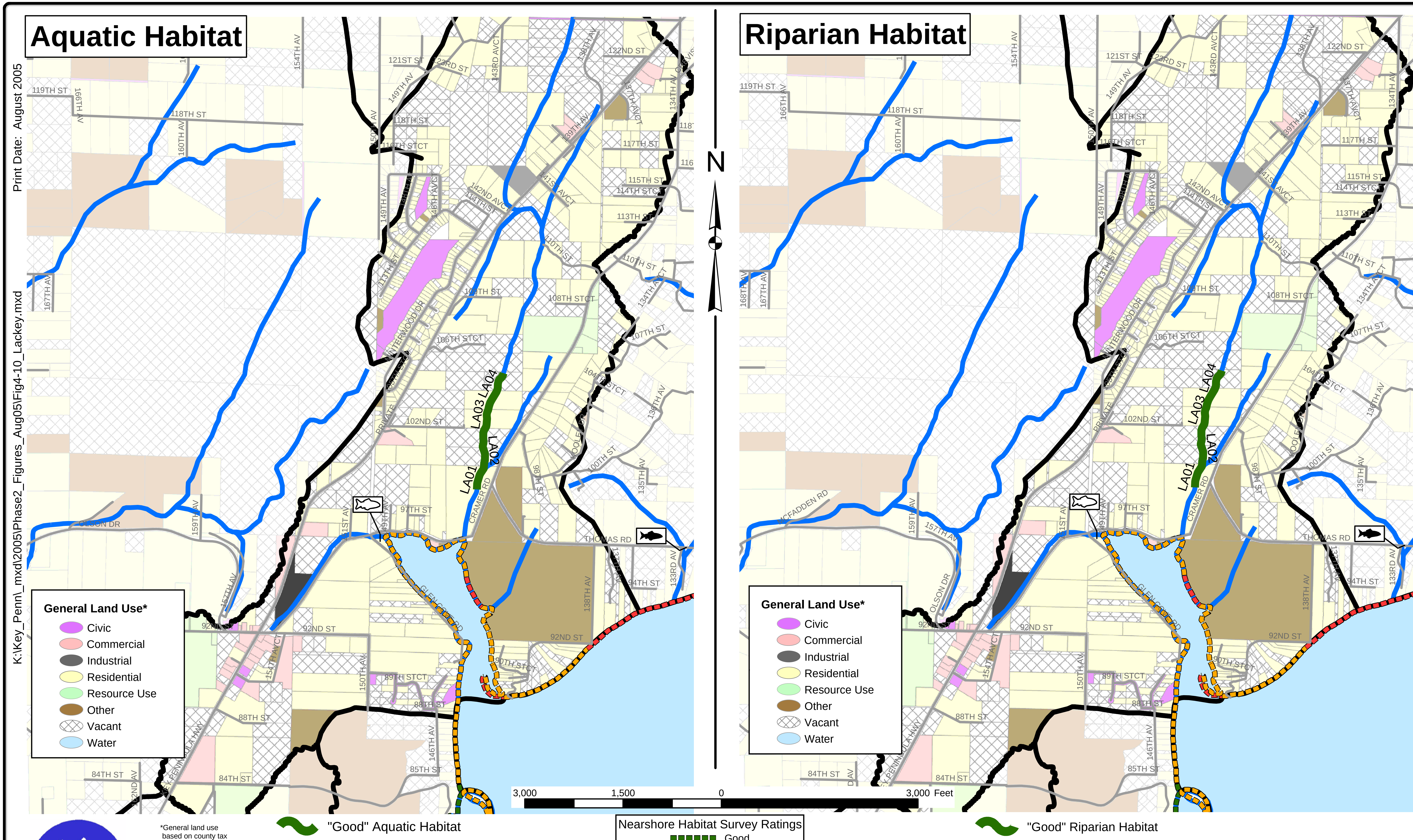
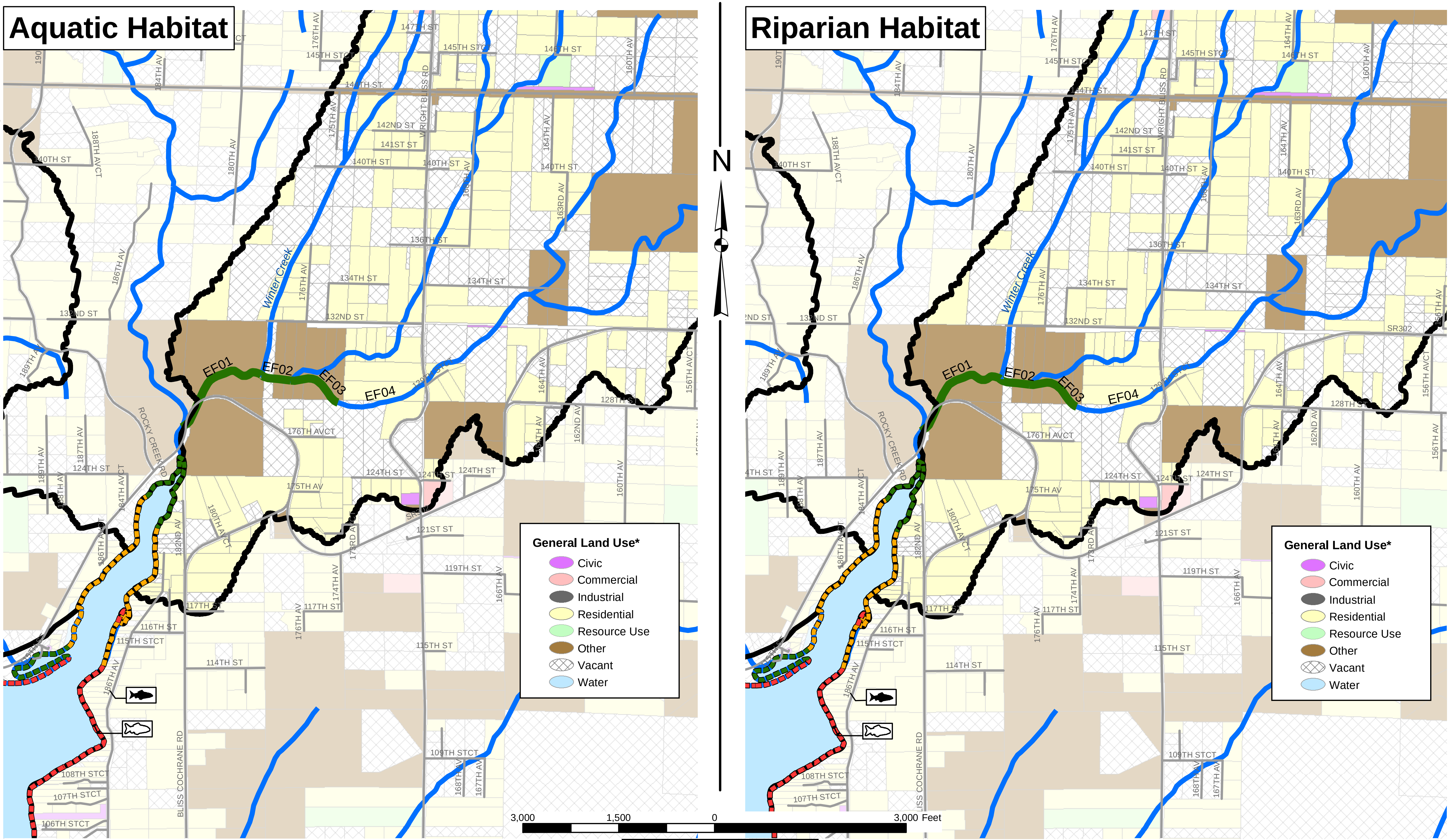


FIGURE 4-10
LACKEY CREEK

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON



Pierce County Water Programs

*General land use based on county tax assessor land use codes

"Good" Aquatic Habitat
"Fair" Aquatic Habitat
"Poor" Aquatic Habitat
Unsurveyed Stream Reach

Nearshore Habitat Survey Ratings
Good
Fair
Poor

Roads
Subbasin Boundaries
Fish Passage Barrier
Potential Fish Passage Barrier

"Good" Riparian Habitat
"Fair" Riparian Habitat
"Poor" Riparian Habitat
Unsurveyed Stream Reach

FIGURE 4-11
EAST FORK ROCKY CREEK
(FORK MUCK CREEK)

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

Print Date: August 2005

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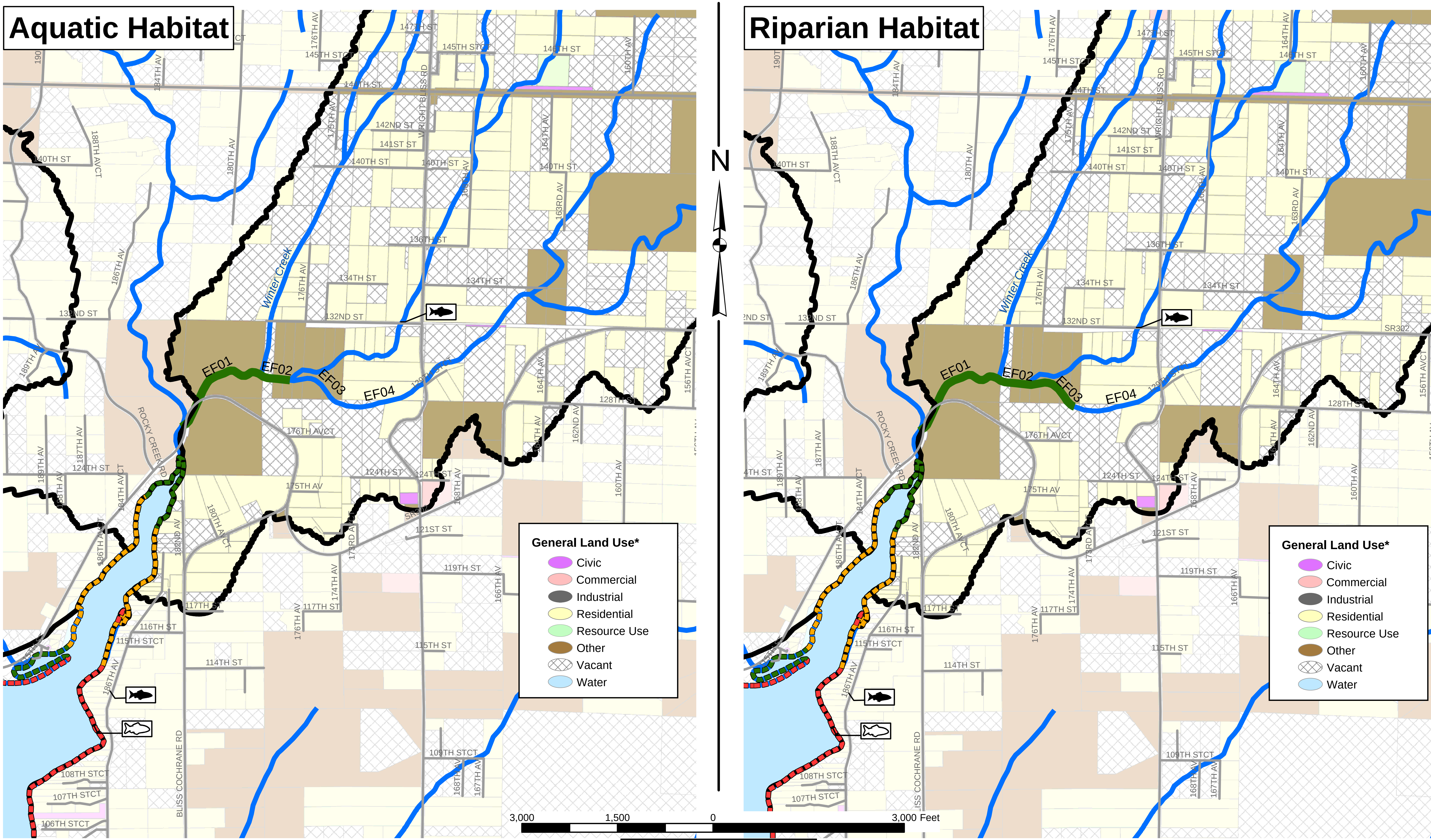


*General land use based on county tax assessor land use codes

"Good" Aquatic Habitat

"Fair" Aquatic Habitat

"Poor" Aquatic Habitat

Unsurveyed Stream Reach

Nearshore Habitat Survey Ratings
- Good
- Fair
- Poor

Roads

Subbasin Boundaries

Fish Passage Barrier

Potential Fish Passage Barrier

"Good" Riparian Habitat

"Fair" Riparian Habitat

"Poor" Riparian Habitat

Unsurveyed Stream Reach

Pierce County Water Programs

FIGURE 4-11
EAST FORK ROCKY CREEK (FORK MUCK CREEK)

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

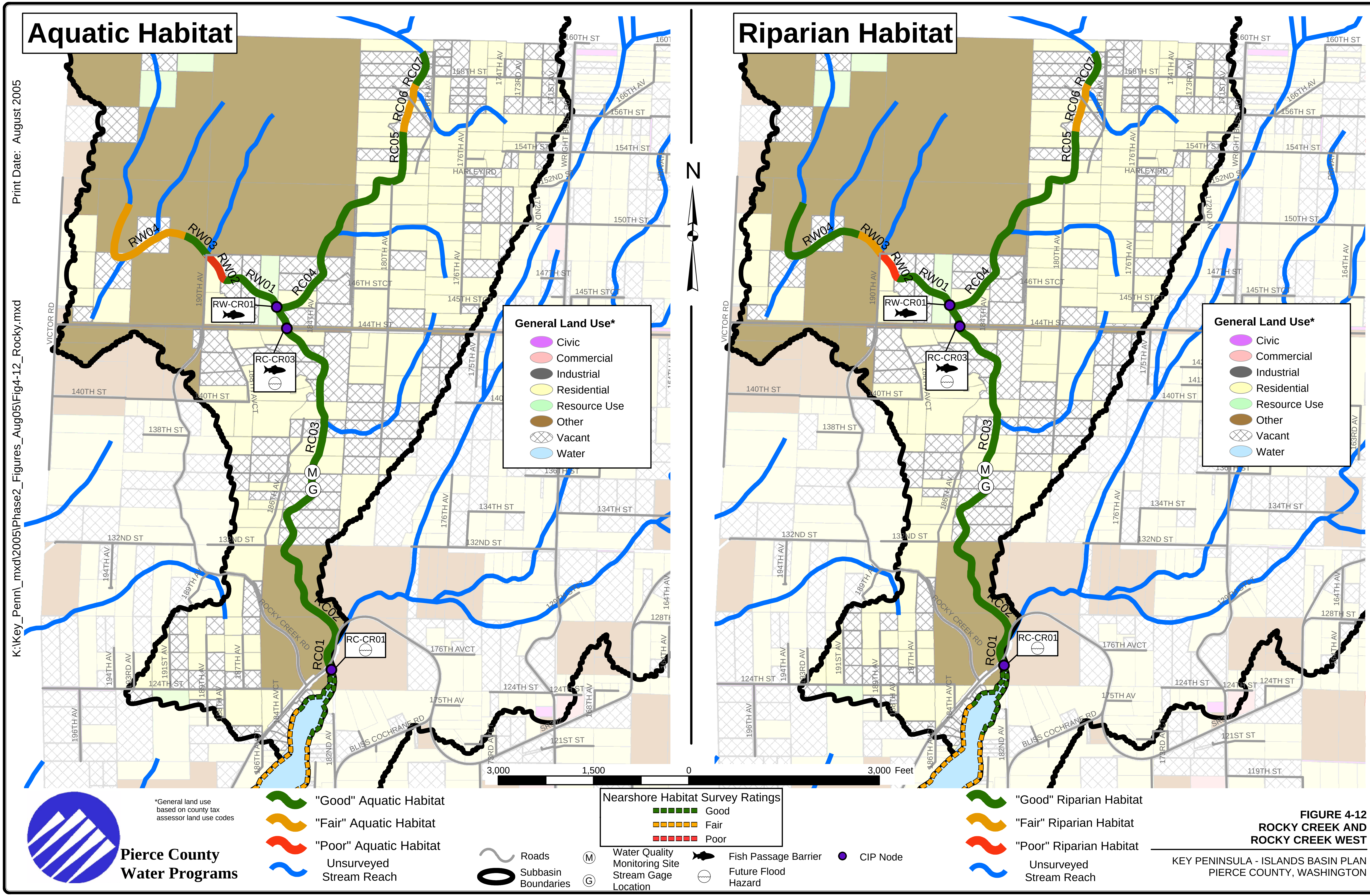


FIGURE 4-12
ROCKY CREEK AND ROCKY CREEK WEST

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

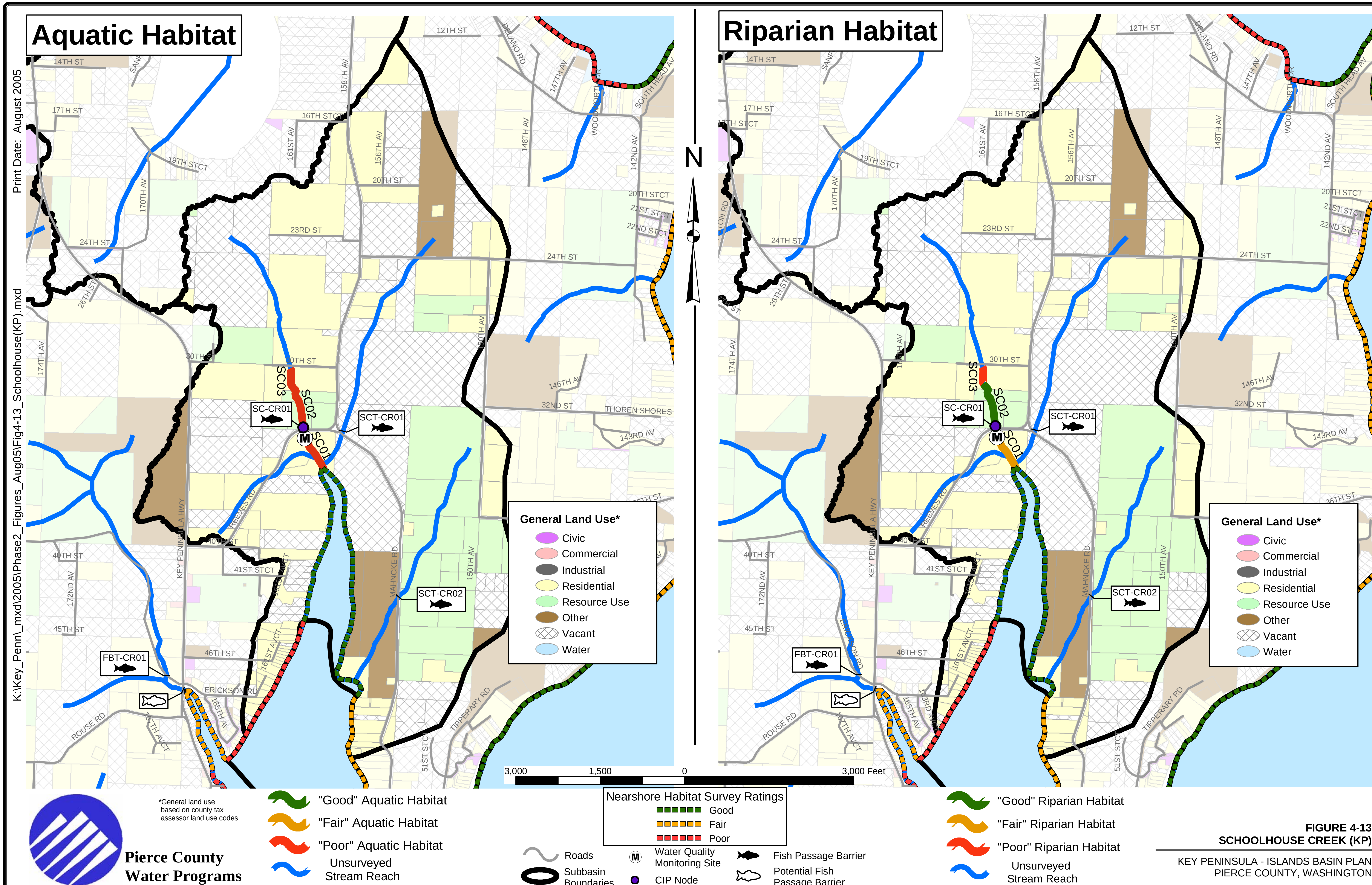


FIGURE 4-13
SCHOOLHOUSE CREEK (KP)

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

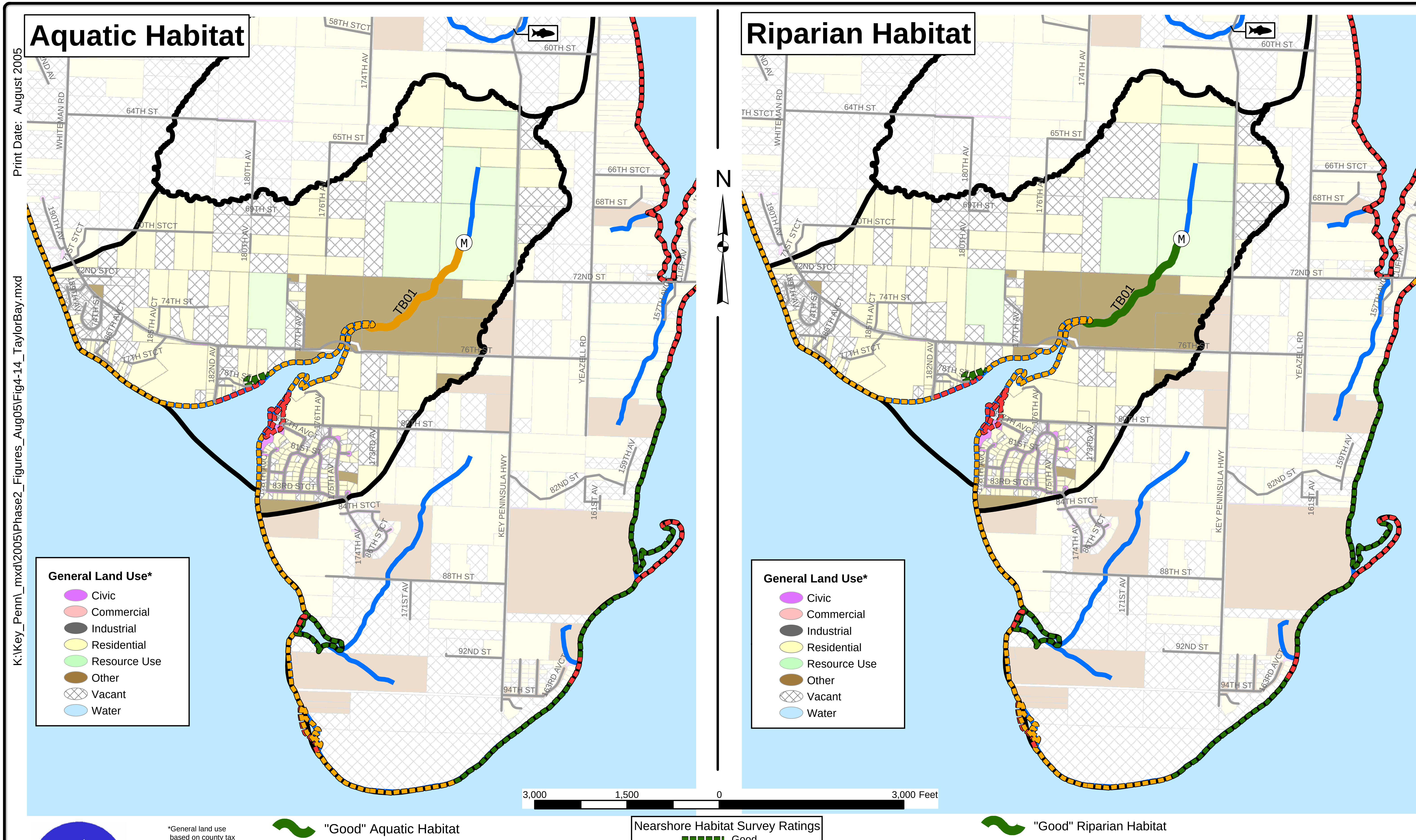
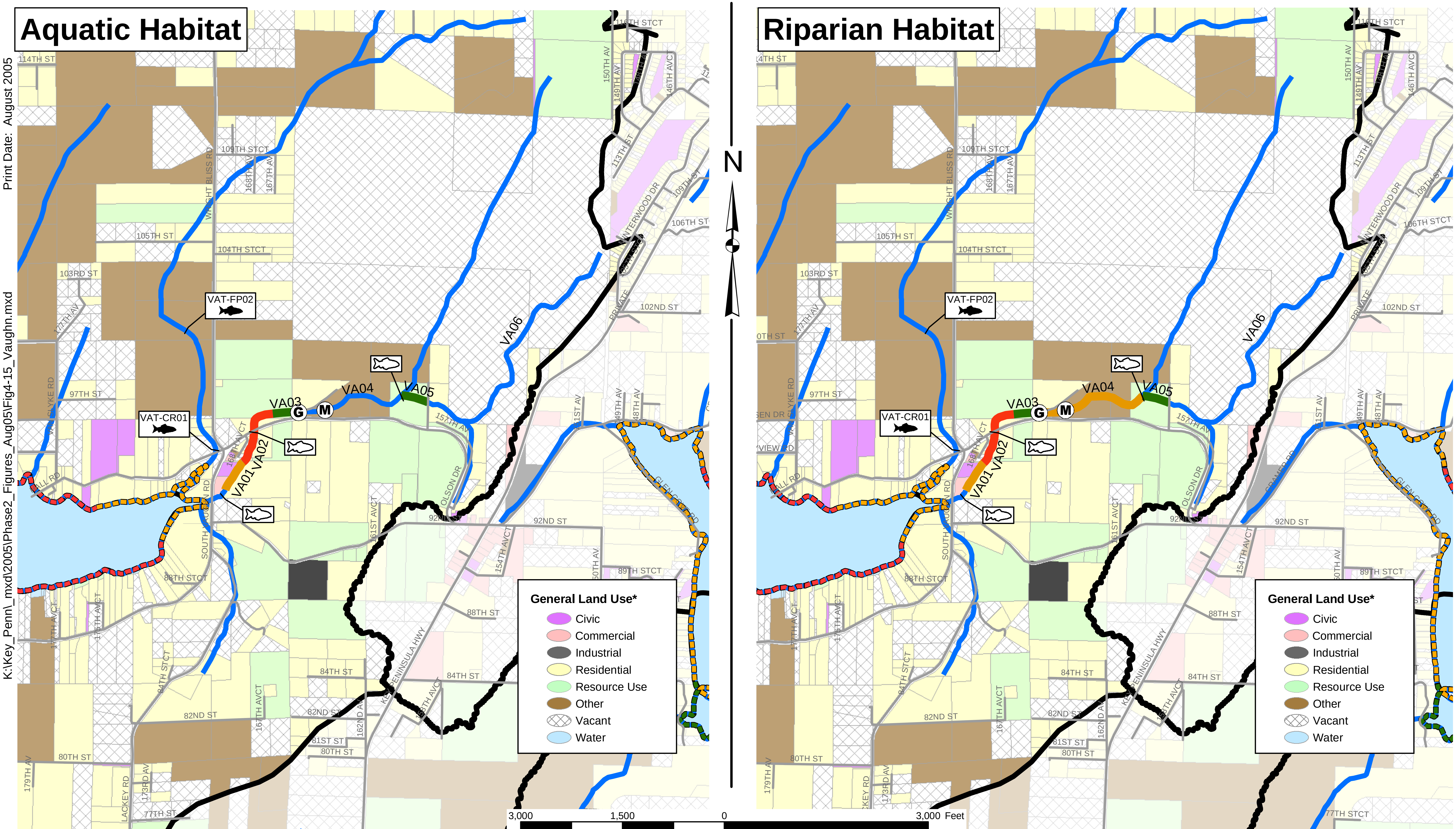


FIGURE 4-14
TAYLOR BAY CREEK

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON



*General land use based on county tax assessor land use codes

"Good" Aquatic Habitat
"Fair" Aquatic Habitat
"Poor" Aquatic Habitat
Unsurveyed Stream Reach

Nearshore Habitat Survey Ratings
Good
Fair
Poor

Roads
Subbasin Boundaries
M Water Quality Monitoring Site
G Stream Gage Location
Fish Passage Barrier
Potential Fish Passage Barrier

"Good" Riparian Habitat
"Fair" Riparian Habitat
"Poor" Riparian Habitat
Unsurveyed Stream Reach

Pierce County Water Programs

FIGURE 4-15
VAUGHN CREEK

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

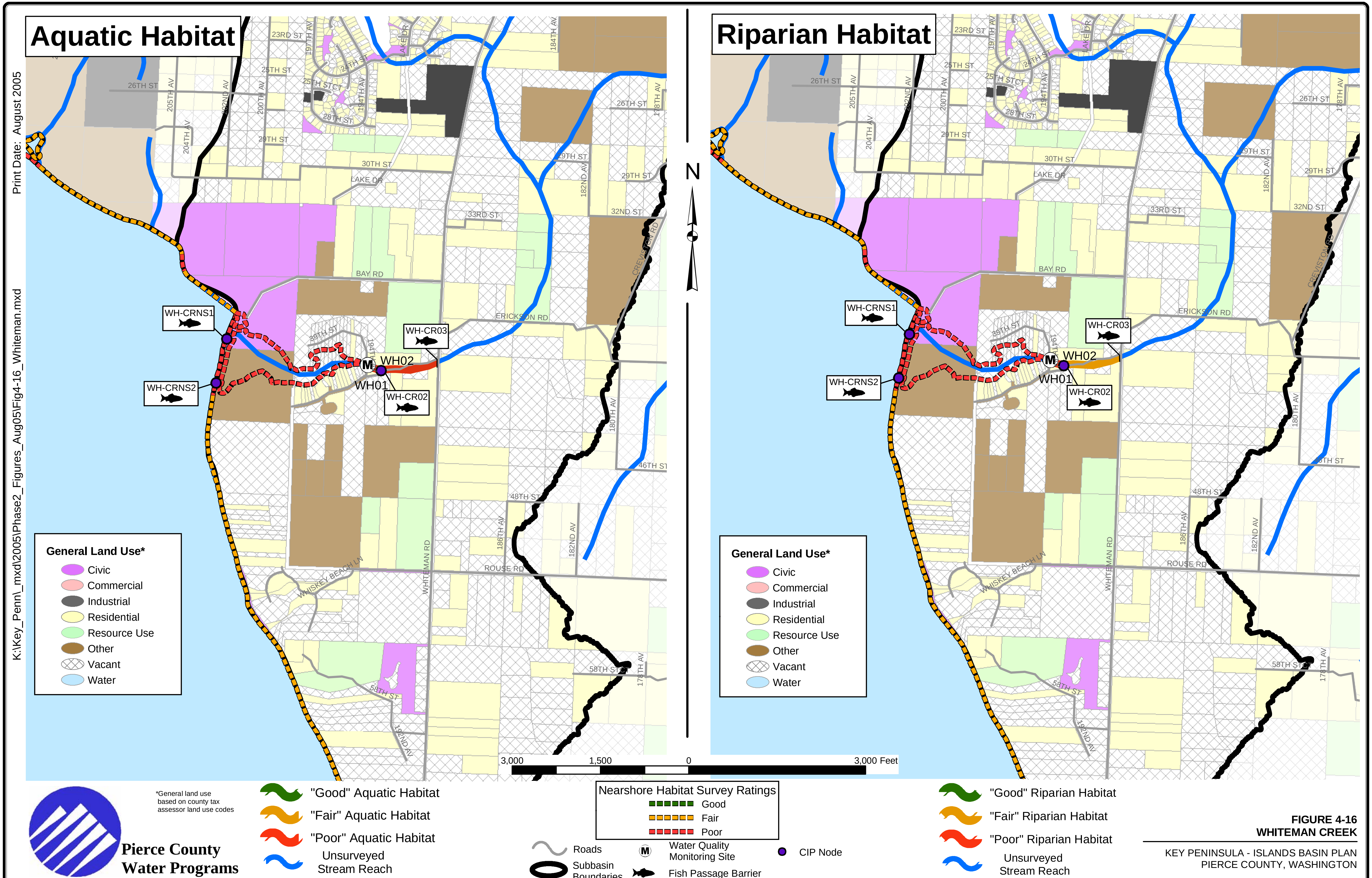
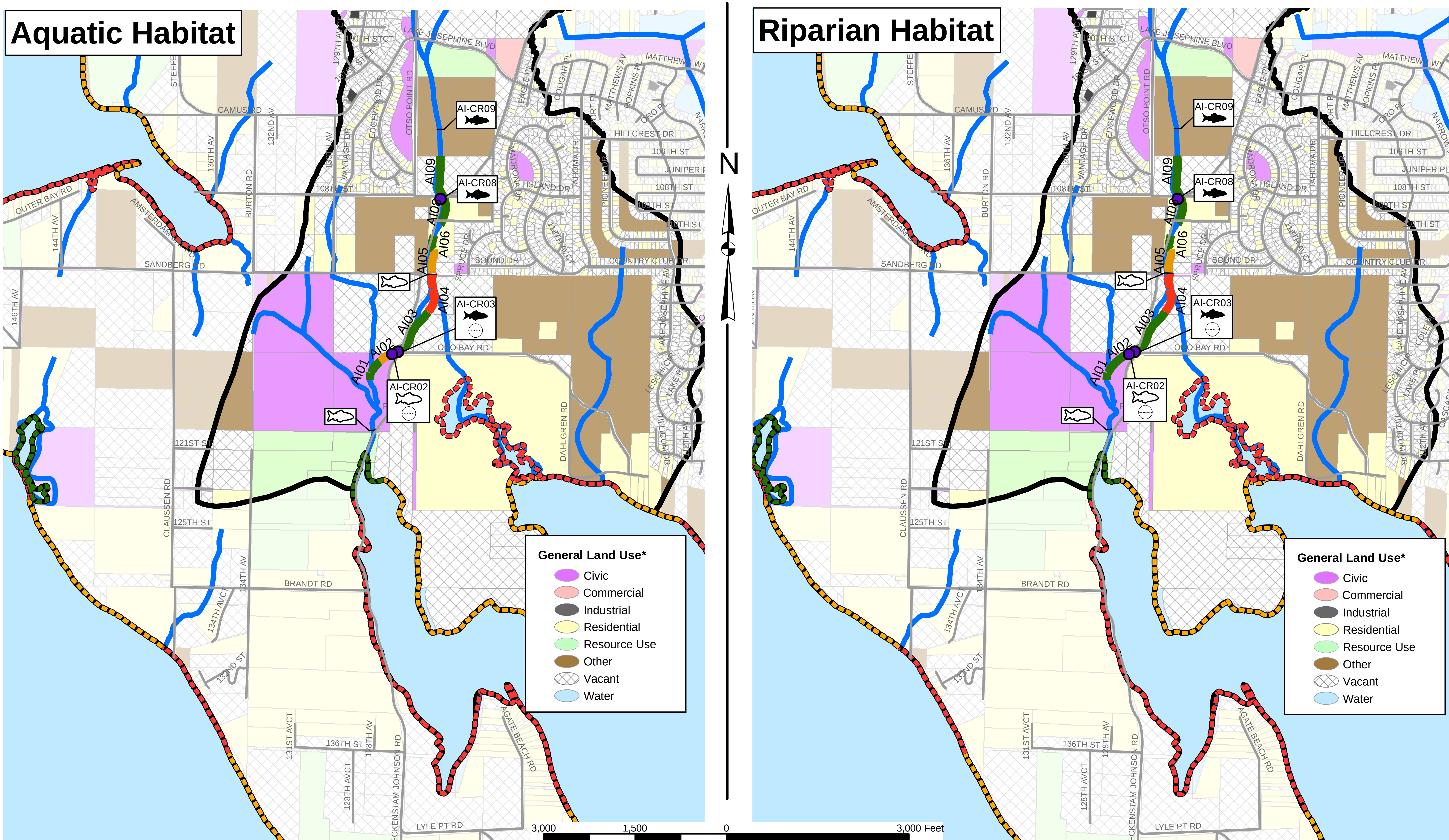


FIGURE 4-16
WHITEMAN CREEK

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON



Print Date: August 2005

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*General land use based on county tax assessor land use codes

"Good" Aquatic Habitat
"Fair" Aquatic Habitat
"Poor" Aquatic Habitat
Unsurveyed Stream Reach

Nearshore Habitat Survey Ratings
Good
Fair
Poor

Roads
Subbasin Boundaries
Fish Passage Barrier
Potential Fish Passage Barrier
CIP Node
Future Flood Hazard

"Good" Riparian Habitat
"Fair" Riparian Habitat
"Poor" Riparian Habitat
Unsurveyed Stream Reach

Pierce County Water Programs

FIGURE 4-17
SCHOOLHOUSE CREEK (AI)

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

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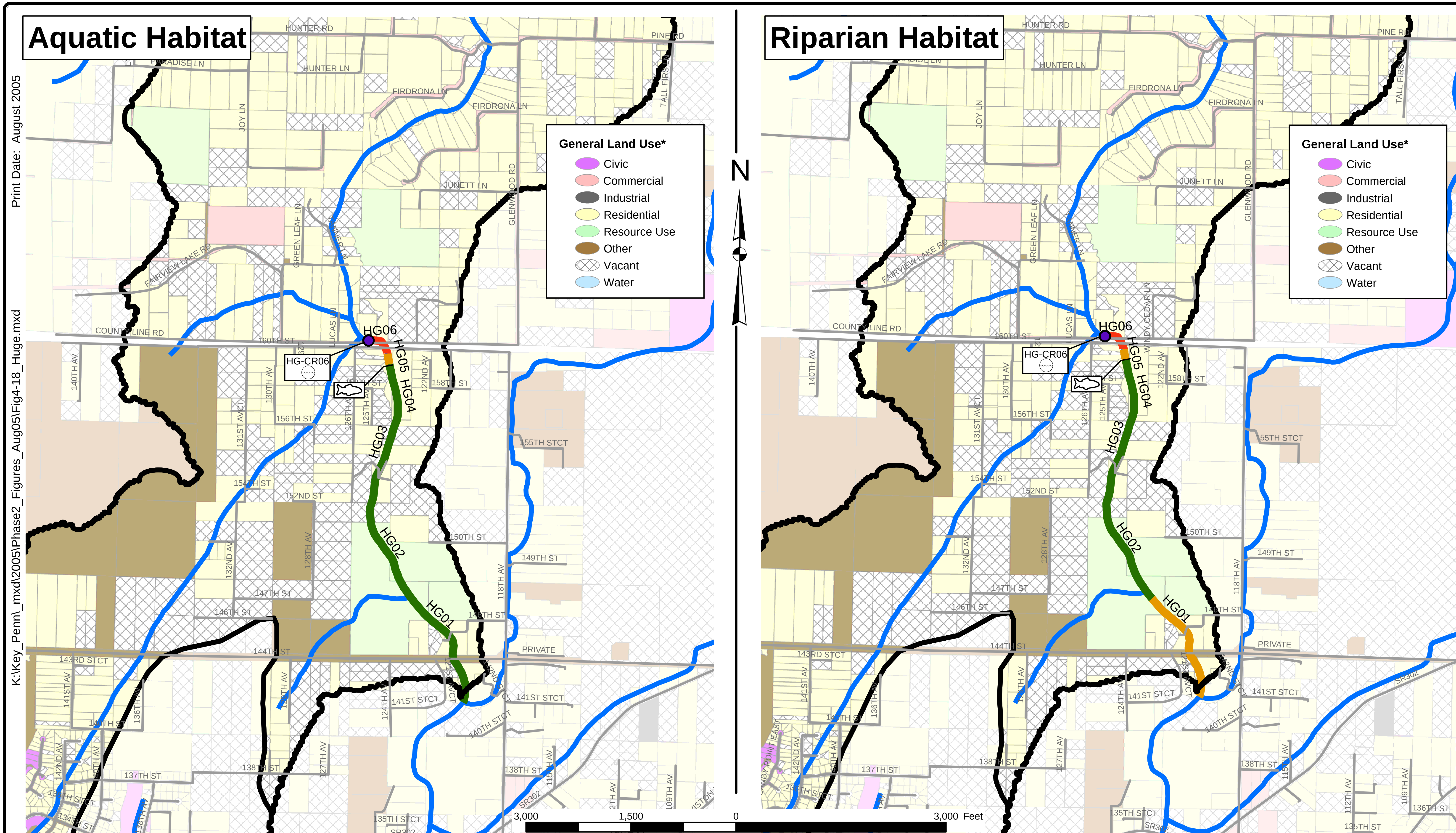


*General land use based on county tax assessor land use codes

"Good" Aquatic Habitat
"Fair" Aquatic Habitat
"Poor" Aquatic Habitat
Unsurveyed Stream Reach

Roads
Subbasin Boundaries
CIP Node
Future Flood Hazard
Potential Fish Passage Barrier

"Good" Riparian Habitat
"Fair" Riparian Habitat
"Poor" Riparian Habitat
Unsurveyed Stream Reach

Pierce County Water Programs

FIGURE 4-18
HUGE CREEK

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

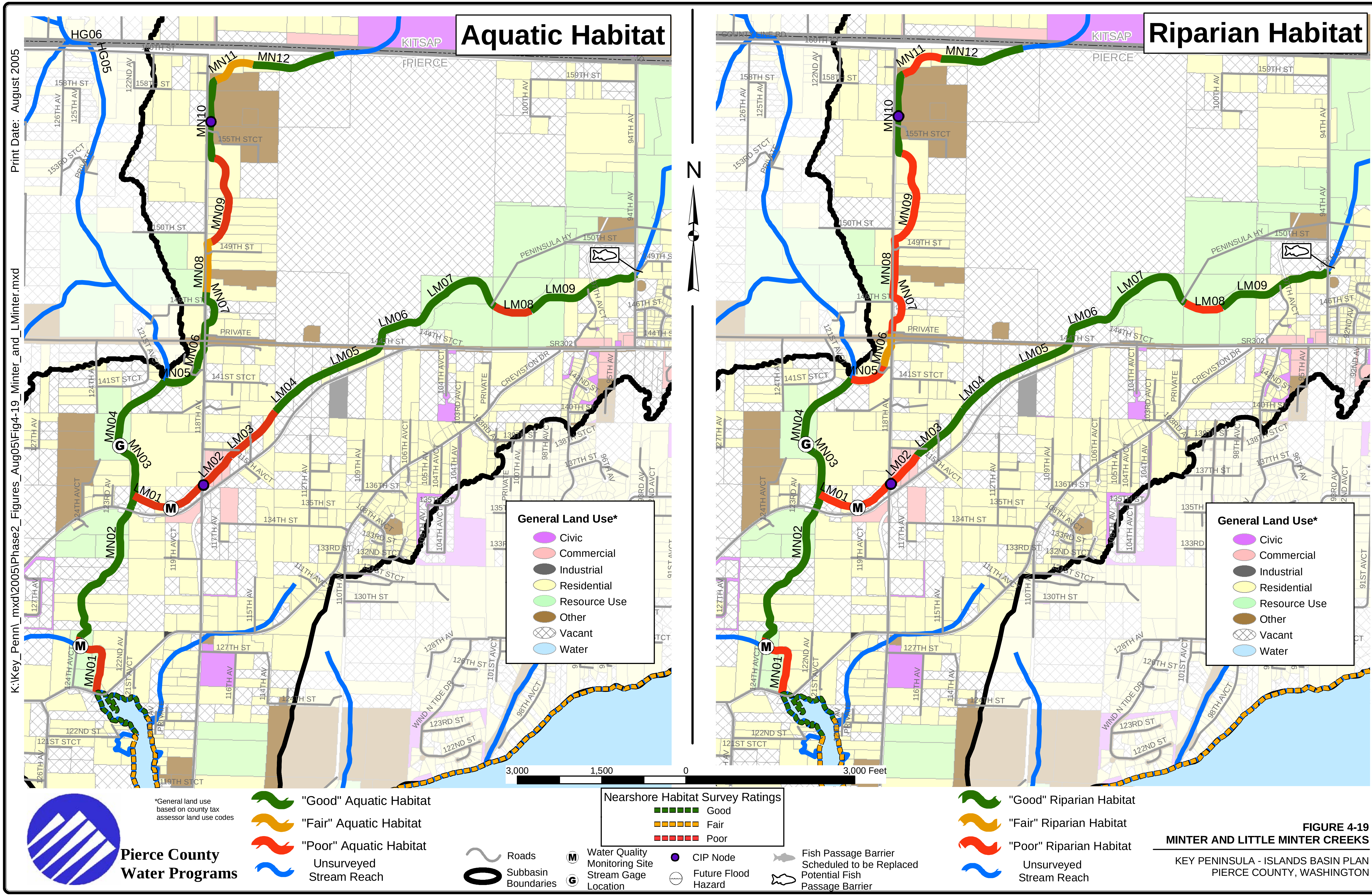


FIGURE 4-19
MINTER AND LITTLE MINTER CREEKS

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

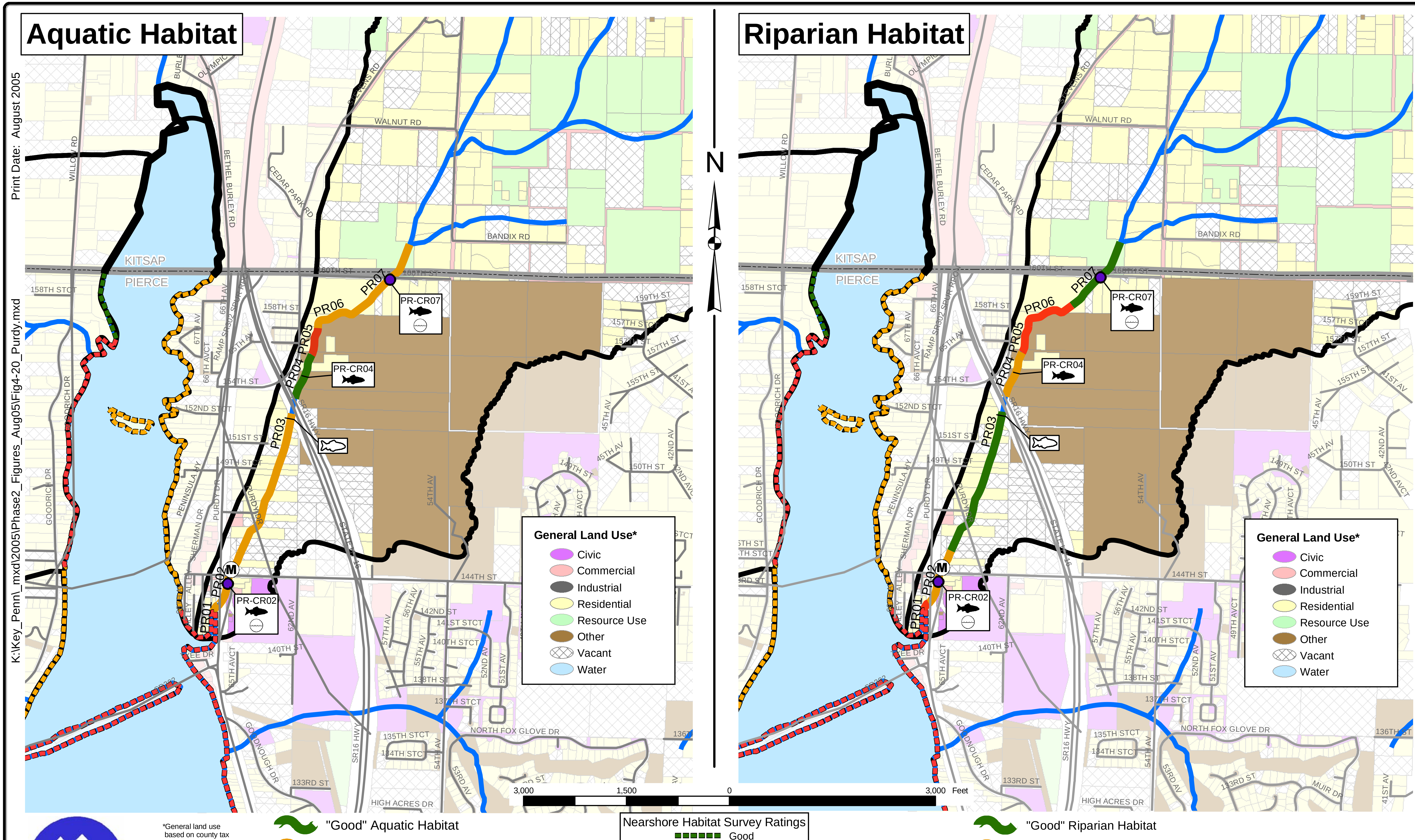


FIGURE 4-20
PURDY CREEK

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

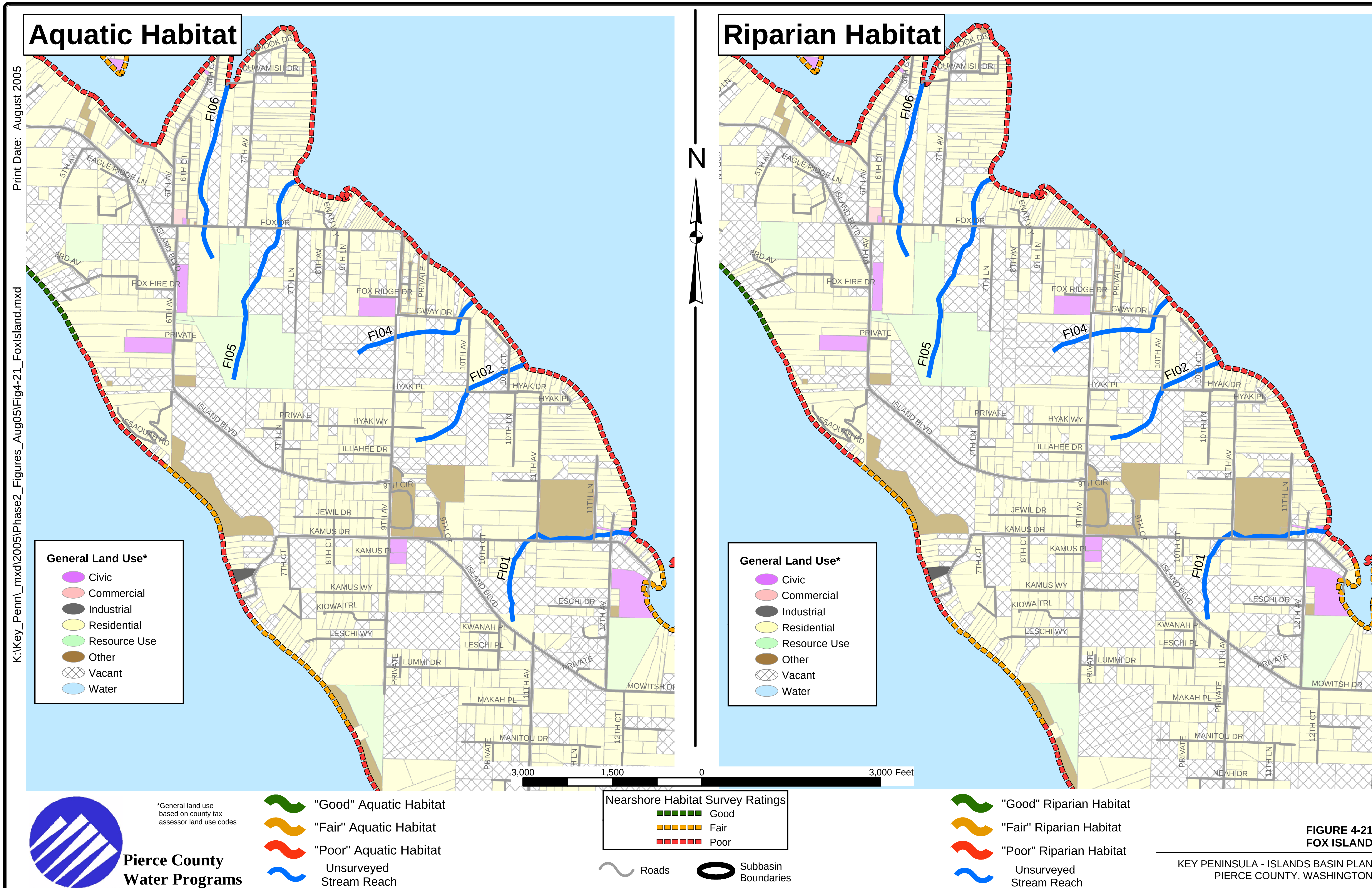


FIGURE 4-21
FOX ISLAND

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

CHAPTER FIVE
Identification of Existing Problems

5.1 INTRODUCTION

Problems investigated and evaluated for the Key Peninsula-Islands (KI) Basin include flooding, water quality degradation and degradation of aquatic and terrestrial wildlife habitat along stream corridors. Current land use practices were also evaluated to determine whether they are contributing to the problems.

5.2 PROBLEM DEFINITION

Flooding occurs when surface streams overflow their banks and water spreads across the floodplain. Often, floodwater can spread out harmlessly, but if it causes damage to property, makes roads impassable or threatens public safety, it becomes a problem.

Water quality problems are defined with reference to the *Clean Water Act (CWA)* and the State Water Pollution Control Act. The CWA requires that state and federal governments establish standards for surface waters that protect the beneficial uses of streams, rivers, lakes and coastal waters[1]. Surface waters that fail to meet applicable standards are considered problematic. The State Water Pollution Control Act makes it illegal to discharge pollutants without a permit from the Department of Ecology.

There are no universally agreed upon ways to precisely measure the quality of aquatic and terrestrial wildlife habitat and determine whether it is problematic. As discussed in *Chapter 4*, the method used in this study was based on work by the Tri-County Urban Issues Study Group, but modified by URS to better evaluate habitat for species other than fish. For the purposes of this analysis, any stream reach that receives a “Fair” or “Poor” rating for aquatic habitat or the riparian corridor was considered to be substantially degraded and therefore problematic.

Land use in a watershed has a profound effect on watershed hydrology, water quality and wildlife habitat. Land use practices are considered problematic if they are damaging to water quality or terrestrial and aquatic wildlife habitat.

[1] A discussion of the Clean Water Act and its provisions can be found in *Guidelines for Basin Planning, Pierce County, 2000*.

5.3 FLOODING

Most stormwater runoff in the KI Basin is routed to streams that flow to Puget Sound, with a few lakes interrupting flows in a couple of subbasins. Natural drainage patterns remain largely unaltered, although many culverts have been built to carry stream flow under roads and driveways. As a largely rural basin, there are few curbs, gutters, and underground storm drainage systems. Stormwater runoff in rural communities is typically routed to roadside ditches and then into natural streams. Some streams flow through well defined ravines where stream-side properties are generally located a considerable distance above the water level. Others flow through flatter terrain where the flood plain is broader. Wetlands often exist within the floodplain and have served as a deterrent to development.

There is no history of major, serious, damaging, flooding in the KI Basin but localized flooding incidents were identified through stream surveys, comments at public meetings and querying the County's database for complaints and requests for service. Local residents were invited to two public meetings in 2003, and one public meeting in 2004, to provide input on the project and to identify any known flooding problems. A questionnaire was sent to approximately 500 streamside property owners requesting information. Twenty-three questionnaires were returned but those that mentioned flooding merely confirmed known problems. Flooding problems were largely identified through the County database.

Pierce County records any incidents of flooding reported by its own staff or citizens. The records date back to January of 1999. The files contained a total of 52 complaints, of which 27 were private property issues, 14 involved Pierce County technical assistance, programmatic solutions, or maintenance, and nine were unrelated to surface water problems. Private property complaints included maintenance issues and neighborhood disputes.

The flooding problems that have occurred in the KI Basin are localized and relatively minor. Few have involved floodwater on public roads. In general, the existing drainage system appears to have sufficient capacity to carry stormwater away from structures at the current level of urban development. Most of the reported problems are probably the result of debris accumulating in culverts and ditches and could be solved by improved maintenance. A few problems may be the result of design deficiencies in engineered drainage systems in some residential sub-divisions. All complaints received are listed in *Appendix G*.

Of particular note, are the flooding complaints received by Pierce County following an unusually high rainfall event in 1995-1996 water year. The City of Olympia recorded rainfall of 7.40 inches during a storm that lasted from February 3 through February 9, 1996. Average rainfall for the entire month of February is typically 5.8 inches. Pierce County rainfall criteria describe 4.8 to 6 inches of rainfall in 24 hours as a 100-year storm. A total of 16 complaints were made during and following the February 1996 storm. Five complaints stated there was water over the road, two addressed unspecified flooding and two were maintenance complaints (plugged tile drains). A few other storm-related problems, including road subsidence, a street drain and driveway washing away, and a slide from Pebble Beach were reported to Pierce County. Of the 16 complaints, five came from Fox Island, four came from Vaughn, and three came from Rocky Bay. A list of complaints received after the February 1996 storm is contained in *Appendix G.*

Whether the February 1996 event can be considered a 100-year storm is the subject of debate. It is clear, however, that this level of rainfall, and associated runoff, is infrequently experienced in the area. New public roadway culverts and local stormwater systems are designed for 100-year storm events but older stormwater systems were designed to less rigorous standards. Pierce County established standards to accommodate 25-year storm events in 1986. Storm drainage requirements from projects before 1986 were even more ineffectual. Some system failures would be expected in a storm as large as the February 1996 event. The fact that most of the flooding experienced during the storm was relatively minor suggests that the existing storm drainage system in the KI Basin has no major deficiencies.

5.4 WATER QUALITY PROBLEMS

Rain falling on urban and suburban areas conveys numerous pollutants that have accumulated on roofs, streets, landscaped areas, and parking lots into storm drains and natural channels. Urban runoff typically contains suspended solids, oxygen demanding material, oil and grease, bacteria, pesticides, toxic metals, and nutrients in concentrations that are higher than those found in runoff from undeveloped lands. Many of these substances occur in urban runoff as of result of vehicle operation and the use of chemicals around homes and businesses.

Runoff from agricultural and pasture lands, common in the KI Basin, contains suspended solids, oxygen-demanding material, nutrients, bacteria, pesticides and herbicides in concentrations that are higher than in runoff from undeveloped forest and grasslands. These substances occur in runoff from agricultural lands because crop cultivation usually involves the repeated disturbance of the soil surface and the application of fertilizers and pesticides.

Animal husbandry makes manure available for conveyance into waterways in stormwater runoff and can cause soil erosion if pasture is overgrazed or animals have direct access to waterways. Although the concentrations of pollutants in urban and agricultural runoff are low compared to pollutant concentrations in domestic sewage they are still sufficient to harm the quality of streams, rivers and coastal waters.

Several methods were used to identify water quality problems in the KI Basin. The primary method was by comparing measured water quality and applicable water quality standards. As part of this planning study, samples of water from 10 major streams in the basin were collected, analyzed, and the results of the analyses were compared to the water quality standards. A questionnaire was sent to streamside residents with a request that they report any water quality problems that they may have observed. Pierce County's records were examined for complaints about water quality. The URS and Pierce County staff that conducted the field survey of 17 streams in the basin recorded observable occurrences of compromised water quality and identified factors that may influence overall water quality. Finally, a comparison of measured water quality in many KI Basin streams with water quality standards was done by the Washington State Department of Ecology as part of their responsibilities under the Clean Water Act. This information was used as an additional source of water quality data.

5.4.1 Ambient Water Quality Standards

The federal Clean Water Act requires the states to establish ambient water quality standards that protect the beneficial uses of the nation's waters. The Washington Department of Ecology recently revised the state's water quality standards. The current standards for fresh waters are shown in *Table 5-1*. Separate standards for water temperature, dissolved oxygen, turbidity and pH have been established for two types of waters based on the need to protect cold water fish species. Core rearing standards are applicable to waters where the overall aquatic environment supports greater numbers of juvenile salmonids while the non-core rearing standards are applicable to waters that see less juvenile salmon. Pierce County recommends using the core-rearing standard for Rocky, Minter, and Burley Creeks and the non-core rearing standard for comparison of all other streams in the study area.

The Washington Department of Ecology has also established standards for fecal coliform bacteria in fresh and marine waters. The fecal coliform standards for fresh and marine waters are designed to protect recreational users that come into intimate contact with these waters. A more stringent fecal coliform standard has been established for marine waters where shellfish are harvested.

Table 5-1
Water Quality Standards For Fresh Waters
Interpreted from WAC 173-201A-200 – Fresh water designated uses and criteria

Constituent	Core Rearing Standard(1) Conforms with old Class AA standards	Noncore Rearing Standard (2) Conforms with old Class A standards
Temperature – Measured by the 7-day average of the daily maximum temperature	<16 degrees Celsius (60.8 degrees Fahrenheit)	<17.5 degrees Celsius (63.5 degrees Fahrenheit)
Dissolved Oxygen (DO) Measured as 1-day minimum DO in mg/L.	>=9.5 mg/L	>=8.0 mg/L
Turbidity – Measured in "nephelometric turbidity units" or "NTUs"	Turbidity shall not exceed: - 5 NTU over background when the background is 50NTU or less; or - A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.	Turbidity shall not exceed: - 5 NTU over background when the background is 50NTU or less; or - A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
Total Dissolved Gas (TDG) – Measured in percent saturation	Shall not exceed 110% of saturation at any point of sample collection.	Shall not exceed 110% of saturation at any point of sample collection.
pH – Expressed as the negative logarithm of the hydrogen ion concentration.	Between 6.5 and 8.5, with a human caused variation within the above range of less than 0.2 units.	Between 6.5 and 8.5, with a human caused variation within the above range of less than 0.5 units.

Constituent	Extraordinary Primary Contact Recreation Conforms with old Class AA standards	Primary Contact Recreation Conforms with old Class A standards
Fecal Coliform - Measured as the geometric mean value, including five or more events over a 30-day period.	Must not exceed a geometric mean value of 50 colonies/100mL, with not more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100mL.	Must not exceed a geometric mean value of 100 colonies/100mL, with not more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100mL.

5.4.2 Compliance with Standards

Section 303(d) List

Pursuant to Section 303(d) of the Clean Water Act, the Washington Department of Ecology periodically prepares a list of all surface waters in the state that do not meet water quality standards. To prepare the list the Department of Ecology compiles water quality information on ambient water quality from a variety of sources and compares the data to the applicable standards. *Chapter 4* provided a summary of reaches in the KI Basin that are water quality impaired and/or 303(d) listed (*Table 4-8*). Four creeks in the KI Basin included reaches that were on the 303(d) list in 2005. Aside from the 303(d) listing of one reach for dissolved oxygen, three reaches of Burley Creek are currently listed as out-of-compliance with the fecal coliform standard but are currently operating under a pollution control plan, while three other reaches are likely to be 303(d) listed in the future (for fecal coliform and pH). One reach of Huge Creek is currently 303(d) listed for dissolved oxygen while one other reach of Huge Creek is likely to be 303(d) listed in the future for fecal coliform. Both Little Minter Creek and Minter Creek have reaches on the 303(d) list for fecal coliform and dissolved oxygen respectively. In addition, another six reaches of Minter Creek are 303(d) listed for fecal coliform as well.

Purdy Creek and Rocky Creek are not on the 303(d) list but they have reaches with compromised water quality that are likely to be listed in the future. Two reaches of Purdy Creek are operating under a pollution control plan for fecal coliform, while one reach is likely to be 303(d) listed in the future for dissolved oxygen. A single reach of Rocky Creek is likely to be listed as out-of-compliance with the dissolved oxygen standard in the future.

Water Quality Sampling

As part of the field work for this study, grab samples were taken from 10 major streams on October 16, 2003, November 11, 2003 and October 20, 2004 and analyzed for a variety of constituents including temperature, pH, dissolved oxygen (DO), turbidity, specific conductivity, fecal coliform, total phosphorus, and nitrate. Water temperature measurements were made every 15 minutes at the gauging stations on Vaughn and Minter Creeks, beginning in November 2003, and on Rocky Creek, beginning in February 2004. The results of grab sampling are shown in *Table 5-2*.

Pierce County has determined that the applicable standard for Rocky, Minter, and Burley Creeks is the core-rearing standard and the applicable standard for all other streams in the KI Basin is the non-core rearing standard (1).

When it established the water quality standards shown in *Table 5-1*, the Washington Department of Ecology also specified sampling methods that would ensure a statistically rigorous comparison of measured water quality with the standards. Although grab sampling on October 16th and November 20, 2003 and October 20, 2004 did not fully adhere to the proscribed methods, the comparison that follows, while not strictly meeting the sampling procedure outlined in *WAC 173-201A-200*, is informative. (In order to ensure accurate comparison, fecal coliform should be sampled a minimum of five times in a 30-day period and the geometric mean of the samples should be compared to the criteria. Due to timing and budget constraints, the appropriate number of samples was not acquired.)

The figures in bold in *Table 5-2* show water samples that were out of compliance with water quality standards. All pH measurements were in compliance with the standards. About one-third of the dissolved oxygen measurements and almost all the fecal coliform measurements were out-of-compliance with standards. It was difficult to determine compliance with turbidity standards but most of the turbidity measurements were low and consistent with expectations for lowland streams in the Pacific Northwest.

Grab sample water temperatures cannot be directly compared to the standards, which are expressed in terms of the seven day average of daily maximum temperatures, but they were all below the allowed maximum temperatures by a considerable margin, as would be expected for samples taken in the October and November. The continuous recording thermographs that were installed on Minter, Rocky and Vaughn Creeks and operated through the summer of 2004 indicated that water temperatures were in compliance with standards at all times although they were close to the allowed maximum temperatures during a few hot days in late July.

Elevated concentrations of plant nutrients promote algae blooms, which can adversely affect water quality, raising the pH and causing dissolved oxygen levels to fluctuate and finally decline as the algae dies. The concentrations of nitrate and phosphorus measured during the three sampling events do not appear to be at levels that would prompt quality concerns in moving water but could be problematic if stream water is impounded behind dams or streams are reduced to isolated pools during low flow periods. Surveyors reported excessive aquatic plan growth at several locations during the field surveys.

Grab samples provide information on water quality conditions at the instant in time when the sample is taken. But water quality typically varies seasonally and diurnally. Unless frequent grab samples are taken, and they rarely are for economic reasons, they provide a very limited picture of water quality. Depending on their timing, grab samples may miss seasonal and diurnal variations in water quality and will almost certainly miss events that have transitory effects on water quality, like a chemical spill or the sudden collapse of a stream bank. Some of the disadvantages of grab sampling can be offset by supplementing grab sampling with macroinvertebrate sampling. The characteristics of the macroinvertebrate community provide an indicator of long-term stream health because they serve as a continuous monitor of water quality.

The effects of a chemical spill that may only last for a few hours will be reflected by the macroinvertebrate community but would likely be missed by grab sampling.

5.4.3 Observations and Complaints

Chapter 4 includes a summary of field observations as related to water quality under each surveyed stream segment. A number of informative observations were made with regards to possible sources of water quality impairments, which were used to compare and verify water quality monitoring results, discussed later in *Chapter 7*. Typical observations and probable sources of water quality impairments include algal growth, bank erosion, animal access to streams, trash disposal, and agricultural runoff.

Some of the questionnaires sent to streamside property owners were returned with comments on water quality and some attendees at the public meetings commented on water quality. Although no specific water quality problems were identified, some of the comments received referred to activities that could harm water quality. Review of the public comment summaries indicates that the public recognizes that clear-cutting, removal of riparian vegetation, illicit dumping of garbage or sewage, and domestic animals in and around streams can cause water quality problems.

Bacterial contamination of streams sometimes occurs in rural areas that depend on septic tanks systems for sanitary wastewater disposal. Older systems, built before current septic tank system standards were put in place, often fail due to age, design deficiencies and inadequate maintenance. Tacoma-Pierce County Health Department estimates that 5 to 10% of septic systems in the county have problems at any give time[2]. Typically, the failure of a residential septic tank system becomes apparent when effluent appears on the surface of the ground above the drainfield rather than percolating into the ground. This phenomenon can create a hazard to public health but is usually too small in scale to have much effect on surface water quality. Another form of septic system failure occurs if the soil drains too quickly, preventing the septic tank effluent from being in contact with the soil long enough to provide effective treatment by the microorganism in the soil; thus, untreated effluent flows into creeks and bays

Tacoma-Pierce County Health Department (TCPHD) records do not indicate major problems with failing septic systems in the KI Basin. One area on Anderson Island has poor soils, which tend to cause problems for septic systems. However, septic tank systems failures are not always easy to detect and may go unnoticed.

5.4.4 Conclusions

Water quality in streams in the KI Basin appears to be generally good but with some significant impairments. Eighteen creek reaches are either listed by the Washington Department of Ecology, or likely to be listed, as out-of-compliance with fecal coliform standards. The recorded fecal coliform concentrations in KI Basin streams are higher than would be expected absent

[2] Personal Communication – Chris Matter-Rinehart, Tacoma-Pierce County Health Department, May 2, 2005

human influences. Review of the sampling results over the three-sample period shows significant variability in the fecal coliform concentrations. The results suggest that there are no major continuous discharges of untreated human waste or domestic animal waste to the creeks but that some contamination is occurring, possibly as a result of domestic animals in or near creeks, failing septic systems, and discharges from small private fish hatcheries. Fluctuations in fecal concentrations may also be the result of rainfall patterns – fecal coliform concentrations in streams typically rise during storms and remain elevated for several days afterward.

Violations of the dissolved oxygen standards are less widespread than the violations of fecal coliform standards but they still occur with considerable frequency. Six stream reaches are listed, or will likely be listed in the future, as out-of-compliance with dissolved oxygen standard. Eight of 20 grab samples were out of compliance with the dissolved oxygen standards. If the grab samples had been taken in the summer months when water temperatures are elevated it is likely that even more violations of the standards would have been found.

Although violations of the dissolved oxygen standards are common, the stream waters of the KI Basin are generally cool and well oxygenated. In most cases, violations are attributable to measurements of dissolved oxygen that are only slightly below the standard. The somewhat sub-standard dissolved oxygen levels could be attributable to human activity or the standards may simply be set too high for relatively shallow gradient streams. Dissolved oxygen levels in slow-flowing streams are generally lower than in cascading streams because there is more time for oxygen depletion to occur and reaeration rates are lower.

5.5 FISH AND WILDLIFE HABITAT DEGRADATION

Human use of the land, waters and natural resources of Puget Sound has had an adverse effect on aquatic and terrestrial wildlife and their habitat. One of the species to suffer is the salmon. In March 1999, the Puget Sound chinook salmon was listed as threatened under the *Endangered Species Act (*64 Fed. Reg. 14307). The status review that led to the listing identified the high level of hatchery production which masks severe population depression of native Puget Sound chinook as well as severe degradation of spawning and rearing habitats, and restriction or elimination of migratory access as causes for the range-wide decline in Puget Sound Chinook salmon stocks (NMFS, 1998a, and 1998b).

Habitat alterations and availability impose an upper limit on the production of naturally spawning populations of salmon. The National Research Council Committee on Protection and Management of Pacific Northwest Anadromous Salmonids identified habitat problems as a primary cause of declines in wild salmon runs (NRCC, 1996). Some of the habitat impacts identified were the fragmentation and loss of available spawning and rearing habitat, migration delays, degradation of water quality, removal of riparian vegetation, decline of habitat complexity, alteration of streamflows and streambank and channel morphology, alteration of ambient stream water temperatures, sedimentation, and loss of spawning gravel, pool habitat, and large woody debris (NMFS, 1998a, NRCC, 1996). Other factors such as increased impervious area, upland land use practices and polluted runoff, contaminants in coastal wetlands and estuaries, shoreline modifications, and dredge spoil disposal have also been identified as habitat problems contributing to the decline of Chinook salmon (PFMC, 1995). Essential features of chinook salmon critical habitat include adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions (NRCC, 1996).

As noted above, habitat degradation at the regional scale was identified as one of the reasons for the decline of salmon in Puget Sound. As part of this planning study, a team of technical specialists assessed the condition of aquatic and riparian habitat in a portion of the Puget Sound watershed, the KI Basin. Approximately 110,000 feet of stream were surveyed as described in detail in *Chapter 4*.

5.5.1 Riparian Habitat

Riparian corridors have a significant habitat role for a wide variety of plants and wildlife that live in or near water, or spend part of the year using the riparian areas for forage, nesting, and cover. Healthy riparian conditions contribute to water quality by providing stream shading, attenuation and filtering of runoff, long-term supply of woody material to the stream channel that act as habitat forming structure, and serves as a source of invertebrates which provide food for aquatic and terrestrial animals.

Development in the KI Basin has often resulted in the loss of riparian vegetation and a resulting reduction in riparian function. Stream corridors naturally evolve in an environment of fluctuating flows and seasonal rhythms. Native species adapted to such conditions might not survive without them. For stream corridors that have naturally evolved in an established pattern, the diminution of such patterns can result in the creation of a new succession of plants and wildlife and the decline of native species.

Major causes of riparian zone degradation include both human actions and natural processes, sometimes resulting from or accelerated by human actions far removed from the basin. When the basin was first settled by Euro-Americans, land along streams was attractive to loggers due to the availability of large trees and because stream corridors provided a convenient route for skidding and/or floating logs to waiting ships. Farmers also valued the productive soils of streamside lands and available year-round water supplies. Today, many residents choose to site their homes near streams for aesthetic reasons.

Removal of native riparian vegetation decreases cover that juvenile salmonids in various stages of development use to avoid predation. Removal of shade trees increases water temperature which can be detrimental to fish physiology and may lead to lowered dissolved oxygen levels, further increasing fish mortality. Non-native, invasive plant species such as reed canary grass, Himalayan blackberry, and Scotch broom have replaced native riparian vegetation. The introduction of exotic species, whether intentional or not, can cause disruptions such as reduction in forage productivity for both fish and terrestrial organisms, reduced stream shading, elimination of long term woody debris recruitment, and the introduction of diseases. Nonnative species compete with native species for moisture, nutrients, sunlight, and space while simultaneously lacking the ability to provide many of the functions of the native species they replace. In many residential areas, native vegetation has been replaced with mowed lawns and ornamental plants.

Of the streams surveyed as part of this study, Knackstedt Creek, Kingman Creek, Lackey Creek, Muck Creek, and Taylor Bay Creek all received a rating of 100% good riparian corridor. Other streams in good condition include Rocky Creek, with more than 96% of the riparian corridor rated in good condition; Schoolhouse Creek (Anderson Island), Little Minter, Minter, and Rocky West Tributary were all rated with more than 70% of riparian corridor in good condition. Rocky Creek has the greatest amount, 18,380 linear feet, of riparian corridor in good condition.

5.5.2 Aquatic Habitat

Natural stream ecological processes in the KI Basin have been altered due to adjacent land management practices and direct actions within the stream corridor. Agricultural activities in the floodplains have led to channelized streams, drained wetlands, and removal of vegetation from riparian zones. These practices have had a variety of negative effects, including reducing channel complexity, pool/riffle ratios, and bank and streambed stability, and eliminating riparian areas and juvenile rearing habitat associated with wetlands. Limiting factors of in-stream habitat complexity can be observed in the lack of adequate large woody debris (LWD) in streams, particularly larger key pieces that are critical to developing habitat diversity important to salmonids. Reduced frequency of LWD may result in a variety of habitat impairments; such as inadequate numbers of pools per mile of stream, fewer large deep pools that are important to rearing juvenile salmonids and to adult salmonids on their upstream migration, reduced cover from predators, reduced sediment storage for spawning, and reduced stream/floodplain interaction. Loss of natural floodplain processes which results in the loss of functional off-channel habitat may also be caused by confinement of channels by dikes, levees, bank armoring, and channelization.

On some residential properties in the KI Basin, native riparian habitat has been removed leading to destabilized banks and the need for shoreline armoring using riprap, concrete or other materials that are installed for bank protection. This shoreline armoring interrupts habitat-forming processes, while providing little or no habitat function itself. Numerous reach segments have also been straightened, a stream management technique that while it may prevent localized erosion, also eliminates lateral stream migration which naturally dissipates high stream velocities. Stream velocities increase over long straight channel sections, which can lead to downcutting and severe undercutting of the stream banks, and can worsen erosion downstream of straightened reaches. Channel migration aids in the formation of complex instream habitat including pools, riffles, glides, and secondary channels, key constituents in sustaining healthy fish populations and aquatic species diversity.

Of the streams surveyed, Dutcher Creek, Kingman Creek, Lackey Creek, and Muck Creek, all received a rating of 100% good aquatic habitat. Other streams in good condition include Rocky Creek and Knackstedt Creek, with more than 96% of the aquatic habitat rated in good condition; Schoolhouse Creek (Anderson Island), Huge Creek, and Minter Creek were all rated with 70% or more of the aquatic habitat in good condition. Rocky Creek has the greatest amount, 18,380 linear feet, of aquatic habitat in good condition.

5.5.3 Fish Passage Barriers

Most culverts in the KI Basin were designed and constructed prior to recent state and local regulations that require consideration of fish passage in culvert design. There are many man-made barriers to fish passage on streams in the KI Basin. Prior to the 1990s, fish passage on small streams was given little consideration. Public and private parties typically used culverts to convey small streams under highways and driveway fills because they were less expensive than fish–friendly bridges. Today, many existing road and driveway culverts prevent or obstruct the movement of fish from salt water to freshwater and from one stream reach to another. These culverts form barriers to fish passage due both to aspects of the design of the culverts (slope, outfall conditions, water velocity, water depth, etc.) and maintenance of the culverts (debris blocking the culvert, sediment build-up within the culvert, etc.).

Barriers are particularly deleterious to anadromous or migratory fish, which spend most of their life in the ocean, but return to spawn in their native freshwater streams. Anadromous fish that use small streams may be denied access to streams reaches that provide suitable spawning and rearing habitat due to impassable barriers. Fish passage barriers may also prevent the movement from one stream reach to another by resident species, such as cutthroat trout. The salmonid species that inhabit small streams in the KI Basin are in decline and some are listed as threatened pursuant to the *Endangered Species Act* (ESA).

Some streams in the basin are relatively free of fish passage barriers. In 2000, a culvert at Wright-Bliss Road, a long-standing barrier to fish passage along East Fork Rocky Creek, was replaced with a bridge allowing for unrestricted fish passage upstream toward the headwaters.

5.5.4 Conclusions

Although development in the KI Basin has harmed streams and streamside vegetation a considerable portion of the stream corridors remains in good, if not pristine condition. Aquatic habitat in 72% of the stream miles examined was rated as in “Good” condition, 15% was rated as in “Fair” condition, and 13% was rated as in “Poor” condition. The riparian corridor in 73% of the stream miles examined was rated as in “Good” condition, 14% was rated as in “Fair” condition, and 13% was rated as in “Poor” condition. Any aquatic or riparian habitat rated as “Fair” or “Poor” is not likely to be regarded by NOAA Fisheries, the agency responsible for protection of salmonids under the *Endangered Species Act*, as in a “properly functioning condition” and thus not supportive of healthy native salmonid stocks. Degraded habitat of this type should be regarded as an environmental problem worthy of solution.

Similarly, streams that contain salmonid habitat that is inaccessible to fish because of barriers are not likely to be considered as in a “properly functioning condition” and thus are not supportive of healthy native salmonid stocks. Barriers to fish passage should be regarded as an environmental problem worthy of solution.

5.6 LAND USE AND STREAM HEALTH

Rural 10 (R10) zoning dominates the Key Peninsula and Islands Basin study area with small areas of Agriculture (A) and very small Rural Activity Center (RAC) and Rural Neighborhood Center (RNC) zoning designations. The Rural 10 zone, indicating a nominal dwelling density of one unit per 10 acres, should provide for adequate opportunities to accommodate residential development that is compatible with the goals of the basin plan. An exception could include parcels dominated by critical areas that limit building opportunities. Development might be permitted on these parcels by variance where strict enforcement of setbacks, and other necessary ordinances, would prevent any economic use of the property (see Pierce County Code 18.160.030 – Applicability). The Current Land Use map indicates a large number of pre-existing lots that have not yet achieved full development suggesting additional subdivision infill construction is possible throughout the study area, even within the R10 zone. Remedial action can be initiated through technical assistance, education and incentives at developed and potential infill sites to reduce the impact of yard maintenance activities; stream buffer and wetland manipulation; and stream crossing problems. Preservation of high quality habitat areas can be achieved through technical assistance and education for present land owners, and incentives, regulation and acquisition for undeveloped sites.

Although the areas zoned Agriculture (A) and Rural Activity Center (RAC) and Rural Neighborhood Center (RNC) are relatively small in extent, they often coincide with impaired aquatic and riparian habitat observed in field studies. Fencing to exclude livestock from the riparian and in stream areas would reduce erosion, mechanical damage to habitat and introduction of fecal matter directly into surface waters. Preventing direct concentrated surface runoff into streams by further buffering, construction of swales or confining animals during periods when soils are saturated can reduce siltation and transport of fecal coliform into streams. (Examples: Taylor Bay Creek, Schoolhouse Creek, Vaughn Creek, Minter Creek, and Little Minter Creek.)

Current county regulations require fencing to prevent livestock access to streams and containment of manure to prevent surface water pollution but based on field observations these requirements are not always implemented. See: *Pierce County Ordinance No. 96-47.*

Table 5-2
Water Quality Characteristics of Streams – Sampling Results

October 16, 2003

Water Body	Sampling Location	*Temper-ature (deg. C)*	*Dissolved Oxygen(mg/L)*	*Turbidity (NTU)*	*pH*	*Specific Conductivity (mS/cm)*	Fecal Coliform* SM 9221E (MPN/100mL)	*Fecal Coliform*, MF, SM 9222D* (CFU/100 ml)	Total Phosphorus, EPA Method 365.1(mg/L)	Nitrate-Nitrogen, EPA Method 300A(mg/L)
Taylor Bay Creek	Twin Creek Farm							1,400	0.15	0.843
Schoolhouse Creek (KP)	Reeves Road							5,400	0.14	0.729
Knackstedt	202nd Ave							270	ND	1.3
Whiteman Creek	194th Ave							4,800	0.15	1.19
Dutcher Creek	Lackey Rd							4,500	0.13	1.7
Vaughn Creek	Olson Rd							2,500	0.06	1.06
Rocky Creek	132nd							510	0.10	0.99
Minter Creek	Creviston Rd							1,100	0.15	0.92
Little Minter Creek	Highway 302							1,100	0.15	1.14
Purdy Creek	Highway 16 &144th							600	0.17	1.85

November 11, 2003

Water Body	Sampling Location	*Temperature (deg. C)*	*Dissolved Oxygen (mg/L)*	*Turbidity (NTU)*	*pH*	*Specific Conductivity (mS/cm)*	Fecal Coliform* SM 9221E(MPN/100mL)	Fecal Coliform*, MF, SM 9222D (CFU/100 ml)	Total Phosphorus, EPA Method 365.1 (mg/L)	Nitrate-Nitrogen, EPA Method 300A (mg/L)
Taylor Bay Creek	Twin Creek Farm	8.7	7.4	12.0	7.86	0.159	8		0.21	ND
Schoolhouse Creek (KP)	Reeves Road	8.1	7.9	17.6	7.90	0.096	33		0.21	0.07
Knackstedt	202nd Ave	8.3	10.0	0.12	7.98	0.074	30		0.11	0.177
Whiteman Creek	194th Ave	8.7	7.5	6.10	7.69	0.092	700		0.19	0.21
Dutcher Creek	Lackey Rd	8.5	9.2	2.50	7.91	0.106	27		0.11	0.562
Vaughn Creek	Olson Rd	8.2	8.0	9.00	7.58	0.076	11		0.16	0.10
Rocky Creek	132nd	9.3	8.6	3.30	7.85	0.074	4		0.53	0.229
Minter Creek	Creviston Rd	8.9	9.3	0.45	7.87	0.092	7		0.09	0.352
Little Minter Creek	Highway 302	9.4	8.8	0.40	7.95	0.112	130		0.16	0.952
Purdy Creek	Highway 16 &144th	9.6	8.1	2.9	7.67	0.109	50		0.15	0.171

October 20, 2004

Water Body	Sampling Location	*Temper a-ture (deg. C)*	*Dissolved Oxygen (mg/L)*	*Turbidity (NTU)*	*pH*	*Specific Conductivity (mS/cm)*	Fecal Coliform* SM 9221E(MPN/100mL)	Fecal Coliform*, MF, SM 9222D (CFU/100 ml)	Total Phosphorus, EPA Method 365.1 (mg/L)	Nitrate-Nitrogen, EPA Method 300A (mg/L)
Taylor Bay Creek	Twin Creek Farm	9.60	**7.82**	25	7.06	0.063		**70**	0.08	0.03
Schoolhouse	Reeves	10.87	9.02	36	6.52	0.051		**190**	0.15	0.061
Knackstedt	202nd Ave	10.20	10.57	2.6	7.36	0.061		11	0.16	1.05
Whiteman Creek	194th Ave	10.46	9.58	17	7.07	0.058		**420**	0.11	0.219
Dutcher Creek	Lackey Rd	10.46	10.24	9.5	7.32	0.067		**125**	0.08	0.839
Vaughn Creek	Olson Rd	10.98	9.04	17	6.80	0.050		**120**	ND	0.469
Rocky Creek	132nd	10.07	10.52	2.0	7.17	0.045		6	ND	0.274
Minter Creek	Creviston Rd	10.16	10.27	2.0	7.25	0.062		**34**	ND	0.501
Little Minter Creek	Highway 302	10.49	**9.30**	2.3	7.08	0.075		**35**	ND	1.34
Purdy Creek	Highway 16 &144th	10.89	10.2	3.0	7.25	0.073		**40**	ND	0.445

Notes:

1) Bold designates values that do not meet standards defined in Water Quality Standards for surface Waters of the State of Washington (WAC 173-201A).

2) Two different tests were conducted to analyze for fecal coliform, the SM 9221 and the SM 9222. Generally, the SM 9222 test is used for very turbid samples typically associated with wastewater treatment facilities while the SM 9221 test is used to analyze less turbid samples associated with surface and stormwater (Standard Methods 1998). Results of the SM 9221 test is reported as most probable number (MPN) per 100 mL and thus statistical representation is reported with the results. Results of the SM 9222 test are reported in "colony forming units" (CFU) per 100mL and were determined by filtering and plating the sample and growing and counting the colonies that formed. Generally the results of both tests have been found to yield consistent results, but statistical comparison of the results of the SM 9221 and SM 9222 indicate that the SM 9222 test tends to be more precise (Standard Methods 1998). As the surface water quality criteria does not specifically state which test to conduct, both tests were conducted in order to compare results. Water quality monitoring conducted for the Gig Harbor Basin Plan in 2002 reported results as CFU/100mL, thus the SM9222 was conducted twice, one year apart and the SM 9221 test was conducted once for reference.

CHAPTER SIX
Analysis of Flooding Problems

6.1 INTRODUCTION

Most stormwater runoff in the Key Peninsula-Islands Basin is routed to streams that flow to Puget Sound, with a few streams flowing through lakes. Natural drainage patterns remain largely unaltered, although many culverts have been built to carry stream flow under roads and driveways. As a largely rural community, there are few curbs and gutters, and few underground storm drains. Stormwater runoff is typically routed to roadside ditches and then into natural streams.

Some streams flow through well defined ravines where streamside properties are generally located a considerable distance above the water level. Where the floodplain is broader, wetlands often exist, and are a deterrent to development. Because of the nature of the terrain and the lack of structures within floodplains, almost all of the flooding problems that occur under existing conditions are localized and relatively minor. In general, the existing system appears to have sufficient capacity to handle stormwater flows in the basin.

Existing flooding problems may be exacerbated, and new problems may emerge, as development occurs. Mathematical models that simulate the hydrology and hydraulics of a watershed are typically used to identify existing flooding problems and predict and describe potential future flooding problems.

The locations of existing and predicted flooding problems, identified in the six basins modeled, are shown in *Table 6-1* and in the individual basin maps in *Figures 4-25*, and *4-32* through *4-35*. The modeled nodes are shown in *Figure 6-1*. *Table 6-1* shows which of the modeled culverts fails to handle flows for either a 2-, 25- or 100-year storm event, under existing or future land-use conditions, and the proposed capital improvement to upsize the culvert to handle flows for a 100-year event for future land-use. Pierce County design standards require new culverts to be able to handle a 100-year flow.

6.2 MODELING METHOD

There are no existing studies or models of the KI Basin. URS and Pierce County identified six basins that would be modeled to determine the basin's hydrology and hydraulics using the U.S. Army Corps of Engineers' HEC-HMS model.

Six stream basins were determined to have the greatest potential for future development and flooding due to the size of the basins, the number of pre-existing lots, and the likelihood of growth pressure from future transportation improvements. These basins included:

- Purdy Creek
- Minter Creek
- Little Minter Creek
- Huge Creek
- Rocky Creek
- Schoolhouse Creek (AI)

In addition to the six streams mentioned above, Lackey, Dutcher, and Vaughn Creek were evaluated and determined to be inappropriate for modeling for several reasons: there are very few stream crossings under County maintained roadways; large bridges are already in place at stream crossings, and minimum flows were observed in the stream channel during field reconnaissance.

As noted above, there have been few serious flooding incidents in the KI Basin because of the nature of the terrain and rural character of the Basin. If flooding does occur in the future, it will most likely be associated with road and driveway culverts because the culverts represent constrictions in the natural drainage system.

Roadway culverts are typically owned by Pierce County, whereas driveway culverts are privately owned. Roadway culverts in the KI Basin are of greater concern in this study than driveway culverts because their failure to pass high stream flows could put public safety at risk. Pierce County is responsible for their performance and the correction of deficiencies would require the use of public funds. The failure of driveway culverts to pass high stream flows may inconvenience individual property owners but are less likely to affect the public-at-large.

The responsibility for driveway culverts lies with private property owners. Thus, to make the best use of available resources, modeling was limited to the hydraulic performance of publicly owned culverts on the six streams identified above. A detailed description of the model and how it was applied to the KI Basin is provided in *Appendix H*.

6.3 PREDICTION OF FUTURE FLOODING

The results of these modeling efforts are shown in *Tables 6-2* and *6-3*. Predicted peak flows and corresponding maximum upstream water levels for each of the culverts are listed. Water levels are expressed as a “stage” value, referenced to the culvert invert, instead of an elevation referenced to sea level. The table shows the simulated performance of roadway culverts in the 2, 25, and 100-year return frequency storms. The design storm for road culverts is the 100-year storm.

The three columns at the extreme right of the table show information for the 100-year storm. The first of these columns, labeled “estimated freeboard to road crest”, indicates the predicted vertical distance between the water surface in the 100-year storm and the crest of the road. Where negative numbers are shown, floodwater would be expected to overtop the road. The second of these columns shows the headwater-to-diameter ratio. The headwater depth is the depth of water over the culvert invert.

Pierce County storm drainage standards require that the headwater-to-diameter ratio not exceed 1.5 during the 100-year event. Stated another way, a culvert should not be surcharged by more than half of its diameter. The last of the three columns indicates whether individual culverts meet the standard.

As indicated in the table, the model predicts that road flooding could occur at thirteen locations, involving 11 culverts and two bridges.

The culverts that may cause road flooding, shown with both node numbers and CIP numbers, include:

- 5'x6' culvert that carries Huge Creek under 160th St. (Node H-02) (CIP HG-CR06)
- 6'x10' bridge that carries Minter Creek under 118th St. (Node M-05)
- 5'x13' bridge that carries Minter Creek under 118th St. (Node M-06)
- 54-inch diameter culvert that carries Minter Creek under 118th St., north of 155th St. (Node M-09)
- Two 30-inch diameter culverts that carry Little Minter Creek under 118th St. (Node LM-01)
- Two 48-inch diameter culverts that carry Purdy Creek under 144th St. (Node P-02) (CIP PR-CR02)
- Two 36-inch diameter culverts that carry Purdy Creek under an unnamed road off 154th St. (Node P-04)
- 18-inch diameter culvert that carries Purdy Creek under 160th St. (Node P-05) (CIP PR-CR07)
- 36-inch and 18-inch diameter culverts that carry Rocky West Creek under an unnamed road (Node RW-01) (CIP RW-CR01)
- 87x93-inch diameter culvert that carries Rocky Creek under 144th St. (Node RC-02) (CIP RC-CR03)
- Two 18-inch diameter culverts that carry Schoolhouse Creek, Anderson Island, under Eckenstam-Johnson Road, near Oro Bay Rd. (Node SC-00) (CIP AI-CR02)
- Two 18-inch diameter culverts that carry Schoolhouse Creek, Anderson Island, under Oro Bay Rd. (Node SC-01) (CIP AI-CR03)
- 36 x 57-inch diameter culverts that carry Schoolhouse Creek, Anderson Island, under Sandberg Rd. (Node SC-02) (CIP AI-CR08)

A field visit was made to several culverts where a drainage deficiency had been predicted to confirm that the physical characteristics of the culverts and their surroundings were accurately simulated in the model.

Several culverts identified as deficient above, did not become capital improvement projects (CIPs) for a variety of reasons. On Minter Creek, the culverts (bridges in this case) at node numbers M-05 and M-06 fail only at the 100-year future build out condition. As this is a rare event, it is not recommended that limited funding be used to upgrade these structures.

For Schoolhouse Creek on Anderson Island, the culvert at node SC-02 fails at the 100-year existing condition, but this culvert is also a fish passage barrier and it is therefore included in the CIP list for improvement.

Fifteen of the 27 stream crossings analyzed do not meet Pierce County's current design standards because they would be surcharged to a greater degree than is allowed by the standards. Although it would be desirable that all culverts meet current design standards, the consequences of non-compliance are not expected to be serious. While road fills are not typically designed to function as dams, they can be expected to do so successfully on rare occasions and for short periods of time.

6.4 CAUSES

The clearing of vegetation for agriculture and urban development alters watershed hydrology. Logging of trees can have a significant impact on drainage and runoff. Areas with a forest canopy intact will experience negligible runoff during a typical annual rainfall event. Clearing of trees and vegetation reduces interception and evaporation of rainfall from leaves, before it reaches the surface of the ground.

Remaining rainfall is absorbed by the highly pervious forest floor. Conversion from forest to pasture has most likely impacted runoff to a greater degree than the low density residential housing that is located in most of the basin. Only a few urban areas are developed, replacing permeable surfaces with impermeable surfaces, and increasing runoff. These changes increase the volume and peak flow rate of stormwater runoff and may cause flooding.

6.5 CONCEPTUAL SOLUTIONS

Due to the rural nature of the KI Basin, the stormwater drainage system consists largely of road and driveway culverts. Although the culverts may have provided adequate protection from flooding when they were installed, changes in the watersheds they drain, and changes in the County's design standards, make some of them inadequate today.

Flood hazards associated with undersized culverts can be reduced in two ways: culverts can be replaced with larger culverts, or upstream programs can be put in place to reduce or delay runoff to reduce peak flows. The natural drainage system can typically handle runoff from an undisturbed basin, but will be overloaded if increases in paving and removal of tree cover cause an increase in peak flows.

Off-stream detention basins are used in undeveloped watersheds to protect downstream floodplain development. These basins are inappropriate in KI because they usually cost much more than enlarged culverts. In-stream detention is no longer permitted since this would create new fish passage barriers. Other considerations for upstream improvements include implementation of Low Impact Development (LID) techniques for new development, or retrofitting existing development, as recommended in the newly updated Stormwater Management Manual. LID techniques maximize the use of infiltration, mimicking the natural drainage and hydrology of the developing area.

Culvert replacements, coupled with programmatic improvements, appear to offer the most effective and cost efficient method for addressing future flooding. Also, culvert replacements can often solve both flooding and fish passage problems.

New development regulations that limit future hydrologic change can play a secondary role in controlling flooding. Standards of this sort are already in place in Pierce County and are expected to reduce peak stormwater flows from new development. The regulations require that post-development peak flows from a site not exceed pre-development peak flows. Post-development peak runoff flows can be controlled by maximizing infiltration and installing detention ponds in urban development, such as commercial facilities, or subdivisions.

Table 6-1
Existing Flooding Problems

Culvert ID	Culvert Diameter (in)	Culvert Type	Location / Description	Siz of Storm When Deficiency Occurs
Purdy				
P-01	72	6'X6' Box	Purdy Dr	
P-02	48	2-48" CMP	144th	100-Yr Future
P-03	66	66" CMP	SR-16	
P-04	36	2-36" CSP	Unnamed Rd off 154th	100-Yr Existing
P-05	48	48" CSP	160th	25-Yr Existing
Little Minter				
LM-01	30	2-30" CMP	118th St	100-Yr Existing
LM-02	48	4'x16' Bridge	115th St	
LM-03	36	2-36" CSP	94th St	
Minter				
M-01	150	2-12.5'x9.67' box	Creviston	
M-02	54	2-4.7'x8.45' Box	Key Pen HWY	
M-03	96	8'x16.2' bridge	144th off 118th	
M-04	90	7.8'x33.8' bridge	118th N of 144th	
M-05	72	6.1'x10.3' bridge	118th	100-Yr Future
M-06	60	5'x13' bridge	118th between M-4 & M-6	100-Yr Future
M-07	84	7'x14.5' bridge	118th N of 149th	
M-08	72	6.1'x14.9' bridge	118th S of 155th	
M-09	54	54" CSP	118th N of 155th	25-Yr Existing
Huge				
H-01	78	6.66'x15.9' bridge	144th	
H-02	60	5'x6'	160th	25-Yr Existing
Rocky				
RW-01	36 & 18	36" CMP & 18" CMP	unnamed Rd	25-Yr Existing
RC-01	90	2-7.5'x6.38' Box	SR-302	
RC-02	93	Arch 7.25 x 7.7	144th	100-Yr Existing
Schoolhouse				
SC-00	18	2-18" CSP	Eckenstam Johnson Rd	2-Yr Existing
SC-01	18	2-18" CMP	Oro Bay Rd	2-Yr Existing
SC-02	36	36"x 57" Arch	Sandberg	100-Yr Existing
SC-03	36	36" CSP	Eckenstam Johnson Rd	
SC-04	48	48" ADS	Lake Josephine Rd	

Table 6-2: Preliminary Results for Culvert Analysis (Existing)

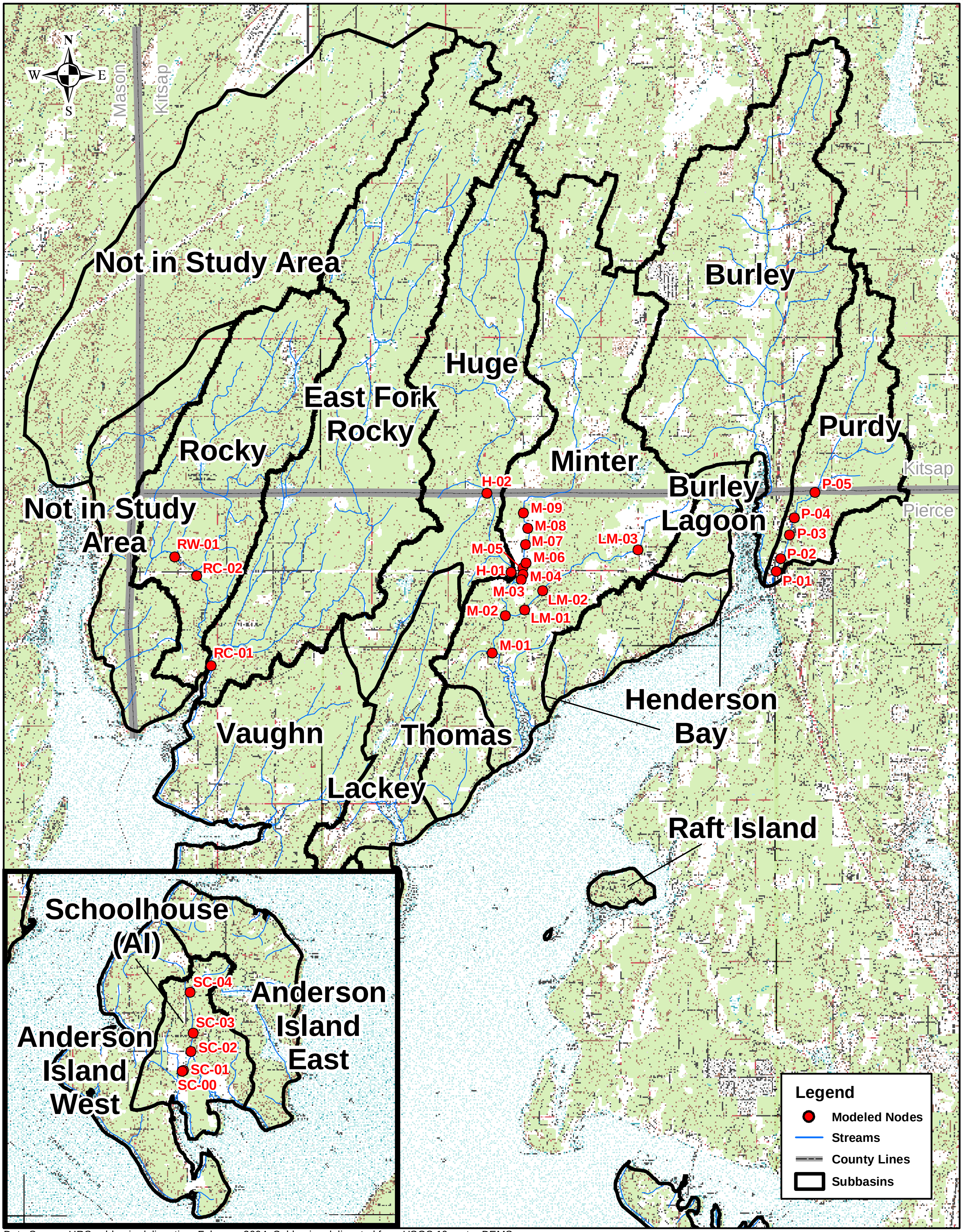
Culvert ID	100 Year Approx. Calibration flow	Culvert Diameter (in)	Culvert Type	Location / Description	Vertical Distance Invert to Road (ft)	U/S invert (ft)	2-Yr Peak Flow (cfs) Inflow	2-Yr Peak Flow (cfs) Outflow	Peak Elev (ft)	Max Stage Above Invert (ft)	Est. Freeboard to Road Crest (ft)	25-Yr Peak Flow (cfs) Inflow	25-Yr Peak Flow (cfs) Outflow	Peak Elev (ft)	Max Stage Above Invert (ft)	Est. Freeboard to Road Crest (ft)	100-Yr Peak Flow (cfs) Inflow	100-Yr Peak Flow (cfs) Outflow	Peak Elev (ft)	Max Stage Above Invert (ft)	Est. Freeboard to Road Crest (ft)	Headwater/Diameter Ratio	Meets Design Std?
Purdy																							
P-01	409.5	72	6'X6' Box	Purdy Dr	11.7	6	66.1	66.1	8.4	2.4	9.2	181.5	181.4	10.7	4.7	6.9	255.3	255.2	12.0	6.0	5.6	1.0	YES
P-02		48	2-48" CMP	144th	8.0	20	65.1	65.1	22.4	2.4	5.6	179.9	179.5	25.0	5.0	3.0	256.9	252.8	27.9	7.9	0.1	2.0	NO
P-03		66	66" CMP	SR-16	23.0	77	62.7	62.7	80.4	3.4	19.6	175.2	173.9	83.3	6.3	16.7	258.4	248.7	86.4	9.4	13.6	1.7	NO
P-04		36	2-36" CSP	Unnamed Rd off 154th	8.5	78	60.8	60.8	80.6	2.6	5.9	174.7	169.6	84.7	6.7	1.8	251.7	250.3	86.9	8.9	-0.4	3.0	NO
P-05	347	48	48" CSP	160th	5.0	91	54.7	54.5	94.2	3.2	1.8	158.6	158.2	96.3	5.3	-0.3	229.7	229.1	96.8	5.8	-0.8	1.4	YES
Little Minter																							
LM-01		30	2-30" CMP	118th St	10.1	85	38.7	38.7	87.7	2.7	7.4	108.6	108.6	93.6	8.6	1.4	169.2	169.2	95.3	10.3	-0.2	4.1	NO
LM-02		48	4'x16' Bridge	115th St	5.4	109	37.0	37.0	109.7	0.7	4.7	115.2	115.2	110.8	1.8	3.6	165.4	165.4	111.3	2.3	3.1	0.6	YES
LM-03		36	2-36" CSP	94th St	8.3	216	20.2	20.2	217.0	1.0	7.3	72.8	72.8	219.3	3.3	5.0	100.7	100.7	220.4	4.3	4.0	1.5	YES
Minter																							
M-01	1596	150	2-12.5'x9.67' box	Creviston	14.2	6	365.1	365.1	9.0	3.0	11.2	1084.7	1084.7	13.2	7.2	7.0	1498.0	1498.0	15.3	9.3	4.9	0.7	YES
M-02		54	2-4.7'x8.45' Box	Key Pen HWY	43.66	39	346.2	346.2	42.5	3.5	40.2	1046.3	1046.3	49.5	10.5	33.2	1446.9	1446.9	63.8	24.8	18.9	5.5	NO
M-03		96	8'x16.2' bridge	144th off 118th	10.53	84	126.8	126.8	84.7	0.7	9.8	411.4	411.4	88.1	4.1	6.4	584.8	584.8	89.4	5.4	5.1	0.7	YES
M-04		90	7.8'x33.8' bridge	118th N of 144th	9.5	84	126.8	126.8	84.7	0.7	8.8	411.1	411.1	86.5	2.5	7.0	584.3	584.3	87.8	3.8	5.7	0.5	YES
M-05		72	6.1'x10.3' bridge	118th	7.94	95	126.4	126.4	97.5	2.5	5.4	409.4	409.4	100.7	5.7	2.2	581.8	581.8	102.9	7.9	0.0	1.3	YES
M-06		60	5'x13' bridge	118th between M-4 & M-6	7	95	126.2	126.2	97.3	2.3	4.7	409.2	409.2	99.9	4.9	2.1	586.8	586.8	101.7	6.7	0.3	1.3	YES
M-07		84	7'x14.5' bridge	118th N of 149th	8.9	100	125.6	125.6	101.8	1.8	7.1	407.1	407.1	104.5	4.5	4.4	585.2	585.2	105.5	5.5	3.4	0.8	YES
M-08		72	6.1'x14.9' bridge	118th S of 155th	8.1	119	123.4	123.4	121.2	2.2	5.9	401.6	401.6	123.2	4.2	3.9	584.8	584.8	124.5	5.5	2.6	0.9	YES
M-09	580.5	54	54" CSP	118th N of 155th	6.5	135	120.5	120.5	140.0	5.0	1.5	396.0	396.0	142.7	7.7	-1.2	577.1	577.1	143.5	8.5	-2.0	1.9	NO
Huge																							
H-01	82.5	78	6.66'x15.9' bridge	144th	9.2	84	181.5	181.5	88.5	4.5	4.7	515.4	515.4	88.8	4.8	4.4	667.3	667.3	90.0	6.0	3.2	0.9	YES
H-02	670	60	5'x6'	160th	7.5	165	163.8	163.8	169.5	4.5	3.0	472.6	472.6	173.5	8.5	-1.0	722.1	722.1	174.3	9.3	-1.8	1.9	NO
Rocky																							
RW-01		36	36" CMP	unnamed Rd	5.5	151	34.8	34.8	155.9	4.9	0.6	113.3	113.3	156.8	5.8	-0.3	160.0	160.0	156.9	5.9	-0.4	2.0	NO
RW-01		18	18" CMP	unnamed Rd	2.5	154									-154.0	156.5				-154.0	156.5	-102.7	YES
R-01		90	2-7.5'x6.38' Box	SR-302	37.1	4	500.0	500.0	9.2	5.2	31.9	1271.0	1271.0	16.0	12.0	25.1	1709.0	1709.0	21.0	17.0	20.1	2.3	NO
R-02	482.3	93	Arch 7.25 x 7.7	144th	9.5	124	137.5	137.5	128.4	4.4	5.1	355.2	355.2	132.0	8.0	1.5	550.0	550.0	134.2	10.2	-0.7	1.3	YES
R-06	1317																						
RC-01	1709.4																						
Schoolhouse																							
SC-00	126	18	2-18" CSP	Eckenstam Johnson Rd	2.5	11.5	47.7	47.7	14.0	2.5	-0.03	110.8	110.8	14.3	2.8	-0.3	138.0	138.0	14.5	3.0	-0.5	2.0	NO
SC-01		18	2-18" CMP	Oro Bay Rd	1.83	13	47.6	47.6	15.0	2.0	-0.2	110.4	110.4	15.3	2.3	-0.4	138.0	138.0	15.4	2.4	-0.6	1.6	NO
SC-02		36	36"x 57" Arch	Sandberg	4.64	26	42.6	42.6	27.6	1.6	3.0	96.2	96.2	30.0	4.0	0.7	114.0	114.0	30.7	4.7	-0.1	1.6	NO
SC-03		36	36" CSP	Eckenstam Johnson Rd	15	94	36.3	36.3	96.2	2.2	12.8	80.1	80.1	98.6	4.6	10.4	94.0	94.0	99.9	5.9	9.1	2.0	NO
SC-04		48	48" ADS	Lake Josephine Rd	4.16	133	20.1	20.1	134.0	1.0	3.1	58.4	58.4	135.6	2.6	1.6	80.0	80.0	136.2	3.2	0.9	0.8	YES

Notes:
1. Headwater depths computed assuming inlet control
2. Invert elevations estimated from 5-ft topo.
3. Pierce County design standard states that H/D not to exceed 1.5 for culverts over natural streams, where H is u/s headwater elevation relative to invert and D is the culvert diameter (or depth, if rectangular).
4. Bold values indicate culvert may have potential roadway flooding

Table 6-3: Preliminary Results for Culvert Analysis (Future)

Culvert ID	Culvert Diameter (in)	Culvert Type	Location / Description	Vertical Distance Invert to Road (ft)	U/S invert (ft)	2-Yr Peak Flow (cfs) Inflow	2-Yr Peak Flow (cfs) Outflow	Peak Elev (ft)	Max Stage Above Invert (ft)	Est. Freeboard to Road Crest (ft)	25-Yr Peak Flow (cfs) Inflow	25-Yr Peak Flow (cfs) Outflow	Peak Elev (ft)	Max Stage Above Invert (ft)	Est. Freeboard to Road Crest (ft)	100-Yr Peak Flow (cfs) Inflow	100-Yr Peak Flow (cfs) Outflow	Peak Elev (ft)	Max Stage Above Invert (ft)	Est. Freeboard to Road Crest (ft)	Headwater/Diameter Ratio	Meets Design Std?
Purdy																						
P-01	72	6'X6' Box	Purdy Dr	11.7	6	87.4	87.4	8.8	2.8	8.8	218.9	218.9	11.4	5.4	6.2	306.3	306.2	12.8	6.8	4.8	1.1	YES
P-02	48	2-48" CMP	144th	8.0	20	86.3	86.3	22.8	2.8	5.2	220.4	216.9	26.6	6.6	1.4	303.7	303.7	28.2	8.2	-0.2	2.1	NO
P-03	66	66" CMP	SR-16	23.0	77	83.5	83.3	81.0	4.0	19.0	222.1	213.8	84.6	7.6	15.4	317.6	295.0	88.7	11.7	11.3	2.1	NO
P-04	36	2-36" CSP	Unnamed Rd off 154th	8.5	78	81.6	81.5	81.2	3.2	5.3	221.6	216.3	86.6	8.6	-0.1	309.5	309.0	87.2	9.2	-0.7	3.1	NO
P-05	48	48" CSP	160th	5.0	91	77.5	74.9	95.0	4.0	1.0	205.4	204.8	96.6	5.6	-0.6	287.1	286.5	97.1	6.1	-1.1	1.5	NO
Little Minter																						
LM-01	30	2-30" CMP	118th St	10.1	85	59.2	56.2	88.4	3.4	6.7	141.6	141.6	95.2	10.2	-0.2	211.2	211.2	95.6	10.6	-0.5	4.2	NO
LM-02	48	4'x16' Bridge	115th St	5.4	109	55.2	55.1	109.9	0.9	4.5	157.1	157.1	111.2	2.2	3.2	222.4	222.4	111.6	2.6	2.7	0.7	YES
LM-03	36	2-36" CSP	94th St	8.3	216	24.0	24.0	217.6	1.6	6.7	85.4	85.4	219.5	3.5	4.8	109.2	109.2	220.6	4.6	3.7	1.5	NO
Minter																						
M-01	150	2-12.5'x9.67' box	Creviston	14.2	6	428.4	428.4	10.1	4.1	10.1	1205.7	1205.7	14.5	8.5	5.7	1596.1	1596.1	15.5	9.5	4.7	0.8	YES
M-02	54	2-4.7'x8.45' Box	Key Pen HWY	43.66	39	407.2	407.2	43.1	4.1	39.6	1161.1	1161.1	50.3	11.3	32.4	1541.7	1541.7	57.7	18.7	25.0	4.2	NO
M-03	96	8'x16.2' bridge	144th off 118th	10.53	84	154.8	154.8	85.8	1.8	8.7	480.3	480.3	88.7	4.7	5.8	678.7	678.7	89.5	5.5	5.0	0.7	YES
M-04	90	7.8'x33.8' bridge	118th N of 144th	9.5	84	154.7	154.7	84.5	0.5	9.0	480.0	480.0	86.5	2.5	7.0	678.1	678.1	87.5	3.5	6.0	0.5	YES
M-05	72	6.1'x10.3' bridge	118th	7.94	95	154.1	154.1	97.7	2.7	5.2	478.0	478.0	101.5	6.5	1.4	675.2	675.2	103.5	8.5	-0.6	1.4	YES
M-06	60	5'x13' bridge	118th between M-4 & M-6	7	95	153.9	153.9	97.5	2.5	4.5	478.4	478.4	100.5	5.5	1.5	675.4	675.4	102.3	7.3	-0.3	1.5	YES
M-07	84	7'x14.5' bridge	118th N of 149th	8.9	100	153.1	153.1	102.3	2.3	6.6	476.3	476.3	104.7	4.7	4.2	672.9	672.9	106.0	6.0	2.9	0.9	YES
M-08	72	6.1'x14.9' bridge	118th S of 155th	8.1	119	150.3	150.3	121.5	2.5	5.6	471.2	471.2	124.0	5.0	3.1	670.6	670.6	125.4	6.4	1.7	1.1	YES
M-09	54	54" CSP	118th N of 155th	6.5	135	147.0	147.0	141.1	6.1	0.4	465.2	465.2	143.0	8.0	-1.5	662.5	662.5	143.5	8.5	-2.0	1.9	NO
Huge																						
H-01	78	6.66'x15.9' bridge	144th	9.2	84	203.7	203.7	86.5	2.5	6.7	567.1	567.1	89.0	5.0	4.2	781.1	781.1	90.5	6.5	2.7	1.0	YES
H-02	60	5'x6'	160th	7.5	165	189.7	189.7	169.8	4.8	2.7	529.1	529.1	173.5	8.5	-1.0	734.7	734.7	174.5	9.5	-2.0	1.9	NO
Rocky																						
RW-01	36	36" CMP	unnamed Rd	5.5	151	43.0	43.0	154.6	3.6	1.9	138.1	138.1	156.9	5.9	-0.4	193.0	193.0	157.2	6.2	-0.7	2.1	NO
RW-01	18	18" CMP	unnamed Rd	2.5	154				-154.0	156.5				-154.0	156.5				-154.0	156.5	-102.7	YES
RC-01	90	2-7.5'x6.38' Box	SR-302	37.1	4	557.0	557.0	9.8	5.8	31.3	1370.0	1370.0	17.5	13.5	23.6	1802.0	1802.0	22.9	18.9	18.2	2.5	NO
RC-02	93	Arch 7.25 x 7.7	144th	9.5	124	177.0	177.0	128.9	4.9	4.6	437.0	437.0	133.5	9.5	0.0	585.0	585.0	135.2	11.2	-1.7	1.5	YES
Schoolhouse																						
SC-00	18	2-18" CSP	Eckenstam Johnson Rd	2.5	11.5	78.5	78.5	14.3	2.8	-0.3	139.1	139.1	14.6	3.1	-0.6	167.5	167.5	15.8	4.3	-1.8	2.9	NO
SC-01	18	2-18" CMP	Oro Bay Rd	1.83	13	78.3	78.3	15.4	2.4	-0.6	138.7	138.7	15.5	2.5	-0.7	167.3	167.3	15.6	2.6	-0.8	1.7	NO
SC-02	36	36"x 57" Arch	Sandberg	4.64	26	72.1	72.1	30.0	4.0	0.6	118.2	118.2	31.0	5.0	-0.4	138.7	138.7	31.1	5.1	-0.5	1.7	NO
SC-03	36	36" CSP	Eckenstam Johnson Rd	15	94	63.1	63.1	98.5	4.5	10.5	96.6	96.6	102.1	8.1	6.9	110.4	110.4	104.0	10.0	5.0	3.3	NO
SC-04	48	48" ADS	Lake Josephine Rd	4.16	133	36.5	36.5	135.5	2.5	1.7	81.8	81.8	137.0	4.0	0.2	108.6	108.6	137.2	4.2	0.0	1.1	YES

Notes:
1. Headwater depths computed assuming inlet control
2. Invert elevations estimated from 5-ft topo.
3. Pierce County design standard states that H/D not to exceed 1.5 for culverts over natural streams, where H is u/s headwater elevation relative to invert and D is the culvert diameter (or depth, if rectangular).
4. Bold values indicate culvert may have potential roadway flooding



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Print date: August 2005

Data Source: URS subbasin delineation, February 2004. Subbasins delineated from USGS 10-meter DEMS.
See Appendix A for detailed description of delineation.

1 inch equals 9,000 feet

0 5,000 10,000 20,000 30,000 Feet

0 1,250 2,500 5,000 7,500 Meters

Pierce County Water Programs

DRAFT

FIGURE 6-1
MODELED NODE LOCATIONS

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

CHAPTER SEVEN
Analysis of Water Quality Problems

7.1 INTRODUCTION

Determining the primary sources of water quality impairments and the effects of water quality improvements is a complex task. Water quality impairments can be the result of a multitude of point and nonpoint source pollutants and land use practices. Point sources of water pollution in the Key Peninsula-Islands (KI) Basin Plan may include community wastewater treatment systems and/or hatcheries. If a point source is identified, a variety of treatment systems and/or practices can be adopted to specifically target the problematic parameters and constituents.

Nonpoint sources of water pollution are generally harder to identify, encompass a greater variety of activities, facilities and practices, and are generally dispersed over a wide area. Stormwater runoff is the primary mechanism by which nonpoint source pollutants may be transported into the receiving waters. Common sources of nonpoint pollution in the KI Basin include failing septic systems that cause sewage to reach ground surfaces, pollutants from roadways and parking lots, landscaping runoff, construction site runoff, and waste from pets and livestock. It is difficult to target nonpoint source pollutants if the locations of the sources cannot be isolated or identified. Reducing nonpoint source pollution in an area requires a mix of education, voluntary incentives, technical assistance, and regulatory enforcement activities.

Data gathered during the characterization phase of the KI Basin Plan indicate that water quality in streams throughout the basin is generally good, with the exception of elevated fecal coliform levels. Also, dissolved oxygen and turbidity levels do not always meet the water quality standards in select locations. Temperature and pH levels generally remain well within the identified range for water bodies meeting the water quality standards.

7.2 WATER QUALITY PROBLEMS

Point and nonpoint source pollution contribute a variety of detrimental constituents including sediments, hydrocarbons, nutrients, bacteria, organics, and metals into receiving estuaries, streams, lakes, rivers, and saltwater. Per *Section 303(d)* of the *Clean Water Act* (CWA), Washington State must periodically prepare a list of all surface waters in the state where beneficial uses (drinking, recreation, aquatic habitat, and industrial use) are impaired by pollutants. Current water quality classifications in Washington outline different “categories” of impairments for specific reaches, ranging from waters of concern to waters with an established Total Maximum Daily Load (TMDL).

These different classification levels were developed to prompt awareness and remediation activities before a reach is actually 303(d) listed. A Category 5 classification means that a water body has been 303(d) listed and, thus, requires a TMDL. As of 2005, four creeks in the KI Basin were 303(d) listed for two different constituents (*Table 7.1*), and there are currently no established TMDLs.

Following classification as a Category 5 water body (303(d) listed), the Washington State Department of Ecology begins a five-step prioritization and scheduling process to establish a TMDL. The first step of the five-step process is scoping, and the Key Peninsula basin is part of the Kitsap Water Quality Management Area (WRIA 15), which is scheduled to undergo scoping activities in 2007 and 2012. Conversations with Sally Lawrence, the Kitsap area regional TMDL coordinator, indicates that none of the current 303(d) listed streams in the Key Peninsula basin are anticipated for scoping activities to occur in the near future.

Without the establishment of TMDLs, little water quality monitoring data has been gathered and analyzed for reaches in the Key Peninsula Basin. In the mid-1990's, some limited surface water quality data was collected by the Pierce Stream team, and this volunteer monitoring effort generally focused upon parameters that could be measured onsite (temperature, pH, nitrate, DO and turbidity). As part of the KI Basin Plan work, water quality monitoring was conducted on select, major streams in the basin for specific parameters related to the 303(d) designations. Results of recent monitoring efforts are further discussed in *Sections 7.2.1* and *7.2.2*.

TABLE 7.1: WATER QUALITY CLASSIFICATION OF REACHES IN THE KI BASIN, INCLUDING CURRENT TMDL AND 303(D) STATUS

Subbasin	Stream	Stream Number	Category	Parameter	Number of Listings
Rocky	Rocky Creek	150015	2	Dissolved oxygen	1
Burley	Bear Creek	150057	2	Dissolved Oxygen	1
Burley	Bear Creek	150057	4B	Fecal Coliform	2
Burley	Burley Creek*	150056	5	Dissolved oxygen	1
Burley	Burley Creek	150056	4B	Fecal Coliform	3
Burley	Burley Creek	150056	2	Fecal Coliform	2
Burley	Burley Creek	150056	2	pH	1
Huge	Huge Creek*	150052	5	Dissolved oxygen	1
Huge	Huge Creek	150052	2	Fecal Coliform	1
Minter	Little Minter Creek*	150051	5	Fecal Coliform	2
Minter	Minter Creek*	150048	5	Dissolved oxygen	1
Minter	Minter Creek*	150048	5	Fecal Coliform	6
Purdy	Purdy Creek	150060	4B	Fecal Coliform	2
Purdy	Purdy Creek	150060	2	Dissolved oxygen	1

Notes:

1) A * indicates stream is 303(d) listed for specified parameter.
2) Category 2 indicates a water of concern for the specified parameter, and the stream will become 303(d) listed shortly.
3) Category 4B indicates a pollution control plan has been established for the stream and the parameter, but is not 303(d) listed.

7.2.1 Ambient Water Quality Standards

The *Water Quality Standards for Surface Waters of the State of Washington* (*WAC 173-201A*) provides quantitative standards for various classes of surface waters throughout the state. *Table 7.2* provides a comparison of these water quality standards for freshwaters, depending upon the protection of spawning, rearing, and migration of salmon, trout, and other aquatic species. The water quality standards are generally classified as core rearing and non-core rearing.

Core rearing standards are in place for areas where the overall aquatic environment supports greater numbers of juvenile salmon species while the non-core rearing standards are in place for areas that see less juvenile salmon. Core and non-core rearing standards for temperature, dissolved oxygen, turbidity, total dissolved gas, and pH coincide with the previously used Class AA and Class A designations. Pierce County recommends using the core-rearing standard for Rocky, Minter, and Burley Creeks and the non-core rearing standard for all other streams in the study area (1).

Table 7.3 presents the water quality standards for marine waters of the state. Generally, the marine standards are more stringent with respect to temperature and pH, but are less stringent for dissolved oxygen.

Marine standards are classified according to extraordinary and excellent water quality for salmonid and other fish migration, rearing, and spawning; clam, oyster, and mussel rearing and spawning; and crustaceans and other shellfish rearing and spawning. Marine standards would apply to only the shoreline and estuaries in the Key Peninsula basin, and as water quality sampling was generally conducted upstream of the shoreline, the freshwater standards are those used for comparison purposes.

Standards for fecal coliform bacteria are provided for fresh waters and for shellfish harvesting and recreational areas. *Table 200(2)(b)* in the *WAC 173-201A* outlines three categories for the bacteria indicator for freshwater bodies: extraordinary primary contact recreation, primary contact recreation, and secondary contact recreation.

The extraordinary primary contact recreation classification is the same as the previous Class AA standard and the primary contact recreation classification is the same as the previous Class A standard. Sections 2 and 3 of the *WAC 173-201A-210* outline fecal coliform standards for marine waters as related to shellfish harvesting and recreational uses.

TABLE 7.2: WATER QUALITY STANDARDS FOR FRESH WATERS

Interpreted from WAC 173-201A-200 – Fresh water designated uses and criteria

Constituent	Core Rearing Standard(1) Conforms with old Class AA standards	Noncore Rearing Standard (2) Conforms with old Class A standards
Temperature – Measured by the 7-day average of the daily maximum temperature	<16 degrees Celsius (60.8 degrees Fahrenheit)	<17.5 degrees Celsius (63.5 degrees Fahrenheit)
Dissolved Oxygen (DO) Measured as 1-day minimum DO in mg/L.	>=9.5 mg/L	>=8.0 mg/L
Turbidity – Measured in "nephelometric turbidity units" or "NTUs"	Turbidity shall not exceed: - 5 NTU over background when the background is 50NTU or less; or - A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.	Turbidity shall not exceed: - 5 NTU over background when the background is 50NTU or less; or - A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
Total Dissolved Gas (TDG) – Measured in percent saturation	Shall not exceed 110% of saturation at any point of sample collection.	Shall not exceed 110% of saturation at any point of sample collection.
pH – Expressed as the negative logarithm of the hydrogen ion concentration.	Between 6.5 and 8.5, with a human caused variation within the above range of less than 0.2 units.	Between 6.5 and 8.5, with a human caused variation within the above range of less than 0.5 units.

Constituent	Extraordinary Primary Contact Recreation Conforms with old Class AA standards	Primary Contact Recreation Conforms with old Class A standards
Fecal Coliform - Measured as the geometric mean value, including five or more events over a 30-day period.	Must not exceed a geometric mean value of 50 colonies/100mL, with not more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100mL.	Must not exceed a geometric mean value of 100 colonies/100mL, with not more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100mL.

TABLE 7.3: WATER QUALITY STANDARDS FOR MARINE WATERS

Interpreted from WAC 173-201A-200 – Marine water designated uses and criteria

Constituent	Extraordinary Aquatic Life Uses	Excellent Aquatic Life Uses
Temperature – Measured by the 1-day maximum temperature.	<13 degrees Celsius (55.4 degrees Fahrenheit)	<16 degrees Celsius (60.8 degrees Fahrenheit)
Dissolved Oxygen (DO) - Measured as 1-day minimum DO in mg/L.	=7.0 mg/L	=6.0 mg/L
Turbidity – Measured in "nephelometric turbidity units" or "NTUs", reported as a one-day maximum turbidity allowed as a result of human actions.	Turbidity shall not exceed: - 5 NTU over background when the background is 50NTU or less; or - A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.	Turbidity shall not exceed: - 5 NTU over background when the background is 50NTU or less; or - A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
pH – Expressed as the negative logarithm of the hydrogen ion concentration.	Between 7.0 and 8.5, with a human caused variation within the above range of less than 0.2 units.	Between 7.0 and 8.5, with a human caused variation within the above range of less than 0.5 units.

Constituent	Shellfish Harvesting Criteria (3)	Primary Contact Recreation Criteria (3)
Fecal Coliform - Measured as the geometric mean value, including five or more events over a 30-day period.	Must not exceed a geometric mean value of 14 colonies/100mL, with not more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 43 colonies/100mL.	Must not exceed a geometric mean value of 14 colonies/100mL, with not more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 41 colonies/100mL.

Notes:

1) Applies to Rocky, Minter, and Burley Creeks per Pierce County. Standards apply for the protection of salmon and trout spawning, core rearing, and migration.
2) Applies to the all other streams in the Key Peninsula reference area. Standards apply for the protection of salmon and trout spawning, noncore rearing, and migration.
3) Applies for the commercial and recreational shellfish harvesting areas, discussed in Appendix M.

7.2.2 Water Quality Testing

Water quality monitoring was conducted on 10 major streams on October 16, 2003, November 11, 2003 and October 20, 2004. Results from each monitoring effort are shown in *Tables 7.4, 7.5,* and *7.6*. Monitored streams include both those with known water quality problems (currently on the 303(d) list) and those that do not necessarily have documented water quality problems, but have a number of beneficial uses that should be preserved. Monitored parameters included temperature, pH, DO, turbidity, specific conductivity, fecal coliform, total phosphorus, and nitrate.

Two different tests were conducted to analyze for fecal coliform, the SM 9221 and the SM 9222. Generally, the SM 9222 test is used for very turbid samples typically associated with wastewater treatment facilities while the SM 9221 test is used to analyze less turbid samples associated with surface and stormwater (Standard Methods 1998). Results of the SM 9221 test is reported as Most Probable Number (MPN) per 100 mL and thus statistical representation is reported with the results. Results of the SM 9222 test are reported in “colony forming units” (CFU) per 100mL and were determined by filtering and plating the sample and growing and counting the colonies that formed.

Generally the results of both tests have been found to yield consistent results, but statistical comparison of the results of the SM 9221 and SM 9222 indicate that the SM 9222 test tends to be more precise (Standard Methods 1998). As the surface water quality criteria does not specifically state which test to conduct, both tests were conducted in order to compare results. Water quality monitoring conducted for the Gig Harbor Basin Plan in 2002 reported results as CFU/100mL, thus the SM9222 was conducted twice, one year apart and the SM 9221 test was conducted once for reference.

Based on the descriptions of sampling procedures related to the water quality criteria specified under Table 7.2, a statistically vigorous comparison of the monitored results with the core and non-core rearing criteria, nor the marine standards for shellfish harvesting, is possible. This is because sampling results obtained for fecal coliform during each of the three sampling events do not coincide with the sampling procedure outlined in the *WAC 173-201A-200*. In order to ensure accurate comparison, fecal coliform should be sampled a minimum of five times in a 30-day period and the geometric mean of the samples should be compared to the criteria. Due to timing and budget constraints, the appropriate number of samples was not acquired.
Specifically for fecal coliform and temperature, additional sampling data will need to determine whether the results are statistically significant. However, the results of the sampling efforts conducted on October 16th and November 20, 2003 and October 20, 2004 are compared to the criteria herein, because the comparison is informative.

7.2.3 Monitoring Results

Results of the water quality monitoring indicate that water quality problems related to turbidity exist consistently for three streams monitored over the one-year period. Dissolved oxygen concentrations showed general improvement from 2003 to 2004, and the 2004 monitoring results showed only one sample in violation of the water quality criteria standards.

Neither total phosphorus nor nitrate are regulated by WAC 173-201A. However, both promote algal bloom growth and, thus, indirectly influence dissolved oxygen concentration and general water body health. The concentrations of nitrate and phosphorus measured during the three sampling events do not appear to be at levels that would prompt quality concerns in moving water and they are fairly consistent through all events.

Temperature and pH readings were taken in November 2003 and October 2004. The pH readings for all streams were found to be lower in 2004 while the temperature readings were higher. This may be due to the weather conditions during sampling, but lower pH levels are generally associated with anthropogenic influences including acidic rainwater and urban stormwater runoff. Increasing temperatures may also be attributed to human activities including urban stormwater runoff and removal of vegetation along streambanks.

Comparing the measured pH and temperature readings to the *WAC 173-201A*, all streams met the core rearing standards for pH, with the exception of Schoolhouse Creek (KP) during the October 20, 2004 sampling event, which did not meet either the core or the non-core water quality standard. Both the core and non-core rearing standards were consistently met for temperature, although the samples were taken as a grab and not as a 7-day average of the maximum as the criteria outlines.

All of the streams sampled exceeded the freshwater primary contact recreation standard for fecal coliform during at least one event. Elevated levels observed for the October 2003 sampling may have been attributed to heavy rainfall following an extended dry period. Using the SM 9222D test results for comparison on the October 20, 2004 sampling event, the freshwater extraordinary primary contact standard was exceeded in five of the ten streams sampled, and freshwater primary contact recreation standard was exceeded in four of the ten streams sampled. Again, sampling results obtained for fecal coliform during each of the three sampling events do not coincide with the sampling procedure outlined in the *WAC 173-201A-200*.

7.2.4 Possible Causes of Water Quality Problems

Public survey results and public comments have been continually received and tracked by Pierce County. Some of the comments received are related to activities that the public deems problematic from a water quality perspective. Review of the public comment summaries indicate that the public recognizes clear-cutting and removal of vegetation to be indicative of water quality problems. Other comments related to probable water quality issues include disposal activities (garbage, sewage) and the relative proximity of animals to the stream.

7.2.5 Analysis of Monitoring Results

Field inspections and surveys were conducted in October 2003 on 17 streams, including the 10 streams sampled and discussed in Section 7.2.2 and Section 7.2.3.

Follow-up inspections on five reaches exhibiting both flooding and water quality problems were conducted in February 2005. Comparison of the field observations and the water quality sampling results provide insight into possible source control measures that can be implemented to improve water quality in the varying areas.

The 17 streams inspected in October 2003 are listed below with notation indicating whether follow up inspections were conducted in February 2005 and whether sampling was conducted.

- Dutcher Creek (1)
- Herron/Knackstedt Creek (1)
- Herron Lake Creek
- Kingman Creek
- Lackey Creek
- East Fork Rocky
- Rocky Creek (1,2)
- Rocky West Tributary (2)
- Schoolhouse Creek, Key Peninsula (1)
- Taylor Bay Creek (1)
- Vaughn Creek (1,2)
- Whiteman Creek (1)
- Schoolhouse Creek, Anderson Island
- Huge Creek
- Minter Creek (1,2)
- Little Minter Creek (1,2)
- Purdy Creek (1,2)

Notes: (1) = Water quality sampling conducted in 2003 and 2004.
(2) = Field inspections conducted in February 2005.

Sources of water quality problems in the Key Peninsula area are most likely related to human activity and influences. Based on the 303(d) parameters, the water quality sampling results and field observations, discharges of oxygen-depleting substances, turbidity, and fecal coliform appear to be the primary causes of water quality problems in the Key Peninsula area.

Dissolved Oxygen

Dissolved oxygen concentrations in surface waters can influence the number and type of aquatic organisms that exist in the water body and influence overall stream health. Monitoring results indicate that dissolved oxygen levels are generally in the range of 7.0 to 11.0 mg/L for the streams monitored, and levels above 9.5 mg/L are generally desired (extraordinary criteria). Depending on the fish and other aquatic species inhabiting the respective reaches, this variance in levels can have implications regarding relative species diversity, population, and growth.

Field observations indicate that a number of human activities may be resulting in reduced dissolved oxygen concentrations. Algal bloom growth is one visual indicator of oxygen depletion in a stream, and is generally the partial result of nutrient additions in a reach. Nutrient additions, combined with other factors, such as slow velocities and higher stream temperatures, prompt algal bloom growth, thus further depleting the instream oxygen levels. Algal bloom growth was observed on a number of reaches along Rocky (303(d) listed for DO), Minter (303(d) listed for DO), Rocky West, and East Fork Rocky Creeks during both October 2003 and February 2005 inspections.

Another, more indirect, contributing factor to dissolved oxygen depletion may be the removal of riparian vegetation, which provides less shade and increases the instream temperature. Streams with elevated temperatures generally hold less oxygen. Streams where the removal of riparian vegetation was observed include Schoolhouse-Key Peninsula, Whiteman Creek, and Rocky West. Another contributing factor may be the location of pasture and livestock areas in close proximity to the streams (addition of nutrients to the stream). This activity was observed on a number of streams including Schoolhouse-Key Peninsula, Taylor Bay, Minter, and Little Minter. Residential and recreational development may also contribute fertilizers and other organic materials to the stream (nutrient addition). These activities were generally observed along Schoolhouse-Key Peninsula, Vaughn, Minter, Kingman, Rocky West, and Schoolhouse-Islands. Finally, water depletion and removal from streams causes reduction in velocities and may prompt algal growth. This activity was not directly observed on any reach, but along Minter Creek there is a hatchery that removes water directly from the stream and discharges downstream of the inlet location.

Turbidity

Turbidity can also influence a stream's aquatic health, as turbidity is generally related to high concentrations of suspended sediments and algae. High suspended sediment levels may threaten bottom-dwelling animals and the eggs of salmon and trout by blocking light sources (which inhibits photosynthetic reactions) and damaging gills of fish. Suspended sediment is also one of the primary transport mechanisms of toxic metals into surface waters. Metals are a concern because some toxic metals can bioaccumulate in fish tissue.

Field observations indicate that human activities may be contributing to increased turbidity in surface waters in the Key Peninsula Basin. High levels of turbidity may be caused by a number of activities including development along the stream bank, vehicles in the stream, poor erosion control and management, and removal of riparian vegetation. Pasture and agricultural areas are one of the primary sources of turbidity, as livestock often access the stream for water and in the process, scour and erode the stream bank and remove stream bank vegetation. Annual tilling and harvesting of crops also leads to the discharge of suspended sediments into streams, but animal keeping is much more common than crop farming within the KI Basin.

Animal access to the stream was observed on Taylor Bay, Minter Creek, and Little Minter Creek, during field inspections conducted in October 2003. Follow-up inspections in February 2005 verified pasture and possible animal access issues for upstream areas of Purdy Creek and downstream reaches of Little Minter Creek. Downcutting, compromised riparian areas, and recent development along the stream banks were observed for Schoolhouse Creek (KP), Vaughn Creek, Whiteman Creek, Little Minter Creek, and Muck Creek. Other instances of observed siltation were related to logging activities on Rocky West Creek. Compared with the monitoring data from the November 11, 2003 and the October 20, 2004 sampling events, Taylor Bay, Schoolhouse (KP) Creek, and Vaughn Creek each had turbidity levels exceeding water quality standards for both samples which is consistent with the field observations for the three sites.

Fecal Coliform

Concentrations of fecal coliform exceeding the optimum level specified for core and non-core rearing exist for all sampled streams (*Tables 5-1* and *5-2*). Based on the 303(d) listed constituents in the Key Peninsula Basin, fecal coliform also appears to be one of the most highly monitored and problematic pollutants affecting surface waters in the area. Excessive fecal coliform levels harm commercial and recreational shellfish growing areas. Fecal coliform bacteria generally serves as an indicator of unsanitary conditions, as they are found in the intestines of warm blooded animals and thrive in the same conditions as other, more dangerous bacteria. Sources of fecal coliform contamination include failed on-site septic systems, livestock in streams, pet waste, runoff from pasture and other agricultural lands, and wildlife.

Field observations help indicate locations where source control measures may be enhanced to prevent additional contamination. All residences in the KI basin are on septic systems (with the exception of a few homes that are hooked up to a small, private wastewater treatment system near Taylor Bay). Failed septic systems are a potential source of contamination, but general field observations cannot readily identify septic tank problems. Field observations in October 2003 indicate uncontrolled domestic animal access to parts of Taylor Bay, Minter Creek, and Little Minter Creek. Inspections in February 2005 identified possible livestock access issues on upstream reaches of Purdy Creek and downstream reaches of Little Minter Creek. Pasture and agricultural lands are also a primary source of fecal coliform. Pastures adjacent to streams were observed on almost all reaches monitored but were most common on Schoolhouse-Key Peninsula, Minter Creek, Huge Creek, Little Minter Creek, Purdy Creek, and Rocky Creek.

The monitoring results show a wide fluctuation in fecal coliform levels amongst the three monitored events. As discussed previously, the October 16, 2003 sampling event was conducted after heavy rainfall following an extensive dry period. These circumstances may have contributed to the elevated levels shown in all samples. As the core and non-core rearing criteria are measured using colony forming units (CFU) per 100 mL, the October 20, 2004 test is comparable. Results of the October 20th test show that five of the ten streams are not meeting the core rearing criteria standards, including Taylor Bay and Schoolhouse-Key Peninsula, which were described above as having pasture and agricultural runoff and possible animal access issues.

7.3 ASSESSMENT OF SHELLFISH HABITAT AND RESPONSE

Shellfish habitat in Key Peninsula was evaluated by reviewing current management activities and responses related to water quality degradations in shellfish harvesting areas. A gap analysis was conducted to evaluate deficiencies in the current program in order to make programmatic recommendations, in an effort to protect shellfish resources, prevent downgrades of shellfish growing areas, and protect and improve water quality. A full memo documenting the results of the gap analysis and proposed recommendations is included in Appendix M.

Shellfish are filter feeders that, as a result of their feeding mechanism, can accumulate and concentrate pathogenic microorganisms in their tissue. Consuming shellfish with elevated levels of toxics and bacteria (fecal coliform bacteria generally serves as an indicator) can pose a great risk to human health, which is why the state and local health department closely monitors water quality in shellfish harvesting areas. Pierce County, particularly in the Key Peninsula Basin, has a number of commercial and recreational shellfish harvesting areas. Classification of shellfish growing and harvesting areas currently range from approved to closed due to water quality impairments. Fecal coliform bacteria discharged to streams or coastal waters are the primary cause of water quality degradation and downgrade of shellfish growing and harvesting areas. Sources of fecal coliform bacteria range from failing septic systems to domestic animal and wildlife waste.

A number of state, county, and local agencies play a role in ensuring public health is not compromised by consumption of contaminated shellfish, and these agencies all work to prevent and respond to downgrades of shellfish habitat. Agencies reviewed for the gap analysis include the Tacoma-Pierce County Health Department, the Pierce Conservation District, and the Pierce County Public Works and Utilities Water Programs Division. All agencies conduct unique tasks and maintain individual levels of effort with respect to prevention and response to water quality downgrades. However, there is a lack of coordination between the agencies, which does not allow for a fully cooperative shellfish response program. Variable funding levels and resources make it difficult to specify additional programmatic needs as related to each agency.

A gap analysis was conducted to determine each agency's level of effort with respect to 11 program components and outline specific programmatic recommendations related to each component. The 11 program components include: education and outreach, information sharing, downgrade prevention, monitoring and sampling, source identification, technical assistance, enforcement, data management and dissemination, financial assistance, legal/regulatory support, and funding.

The primary gap that affects all program components is reporting and dissemination of information obtained by the individual agency's efforts. Particularly, if other agencies were regularly made aware of periodic water quality monitoring results, it would allow for increased source identification, public outreach, and technical assistance efforts based on observed, increasing fecal coliform levels.

Another significant gap observed is related to legal support and enforcement. Washington State Department of Ecology, Tacoma-Pierce County Health Department, and Pierce County Water Programs all have potential enforcement powers, depending on the nature of the water quality violation. However, without an ordinance assigning specific roles for enforcing water pollution laws relating to shellfish habitat preservation, it is unlikely that participating agencies will commit the necessary resources.

7.4 FUTURE WATER QUALITY PROBLEMS AND IMPLICATIONS

7.4.1 Future Sources

Section 7.2.5 outlines the probable constituents and sources of water quality issues in the Key Peninsula area. Based on field observations, site background information, and monitoring results in the area, future water quality problems may result if current sources and constituents are not controlled. Future development activities (increased impervious surface, reduced buffers along stream corridors) are expected to contribute additional pollutants to surface water bodies. Thus unless development activities are controlled and enforced, there is an unlimited range of water quality impairments that may be observed.

7.4.2 Future Implications of Reduced Water Quality

Compromised Shellfish Habitat

Discussed previously in *Section 7.3*, increased bacteria levels can downgrade commercial and shellfish harvesting areas, thus causing a negative economic and social impact within the KI Basin. Development activities, particularly in more rural areas where a majority of housing is placed on septic systems and farms tend to acquire additional pastureland for livestock and cattle, prompt a general reduction in stream buffers, an increase in animal and livestock access to stream reaches, and an increased likelihood of failing septic systems. These activities cause significant fluctuations in bacteria levels and if these fluctuations are observed on a consistent basis, may prompt increased sampling activities and the eventual downgrade of shellfish harvesting areas.

Aesthetics

Overall reduced water quality conditions can prompt reduced aesthetic measures for stream reaches including reduced water clarity, increased odor, reduced vegetation, and increased algal growth. These aesthetic measures are generally indicators for other problematic water quality impairments, but can also have a negative social and economic impact for a community. Reduced aesthetic measures can impact a range of typical outdoor recreational activities for a community (swimming, fishing, boating, etc). This can prompt a significant economic impact for a community with regards to tourism and housing.

Poor Groundwater Quality

Dissolved constituents, specifically metals and nutrients are often transported to groundwater. Depending upon the relative location and depth of the groundwater aquifer, human activities on the surface can influence groundwater quality. As a majority of residences in the Key Peninsula Basin obtain their drinking water via groundwater wells, poor groundwater quality can present a serious risk to human health. Surface waters are also replenished and recharged with groundwater also contributes to surface water bodies. Septic systems in well-drained soils are also a source of fecal coliform contamination, if leachate from drain fields does not have adequate time to filter through the soil layers before reaching the groundwater. Nitrate and phosphorus were previously discussed and generally are indicative of water quality degradation due to human activities (fertilizer use, septic systems in well-drained soils).

7.5 CONCEPTUAL SOLUTIONS

7.5.1 Programmatic Improvements

For a lightly populated basin with limited new development, the most effective means of improving water quality will be programmatic efforts like public education and technical assistance. Structural systems for improving water quality may only be effective in more urbanized areas with a distinct pollutant source (highways and roadways, service stations). *Chapter 9* outlines a number of programmatic improvements that may be considered to improve general water quality in the region. These improvements include maintaining adequate buffer requirements based on the water type classification of reaches in the area, increased public awareness and education measures, and revised development standards to promote low impact development techniques. Increased monitoring efforts may also be considered because, as discussed in *Section 7.2*, most of the water quality criteria has a statistical basis for comparison that was not able to be replicated because of time and budget constraints for this project. In order to compare actual monitoring results with the criteria, additional samples will be needed. Because water quality parameters, particularly turbidity and bacteria, are significantly influenced by human activities, these programmatic recommendations are likely to influence water quality on a more widespread basis than site specific capital projects could.

7.5.2 Retrofit Activities

In areas where flood control facilities are located, water quality may also be addressed through a retrofit of these structural facilities to provide additional treatment. Even for areas with existing BMPs for water quality, modifications to the design of the system may promote additional removal of problematic constituents. These types of retrofit activities are discussed further in *Chapters 9* and *10* with regards to capital improvement projects the County may consider.

REFERENCES:

(1) Barbara Ann Smolko, Pierce County Water Programs, Personal Communication with Angela Brown, February 2, 2005.

(2) Key Peninsula-Gig Harbor-Islands Watershed Characterization and Action Plan, July 1999, KGI Watershed Council, Pierce County Water Programs.

(3) Lawrence, Sally, Kitsap Area (WRIA 15) regional TMDL coordinator, Personal Communication with Angela Brown, March 3, 2005.

(4) Standard Methods for the Examination of Water and Wastewater, 20^{th} edition, 1998.

CHAPTER EIGHT
Analysis of Fish and Wildlife Habitat Degradation

8.1 INTRODUCTION

Data gathered in the characterization phase of the KI Basin indicated that 72% of aquatic habitat in the basin is in "Good" condition, 15% is in "Fair" condition, and 13% is in "Poor" condition. Overall, of the streams surveyed, 73% of the riparian corridor is in "Good" condition, 14% is in "Fair" condition, and 13% is in "Poor" condition.

No model exists for predicting the condition of aquatic and wildlife habitat in the future when the basin is fully developed. Instead, a trend analysis enables some estimation of future conditions.

8.2 FUTURE DEGRADATION OF FISH AND WILDLIFE HABITAT

8.2.1 Loss of Riparian Habitat

In the last few years, regulatory changes associated with the Clean Water Act (CWA) and the Endangered Species Act (ESA) have led to stricter regulation of streamside land uses. In 1987, the CWA was amended to include more vigorous regulation of the discharge of pollutants in urban stormwater to the surface waters of the United States. Owners of stormwater drainage systems, typically cities and counties, were charged with the responsibility for removing pollutants in stormwater to the "maximum extent practicable".

New ordinances to protect and restore habitat were adopted by Pierce County and went into effect March 1, 2005. These standards require that a 150-foot wide vegetated buffer zone be maintained along each side of fish-bearing streams. The buffer zone regulations should prevent substantial degradation of the 73% of the riparian corridor in the KI Basin, which remain rated in "Good" condition. The restrictions on streamside land use do not apply to properties that have already been developed. Currently, 26% of the riparian corridors in the KI Basin are in "Poor" or "Fair" condition, are vested under previous rules, and do not address cumulative impacts. It can be expected that already degraded portions of the riparian corridors will remain degraded unless property owners voluntarily choose to restore riparian corridors on their lands.

8.2.2 Changes to Aquatic Habitat

Puget Sound chinook salmon was listed as threatened, under the ESA, on March 24, 1999 (64 Fed. Reg. 14307). Critical habitat was designated on February 16, 2000 (65 Fed. Reg. 7764). The species status review identified a high level of hatchery production, which masks severe population depression in the ESU, as well as severe degradation of spawning and rearing habitats, and restriction or elimination of migratory access, as causes for the range-wide decline in Puget Sound chinook salmon stocks (NMFS, 1998a, and 1998b).

As a result of the listing, most federal activity (e.g., permit issuance, road construction, modification of wetlands, dredging, construction of federally-subsidized housing, etc.) in the region is subject to review, or consultation, under Section 7 of the Endangered Species Act, to ensure it doesn't jeopardize the continued existence of the species. If a project may cause “take” of a listed species, the Section 7 consultation process provides a mechanism to implement conservation measures that will avoid or minimize the harm, and, if needed, permit a specific amount of “take” of individual fish for a given project. Once a species is designated under the ESA, any citizen can ask the courts to force an end to actions that harm the threatened species. Under the Act, measures may be imposed by federal agencies and courts to limit further decline of the listed species and ultimately restore sustainable populations. The designation of the Puget Sound Chinook salmon as threatened was the first ESA listing in an urban area or in any region shared by such a large human population (about 3 million).

Any recovery plan must address the full range of habitats that the fish depend on, including headwater streams, connecting tributaries, major rivers, estuaries, and the ocean. In each of the freshwater habitat types, critical attributes such as volume, timing, temperature, water quality, sediment movement and storage, channel morphology, organic matter, and food resources may have been altered by human activities. In theory, restoring the basic processes and functions of the aquatic habitats to which salmon have adapted should lead to recovery of salmon populations.

Many of the tools to protect and restore habitat, such as zoning, building and grading codes, management of dikes and levees, operation of water, sanitation, and storm-water systems, and regulation of logging, are implemented by states and local agencies. The local levels of government, as well as volunteer-citizen groups, operate at the appropriate scale for habitat work. If these efforts can be coordinated in an ecosystem and watershed-based framework, the recovery efforts will have a greater chance of success.

8.2.3 Fish Passage Barriers

As noted above, in 1999, Puget Sound chinook salmon were listed as threatened, pursuant to the ESA. The listings caused public agencies that own culverts, or approve the construction of culverts by private parties, and agencies with responsibilities for fish and wildlife protection, to review and revise their practices.

New barriers to fish passage are unlikely to be created in yet-to-be developed areas of the basin. Awareness of the destructive nature of barriers to fish passage is widespread and, as a result, it is unlikely that a public agency would issue a building permit for a project that impedes fish migration. The future condition of access to fish habitat is largely tied to the removal of existing barriers.

Some in-stream structures, including culverts, weirs and other channel modifications, impede upstream migration of anadromous fish. A few diversion structures were built many years ago and are no longer in use, but they remain as barriers.

8.2.4 Changes in Basin Hydrology

Current impermeable surface percentages in individual subbasins in the KI Basin vary from 6% to 16%. In the future, it is estimated that they will range from 7% to 30%. In most subbasins, planned development is expected to increase the amount of impermeable surface by less than 10%, Ketron Island being the exception at a potential increase of 14%. Conversely, this means that 90% of the impermeable surface that will be present at build out already exists. Accordingly, it is apparent that most of the hydrologic change that is going to occur in the KI Basin has already taken place.

Future hydrologic change will also be limited by development regulations put in place by Pierce County in the 1990s and updated with the new Habitat Protection and Restoration regulatory package, effective as of March 1, 2005. Development regulations require that post-development peak flows from a site may not exceed pre-development peak flows. Post-development peak runoff flows can be controlled by maximizing infiltration and installing detention ponds. Although it is not yet known whether the facilities built to comply with the new regulations will completely halt hydrologic change in a watershed, they are certain to retard it.

Impervious surfaces in urban watersheds can increase mean summer stream temperatures. Because temperature plays a central role in the rate and timing of biotic and abiotic reactions in-stream, such increases have an adverse impact on streams. The new Habitat Protection and Restoration Rules provide for use of Low Impact Development, a process that emphasizes mimicking existing conditions with respect to hydrology, stormwater runoff, and water quality.

8.2.5 Unrestricted Livestock Access

The Rural 10 (R10) zoning dominates the KI Basin study area with small areas of Agriculture (A) and very small Rural Activity Center (RAC) and Rural Neighborhood Center (RNC) designations.

Although the areas zoned Agriculture (A) and Rural Activity Center (RAC) and Rural Neighborhood Center (RNC) are relatively small in extent, they often coincide with impaired aquatic and riparian habitat observed in field studies. Fencing to exclude livestock from the riparian and in-stream areas will reduce erosion, mechanical damage to habitat, and introduction of fecal matter directly into surface waters. Preventing direct concentrated surface runoff into streams by further buffering, construction of swales or confining animals during periods when soils are saturated can reduce siltation and fecal coliform.

Current county regulations require fencing to prevent livestock access to streams and containment of manure to prevent surface water pollution. See: *Pierce County Ordinance No. 96-47: Stormwater Pollution Prevention Manual.*

8.3 CONCEPTUAL SOLUTIONS

8.3.1 Riparian and Aquatic Habitat Improvements

Aquatic and wildlife habitat in already developed areas could be improved by stream enhancement projects such as restoration of the riparian corridor and aquatic habitat improvement. Restoration of the riparian corridor would provide water quality benefits, such as increased filtration of pollutants and lowering of water temperatures, which would in turn benefit aquatic life. Such restoration would also benefit birds, mammals, and amphibians by providing cover and food sources.

Mature coniferous riparian vegetation also serves as a source of woody debris that provides shelter for fish. Large woody debris (LWD) is an important structural component of streams systems, creating complex habitat structure, resulting in natural attenuation of flows in streams. In urban and suburban streams, the quantity of LWD found in stream channels is reduced due to the loss of riparian forest cover, storm washout, and channel maintenance practices.

Restoration of the riparian corridor would include riparian planting projects along the upper portion of streambanks and extending from streambanks for a minimum distance of 20-40 feet. Treatments would include the planting of willow stakes and containerized stock such as western hemlock, red cedar, Pacific ninebark, salmonberry, red osier dogwood, and other native species suitable for the location. Except for the willows and dogwoods, the remaining species would be planted at or above the ordinary high water mark.

Aquatic habitat improvement projects would consist of channel enhancement measures such as bank stabilization, LWD installation, and channel relocation (creation of meanders) as necessary for increased in-stream habitat complexity. In some specific locations, past stream habitat enhancement efforts have resulted in further degradation of habitats or inadvertent creation of fish passage barriers. In these locations, the previous in-stream work could be retrofitted to increase function, or, removed and replaced with a more functional project. The objective of aquatic habitat improvement is to create complex habitat with adequate pools and riffles along with in-water and overhead cover in the form of LWD and riparian trees.

Wherever feasible, existing native vegetation should be left in place and protected during stream enhancement projects. Additional native vegetation would be added, and non-native vegetation, with little or no habitat, cover, or food benefit to wildlife, should be removed. Particular attention should be paid to removing extremely invasive non-native vegetation, such as English Ivy, Scotch Broom, and Himalayan Blackberry.

Pierce County has little authority to require stream enhancement work to take place on private lands, but it does have the ability to provide technical assistance, landowner education, and may be able to provide funding through grants or other means. A number of community groups are interested in enhancing streams in the KI Basin. The County could expand on existing partnerships with volunteer groups to restore or enhance riparian and estuarine areas in the KI Basin, while ensuring that projects being implemented are well designed and executed and will function over the long-term. The County should set aside a portion of the Capital Improvement Program budget for stream enhancement projects.

Aquatic and wildlife habitat in yet-to-be-developed areas are protected by requirements for streamside vegetated buffer zones and other programmatic measures, expressed primarily as standards for new development.

Lands with particular value as wildlife habitat could be preserved through acquisition by public agencies or land trusts. The County should set aside a portion of the Capital Improvement Program budget for land acquisition projects. Acquisition of conservation easements and full acquisition of property are important actions to ensure permanent protection of critical habitat over the coming decades and generations. Often, the best means to achieve healthy aquatic habitat is simply allowing nature to take care of itself over a very long period of time.

8.3.2 Removal/Remediation of Fish Passage Barriers

Many forms of urban development are linear in nature (roads, sewers, and pipelines) and cross stream channels. The number of stream crossings increases directly in proportion to impervious cover and many crossings can become partial or total barriers to upstream fish migration, particularly if poor design later leads the streambed to erode below the fixed elevation of the culvert. Crossing designs that place a culvert at an improper gradient, employ culverts that are too small for the stream flow, or include culverts that are too long, frequently block resident and anadromous fish passage.

In already developed portions of the KI Basin, a clear method to improve aquatic habitat in the basin would be to remove some or all of the barriers to fish passage. In most cases, this could be accomplished by replacing existing road or driveway culverts with new culverts designed to facilitate fish passage. In a few cases, it may be possible to modify an existing culvert to be more “fish-friendly” by installing baffles or building a fish ladder. In implementing this approach, the focus should be on resolving passage problems on streams and watersheds with the highest salmon productivity, or the most significant stocks. These projects also have an improved chance of receiving regional and state salmon recovery funds.

As noted earlier in this report, streams in the KI Basin support salmonid species that are listed as threatened pursuant to the ESA. In addition, it is illegal under state law to block fish passage. Apart from ESA related pressures to remove fish passage barriers, there are voluntary efforts taking place to remove barriers because such actions fit with the goals of various public, private, and non-profit entities. Pierce Conservation District (with partial funding from Pierce County Water Programs) and a number of non-profit groups, such as the South Puget Sound Salmon Enhancement Group (SPSSEG), are actively facilitating the removal of publicly and privately owned barriers because of the benefits provided by such work. Pierce County could continue to support and be involved with voluntary efforts such as these to remove fish passage barriers and improve fish habitat in the future. Developing a better communication and coordination structure among the various groups involved in habitat restoration within the KI Basin would further the success of removing fish passage barriers and restoring habitat.

8.3.3 Livestock Fencing/BMPs

Implementing a livestock fencing program on agricultural lands could aid in the prevention of unrestricted livestock access to streams. This project could entail working with local National

Resource Conservation Service (NRCS), Conservation Districts, non-profit groups, and local landowners, to get agreement and resources needed to install fencing. Pierce County could promote livestock fencing by implementing a cost-share program with land owners or by implementing a property tax rebate for land owners who install and maintain livestock fencing. If the cost of fencing is prohibitive, an alternative solution is to develop and apply agricultural BMPs that help mitigate the impacts of livestock in the riparian corridor.

CHAPTER NINE
Development of Basin Plan Recommendations

9.1 INTRODUCTION

Two kinds of improvements are necessary to correct current and potential future flooding and environmental problems in the Key Peninsula Island (KI) Basin: capital improvements and programmatic improvements. Capital improvements are improvements that require the investment of capital by public agencies or private parties. Programmatic improvements are improvements to the ongoing programs or new programs operated by the County related to the services they provide. Alternatives for capital and programmatic improvements are discussed separately below. A regulatory review was also performed and elements of ordinances discussed below.

9.2 CAPITAL IMPROVEMENTS

As discussed in *Chapters 6* and *8*, some flooding, and fish and wildlife habitat problems can be solved or lessened by capital improvements or investments. Water quality problems, discussed in *Chapter 7,* in rural areas such as the KI Basin do not lend themselves to solution solely by capital improvement. Programmatic solutions will be far more effective for water quality improvements, as discussed in the next section. The types of flooding problems encountered in the KI Basin can be corrected by culvert replacement projects. Fish passage problems can also be corrected by culvert replacement projects or by culvert modification. High quality aquatic and riparian fish and wildlife habitat can be acquired for the public and protected from development. Degraded aquatic habitat and riparian habitats can be restored by either public or private entities.

Existing high quality fish and wildlife habitat can be protected by acquisition on behalf of the public and by imposing and enforcing regulations that prevent its destruction by private parties. The most effective program is one that employs a combination of acquisition and enforcement. The development and evaluation of capital projects that are designed to protect fish and wildlife habitat by acquisition are described below.

Degraded fish and wildlife habitat can be improved by restoration on behalf of the public and by promoting habitat restoration by private parties. The development and evaluation of capital projects that are designed to improve degraded fish and wildlife habitat through restoration are described below. The relative merits of restoration by public entities and encouragement of restoration by private parties are discussed in *Chapter 10*. Acquisition associated with restoration are also described and discussed.

9.2.1 Development of Flooding and Fish Passage Capital Projects

Capital projects were developed for each of the identified flooding and fish passage problems. All fish passage barriers that were surveyed in the field, including fish passage barriers identified in the PCD, database are included in the CIP list. A complete list of fish passage barriers is contained in *Appendix L*.

A total of 33 projects are recommended as CIPs, including 30 culvert replacements and 3 fish passage projects. Of these, 15 culverts are identified as undersized and have the potential of causing road flooding during heavy storms. Culverts and fish passage projects on both public and private property are included in the CIP list. Of the 33 projects, 30 are culvert replacements and 3 are fish passage projects.

Undersized culverts were only included in the CIP if flooding occurred for storm events of 25-year return intervals, or less, unless these culverts were also fish passage barriers. The 100-year storm event occurs so infrequently that it is not an optimum use of resources to replace these culverts.

In cases where a culvert is expected to cause flooding at the 25-year storm or less, the preferred solution is replacement with a new culvert that both meets the drainage standards and provides unrestricted fish passage. Typically, this involves the installation of a culvert with an even larger cross-sectional area than that needed for flood flow conveyance alone. The Washington Department of Fish and Wildlife has published guidelines for “fish-friendly” culverts that limit the velocity of flow in culverts during the 2-year return-frequency flow event. In addition, new culverts must now span the width of the stream channel. The stream channel width requirement usually dictates the size of the culvert.

In the case of culverts that cause serious fish passage problems, the preferred solution is replacement with new culverts that both meet the drainage standards and provide unrestricted fish passage. Some culverts that cause serious fish passage problems may be modified to provide fish passage, rather than replaced. For example, a culvert with an impassable drop at the downstream end could be modified by the installation of a fish ladder, and a steeply sloping culvert could have baffles installed to slow and deepen flow. Generally, modifications of this sort are less effective than culvert replacement, but they may be justified when culvert replacement would be very costly or may not take place for some time. For analytical purposes, it was first assumed that any culverts that cause a serious fish passage problem should be replaced with “fish friendly” culverts.

For the purposes of estimating the cost of culvert replacements, a replacement culvert size was chosen for each culvert replacement project. The replacement culvert size chosen was generally either, the width of the streambank, or, one to three standard culvert sizes larger than the existing culvert (e.g. a 54-inch diameter culvert would replace a 36-inch diameter culvert), if the streambank width was not known.
It is important to note that prior to construction each culvert replacement project should undergo a site-specific engineering design process to ensure appropriate sizing, slope, and positioning to accommodate future flows and allow safe fish passage.

Capital improvements were developed to correct potential flooding problems caused by both publicly and privately owned culverts. Removal of fish barriers owned by public agencies without also removing privately owned barriers would not have provided fish with full access to available habitat. Water Programs would like to work with on repair of both public and private culverts, with willing landowners, to resolve fish passage barriers, as funding allows. A full list of fish passage barriers, and potential barriers, is contained in *Appendix L*.

9.2.2 Development of Land Acquisition Capital Projects

Lands that could be obtained by the County for protection or enhancement of important fish and wildlife habitat are identified. Land acquisition projects are identified for protection of existing reaches with good quality fish habitat and good riparian habitat. Stream reaches proposed for acquisition include consideration of continuous corridors to provide connectivity for wildlife. Another criteria for acquisition is the size of the drainage basin. The larger the basin, the greater the capacity of the system to absorb disturbances within the watershed and, therefore, some of the reaches in smaller basins are included.

An alternative to fee simple acquisition is to purchase an easement on the property. This has advantages in that the landowner is responsible for maintenance and liability for the property. However, landowners often view their property as a parcel that they may maintain in the manner they prefer, which is not always beneficial to water quality and wildlife. Easements are more protective than no easement, but not as protective as placing the property in public ownership. In the event the property owner is not willing to sell the stream reach, an easement is a good alternative to consider.

Stream reaches identified for land acquisition include those with associated wetland areas. Wetlands that could be protected include Vaughn Creek (Reach VA-03), and Rocky Creek (Reach RC-07). Additional wetlands, that require restoration, have been identified for acquisition. Restoration sites include Dutcher Creek (Reach DU-02), Anderson Island (AI-04), Whiteman Creek (Nearshore), and Vaughn Creek (Reaches VA-03, VA-04, and VA-05).

Land acquisition is an important tool for the County to protect riparian and aquatic habitats. While land regulations provide protection, they do not apply to properties with vested rights for development under older rules, nor do they address cumulative impacts. *Appendix J* provides a memo listing the advantages and disadvantages of land acquisition, purchasing of an easement, and a list of stream reaches the County could consider for protection. The areas targeted for acquisition typically include floodplains and areas that would be part of a set-back for new development.

9.2.3 Development of Stream Enhancement Projects

This plan includes projects developed for currently degraded reaches with potential for restoration. Data gathered in the characterization phase of the KI Basin plan indicated that, of the approximately 94,000 feet of stream corridor surveyed, 72 percent of in-stream fish habitat in the basin is in “Good” condition, 15 percent is in “Fair” condition, and 13 percent is in “Poor” condition. Seventy-three percent of the riparian habitat is in “Good” condition, 14 percent is in “Fair” condition, and 13 percent is in “Poor” condition.

Stream enhancement alternatives were developed by identifying reaches with poor quality fish habitat or riparian habitat. In many cases, reaches are classified as poor for both riparian habitat and fish habitat because fish habitat often suffers when the riparian habitat is degraded. In these reaches, stream enhancement activities targeted toward both improving fish habitat and the riparian habitat are appropriate to implement.

However, there are a variety of causes for fish habitat degradation, and reaches also exist where fish habitat is in poor condition but the riparian habitat is in fair condition. In these reaches, it may be more cost effective to target stream enhancement activities solely toward improving fish habitat. There are also several reaches where the riparian habitat has degraded to poor condition, but fish habitat has only degraded to fair condition. In these reaches, in may be more cost effective to target enhancement activities solely toward improving the riparian habitat, which over time will also likely improve fish habitat.

Three wetlands areas have been identified for CIPs as wetlands restoration projects. These are also identified above for land acquisition, and include reaches on Anderson Island, Vaughn Creek, and Whiteman Creek.

Thirty-five stream reaches (including the three wetland restoration projects listed above), totaling 35,570 linear feet were identified as potential sites for stream enhancement or wetland restoration that would substantially benefit fish and wildlife. The cooperation of private landowners in reaches targeted for stream enhancement projects will be necessary for successful project implementation.

9.2.4 Evaluation of Capital Improvement Projects

Capital improvement projects were evaluated using a modified form of the procedure outlined in *Pierce County's Guidelines for Basin Planning*. The procedure was designed to provide a means for calculating the benefits and costs of capital projects, so that projects could be prioritized objectively and consistently across basins. The cost of capital projects can be readily estimated but the benefits are more difficult to calculate because they cannot be expressed in monetary terms. Therefore, the potential capital improvement projects were evaluated for their net surface water and natural resource management benefit.

In evaluating net benefit, each project was scored using a prioritization sheet that assigned points for the project's potential for various aspects natural resource management benefit. The scoring schedule is shown in *Table 9-1*. Points were assigned based on benefits related to flood reduction (approximately 35% of total), water quality protection or improvement (approximately 30% of total), natural resource protection or improvement (approximately 30% of total), and other factors such as multiple use, education, and recreation (approximately 5% of total). Each project was reviewed and scored using approximately 40 specific criteria.

The total number of benefit points awarded to a capital project are then divided by the estimated project cost to provide a benefit to cost ratio. Project costs were estimated using cost estimates shown in *Appendix I*. Guidelines for cost estimates were provided from current construction projects, Means Construction Cost Data, and "A Primer on Habitat Project Costs" developed by Puget Sound Shared Strategy.

The results of the evaluation are shown in *Tables 9-2, 9-3*, and *9-4*. *Table 9-2* was developed assuming that fish passage problems created by culverts would be permanently corrected by replacing the existing culverts with "fish-friendly" culverts. Some of the fish passage problems could be temporarily solved by measures such as culvert cleaning, installation of baffles or installation of fish ladders. Capital projects are listed in descending order of score in *Tables 9-2, 9-3*, and *9-4*. Detailed project score forms for each project are in *Appendix J* and cost estimates are contained in *Appendix I*.

9.3 REGULATORY PROGRAMS AND PROGRAMMATIC IMPROVEMENTS

As discussed in *Chapters 6, 7*, and *8*, there are a number of potential flooding, water quality, and aquatic and wildlife habitat problems that may be prevented by regulatory and programmatic improvements. The overall relative increase of flooding hazards associated with increased development in a watershed can be reduced through development standards that require limits on post-development runoff rates and volumes. Increased pollutant loading associated with increased development may be reduced with regulations requiring the installation of water quality improvement facilities (structural BMPs) for new development and the prohibition of development on or near stream banks. Finally, regulations supporting the creation of vegetated buffers or the increase in vegetated buffer widths along stream banks can improve aquatic and wildlife habitat in areas with increased development.

Pierce County has recently enacted regulations and amended development standards to reduce the adverse impacts of human activities on surface water bodies. Initial regulations designed to help Pierce County meet the requirements of the Clean Water Act (CWA) and the Endangered Species Act (ESA) have been updated and incorporated into revised development guidelines and standards and stormwater and surface water management plans.

Before determining whether additional regulatory or programmatic measures are needed to protect surface water bodies in the Key Peninsula Basin, an initial review of the existing regulations and development plans was conducted.

9.3.1 Review and Evaluation of Existing Regulations

To control the potential impacts on stream health from new development in the Key Peninsula Basin, ordinances and regulations have been established at the regional level. Specifically, the current *Pierce County Code* updated in August 2001, including the "Directions for Protecting and Restoring Habitat" (effective as of March 1, 2005) regulatory package, provides the template for much of the regulatory guidelines regarding buffers, low impact development standards, stormwater management, and environmental protection.

The "Directions for Protecting and Restoring Habitat" regulatory package itself contains three ordinances related to critical area protection and amendments updating a large proportion of Title 17 and 18 county codes. The Key Peninsula-Islands Basin does not contain any incorporated areas so these codes apply to the entire Pierce County portion of the basin. The ordinances are described as follows:

Ordinance 2004-56s, Exhibit B, Amendments to the Pierce County Stormwater Management and Site Development Manual

Ordinance 2004-56s, Exhibit B, contains amendments to select chapters of the Pierce County Stormwater Management and Site Development Manual and the addition of an entirely new chapter (*Chapter 10*) which provides guidance on low-impact development (LID) standards and techniques. *Chapter 10* was created to encourage new development to: maintain pre-developed hydrologic conditions onsite, retain and restore native soils and vegetation, limit effective impervious surfaces, and utilize LID BMPs to manage stormwater quantity and quality.

Ordinance 2004-56s, Exhibit D, Amendments to Title 18E, Critical Areas

Pierce County complies with the Washington State Growth Management Act and the ESA by requiring protection of critical areas such as streams, wetlands, and landslide hazard areas. *Ordinance 2004-56s, Exhibit D*, includes amendments to specific sections of *Title 18E - Development Regulations for Critical Areas* of the Pierce County Code, which has recently (March 1, 2005) become effective. Under *Title 18E.40, Fish and Wildlife Habitat*, there are design standards in place for protection of streams and wetlands, specifically related to buffer requirements. Current regulations have a maximum required buffer width of 150 feet or a minimum buffer width of 65 feet, applicable depending on the water type classification. These revised Pierce County buffer requirements are based on the *Tri-County Salmon Recovery Plan* interim protection measures and standards, developed in 2001 to assist in the protection of salmon habitat in Pierce, King, and Snohomish Counties.

Pierce County's revised buffer requirements, like the Tri-County Plan, rely on the Washington Department of Natural Resources (DNR) water-typing scheme to determine the appropriate buffer for each critical fish and wildlife area. The water-typing system is described later in this Section under "Application of the County Buffer Requirements".

9.3.2 Review and Evaluation of Other Sources for Programmatic Improvement

A number of other sources of programmatic suggestions and improvements exist for the Key Peninsula-Islands basin. The *Key Peninsula Community Plan* update is currently in process after being initiated in September 2004, and is scheduled for completion in September 2006. Comprehensive information on the plan update is limited at this time, but the results of the community survey have been released. The survey results contain information regarding the community's views on a variety of topics ranging from quality of life, land use, the economy, and public facilities and services. The survey results can assist in making programmatic recommendations based on the communities regard for various environmental and financial topics.

Another document that was considered in making programmatic recommendations was the *Key Peninsula-Gig Harbor-Islands Watershed Characterization and Action Plan*. This document provides a number of education, outreach, and technical assistance recommendations that may be considered as programmatic improvements.

9.3.3 Review of County Buffer Requirements

Application of County Buffer Requirement

With the approval of the revised county buffer width requirements, the DNR Stream Typing Classification System, as amended by the Fish and Forest Report and adopted by the Washington State Legislature in March 2000, was used to classify streams in the Key Peninsula Basin as water types. The water types correspond to the buffer requirements in the County's regulations. The DNR method of classification is "habitat-driven" and replaces Type 1 through 5 water designations with geomorphic parameters, which help to classify water bodies as S, F, or N. These new water classifications are defined as follows:

- Type S: shorelines of the state.
- Type F: segments of natural waters other than Type S that contain fish or fish habitat.
- Type N: segments of natural waters other than Type S that do not contain fish or fish habitat

It is important to note that waters without fish due to fish passage barriers, but with fish supporting conditions, are considered Type F. The detailed definitions for these water types and the subcategories of each type are provided in WAC 222-16-030. It should be noted that streams within ravines may have associated landslide hazard areas which may require a buffer width greater than those widths listed. Pierce County has adopted the DNR water types, which are provided in the revised buffer requirements in the Pierce County Development Regulations, Section 18E.40.060 and Ordinance 2004-56s Exhibit D.

The water typing system is meant to rely on fish habitat water typing maps. These maps were developed based on a multi-parameter, field-verified geographic information system (GIS) logistic regression model and will be updated every five years. The multi-parameter model is designed to identify fish habitat by using geomorphic parameters such as basin size, gradient, elevation, and other indicators. The modeling process is designed to achieve a level of statistical accuracy of 95% in separating fish habitat streams and nonfish habitat streams.

The geomorphic model, including the water type map database, was released for public use in March 2005. To determine the stream typing classifications, the model and database was queried for each stream that was field inventoried in the Key Peninsula – Islands Basin (*Table 9-5*). Most reaches queried had either an F or N water type designation. A number of upstream reaches were identified as an N6 designation, which according to the data dictionary for the water type map database, indicates that the reach was formerly untyped or an unknown stream feature upstream of a modeled end point. The N6 designation does not have an accompanying buffer width requirement in the *WAC 222-16-030*. *Table 9-5* shows the resulting water type designation based on the query of the geomorphic model. The recommended buffers outlined in *Table 9-5* are based on the reach designations outlined in the *WAC 222-16-030*, and if an N6 designation is shown, the buffer width recommended is based on the adjacent downstream reach water type classification.

Field surveys in the Key Peninsula- Islands Basin confirm that there is a significant difference in stream conditions between those streams with adequate buffers between the water body and development and those streams that have been encroached upon by agricultural and residential development, especially for streams with steep slopes.

Potential Barriers to Effective Implementation of the Buffer Requirements

Because the new buffer requirements would largely be applied to new development, the effectiveness of the requirements depends on the amount of vacant lands that would be subject to development restrictions in critical areas. All new development would be subject to the current critical areas and resource lands regulations (including increased buffer widths), unless a property is vested, meaning the date used to determine which development regulations apply to the permit application is prior to the date that the current regulations became effective.

Within the general provisions section of the development regulations in the Pierce County code, there is a section on vesting which is intended to "provide property owners, permit applicants, and the general public assurance that regulations for project development will remain consistent during the lifetime of the application". This section is applicable to use permits, preliminary plats, final plats, short plats, large subdivisions, binding site planes, shoreline development permits, and any other land use permit application that is determined by the Washington State Legislature to be subject to the Vested Rights Doctrine.

While this section of the development regulations provides protection for applicants and incorporates time limitations so as to avoid rendering new development regulations completely ineffective, this clause does create a barrier to effectively protecting riparian habitats with an increased buffer width ordinance. Therefore, it is important to determine the number of parcels of vacant land that are already platted or have the potential to subdivide under existing regulations that have vested rights requiring only a 35-foot buffer, so as to identify where the new buffer ordinances are rendered ineffective. This type of analysis was not undertaken as part of the Key Peninsula- Islands Watershed Plan, but it is recommended and would be feasible using existing data and information as described below.

As of yet, the county has not conducted any additional studies to aid in assessing the effectiveness of the buffer ordinance as pertaining to the Key Peninsula Basin. The *Key Peninsula Community Plan* is currently in progress and, through its development, additional resources and efforts are being considered. These efforts may be directed at a review of the county assessor's platting information in conjunction with a summary of those vacant lands that are subject to a vesting control to outline those parcels in which the previous buffer requirements (35 feet) may be permissible compared to those parcels subject to the revised buffer requirements. The total area with the potential for protection by the 150-foot buffer could then be calculated and used to qualitatively describe the effectiveness of these ordinances.

As discussed previously, the overall determination of the ordinance effectiveness as related to buffers is controlled by the amount of new development that occurs. Projected growth and development in the Key Peninsula Basin is relatively limited. Current population projections by the Puget Sound Regional Council indicate that the Key Peninsula - Islands area will experience a growth rate of approximately 12.6% from 2000 to 2010, 3.8% from 2010 to 2020, and 6.1% from 2020 to 2030 (1-include citation from Phase 1 report). These growth rates are significantly lower than the 44.9% population increase observed from 1990 to 2000. Therefore, future development is projected to consume less land than development that has already occurred in the Key Peninsula-Islands area.

The primary land use categories in the Key Peninsula Basin are currently residential and vacant, which indicates that the basin is not currently built out and if the need for additional development does occur, there is land available. However, 96% of the basin is currently zoned R10, which means that if development generally follows the zoning designation, new residential development should consist of one dwelling per 10 acres. With new development maintaining relatively low-density, the new requirement for 150-foot buffers should be reasonable for existing lots to accommodate and still have buildable area.

In conclusion, it is difficult to predict the effectiveness of the buffer regulations, due to the limited amount of readily available information regarding current parcel platting, vesting constraints and the variability regarding new development in this area. There is concern that build-out conditions in the watershed, particularly on Ketron, Herron and Anderson Islands, would have harmful effects on water quality and fish and wildlife habitat. Implementation of programs and regulations described in this Basin Plan provide opportunities to mitigate the potential harmful effects of development on vested parcels of property. One effective tool to preserve the existing high quality habitat is for Pierce County Water Programs to implement a land acquisition program for wetlands and along stream corridors. These areas are typically non-buildable portions of properties and can be partitioned to separate out the buildable part of the property for future development.

9.3.4 Review of the County Low-Impact Development Standards

Ordinance 2004-56s, Exhibit B includes amendments to the Pierce County Stormwater Management and Site Development manual, including the addition of *Chapter 10* related to LID standards and guidance. LID techniques are designed to manage stormwater generated from new and redevelopment so that there will be no negative impacts to adjacent or downstream property owners and no degradation to groundwater or surface waters. The revised standards discuss the general process for incorporating LID practices into a project, beginning with site inventories through site design and LID BMP selection. Guidelines for site design include:

- Retain 65% of the site in open space or natural resource protection areas preferably in contiguous blocks or linear corridors when feasible.
- Orient residential lots to minimize site disturbance.
- Eliminate stream crossings with roads and conveyance systems.
- Minimize impervious surfaces by reducing building footprints, road length and width, parking areas, and driveways.
- Eliminate effective impervious surface by directing stormwater from impervious surfaces in swales or low velocity sheet flow to adjacent open space or bioretention areas.
- Utilize small, dispersed bioretention areas to capture, store, and infiltrate stormwater on-site.
- Maintain pre-developed flow path lengths.

- Layout roads and lots to follow topographic contours to minimize soil and vegetation disturbance.
- Utilize pervious paving surfaces such as porous pavement and pavers for roads, driveways, parking lots, or other types of drivable or walkable coverage.
- Direct rooftop runoff to infiltration areas or cisterns for non-potable reuse or utilize vegetative roof systems for evaporation and transpiration of stormwater.
- Limit development in natural resource protection areas.

The effectiveness of LID techniques increases when the concepts are applied at both the individual site scale and at the community and regional scale, especially where transportation infrastructure is considered. As the Key Peninsula-Islands Basin is not currently built out (based on the relatively high proportion of vacant lands present), they are in the unique position to apply these development standards on both the regional and individual site scale. However, with the relatively limited development expected over the next 20 years (based on population projections), it will be difficult to determine the effects any LID techniques are having on water quality and wildlife habitat improvements.

The County may consider the use of incentives to promote implementation of LID as comprehensively as possible on a site specific level, while focusing on LID techniques for redevelopment of transportation corridors, indirectly supporting any development which does occur, on a regional scale.

9.3.5 Other Environmental Protection Policies

The *Key Peninsula- Gig Harbor-Islands Watershed Characterization and Action Plan* includes a number of education, outreach, and technical assistance programs designed to reduce nonpoint source water pollution.

Many of these programs would improve Key Peninsula's residents' understanding of human impacts on streams and provide residents with tools to act as better watershed stewards. Some of the action items proposed in this plan are:

- Encourage riparian buffering by offering landowners technical and financial assistance (AF 7).
- Create and distribute generalized best management practice (BMP) guidebooks for farm and forestry activities (AF 20).
- Develop an education program on slope stability, shoreline armoring, and vegetation management for shoreline landowners (SH 3).
- Provide technical assistance to landowners concerning shoreline stewardship/management options and offer an incentives program guidebook to encourage shoreline property owners to improve habitat and maintain a naturally functioning shoreline (SH 4 and SH 12) [It is also recommended as a part of this Basin Plan that this action item be expanded to include streamside property owners].
- Develop showcase shoreline habitat restoration projects (SH 10).

- Support volunteer shoreline stewardship programs (SH 13).
- Provide assistance to property owners on reducing stormwater flows and implementing BMP's (SW 7).
- Assess streams and develop habitat improvement projects (SW 13).
- Initiate a public outreach program that targets illegal dumping of solid waste (OT 6).
- Implement a voucher system for disposal of "problem items" such as furniture, tires, used batteries and appliances (OT 7).
- Expand the master gardener programs to include public presentations on integrated pest management and other environmentally-friendly gardening practices (OT 9).
- Develop an education program for golf course grounds keepers on water quality, integrated pest management, and habitat enhancement on golf courses (OT 14).
- Pursue alternatives to roadside spraying of herbicides (OT 15).
- Establish a pet waste education program (GN 1).
- Create a buffer improvement program (GN 7).
- Support water conservation projects and encourage water recycling (GN 10 and 11).
- Establish a native plant salvage program and encourage use of native plants in public installations (GN 23 and GN 25).

Although a *Key Peninsula Community Plan* has not been completed, an initial community survey was distributed in September 2004 to help gauge the opinions of the general public with regards to the current quality of life, the natural environment, development, land-use planning, and public facilities and services.

Generally, residents in the Key-Peninsula Basin support protection of the natural environment including streams and wetlands, maintenance of open space and tree cover, and development designed to maintain the rural character of the community. These opinions support select objectives of LID development techniques. The survey also found that the current residents do not necessarily support additional commercial or residential growth on the peninsula, indicating that observed effects of additional buffer requirements and LID techniques may be limited. However, the community tends to support public improvements to transportation corridors (new and existing roads) and public acquisition of open space or shoreline property.

Evaluation of the effectiveness of the alternative (education, outreach, and technical assistance) programmatic measures may provide useful information related to water quality and habitat improvements, considering the limited anticipated development expected in the Key Peninsula - Islands Basin. Cost estimates, potential funding sources, and methods of implementation were developed for each of the action items in the *Key Peninsula-Gig Harbor-Islands Watershed Characterization and Action Plan*.

Pierce County, Kitsap County, and the City of Gig Harbor are the regulatory organizations identified in the Plan that will implement the action items in the plan. The KGI Watershed Council and Steering Committee will pursue implementation of the action plan with these organizations. The KGI Watershed Council is responsible for coordination of plan implementation, monitoring, and public involvement.

9.3.6 Stormwater Management

Pierce County's stormwater management plan and development standards include a number of provisions designed to reduce the adverse effects of urban stormwater runoff on streams. They include the implementation of various best management practices (BMPs) that limit the discharge of pollutants in stormwater to surface waters from both existing and new development and limit the hydrologic change associated with new development. Some BMPs are incorporated into the new LID guidelines and standards.

Because urban runoff control technology is in its infancy, it is not yet known how effective the BMPs will be over the long run. BMPs for stormwater management have been in effect for less than ten years in the most urban areas, including Pierce County, and few attempts have been made to measure their effects on water quality and stream health. In addition, there has been limited recent development in the Key Peninsula - Islands Basin and it is unlikely that an inventory of existing BMPs is available for monitoring or tracking.

9.3.7 Possible Regulatory and Programmatic Improvements

Based upon review of the current Pierce County regulations designed to reduce development-related adverse effects on streams, it is clear that positive changes have been made in the regulatory structure regarding stream buffers, development regulations, and other environmental protection policies. The changes have resulted from a better understanding of the connection between development patterns and stream health and the placement of a greater emphasis on protecting water quality and fish and wildlife habitat.

The buffer regulations, LID regulations, education programs, and water quality regulations implemented as a part of the local planning and regulatory efforts described above are expected to reduce degradation of water quality and habitat loss as a result of streamside development. Environmental policies proposed in the upcoming Key Peninsula Community Plan could further reduce the impacts of current land practices and new development activities within stream corridors if implemented consistently.

Additional programmatic and regulatory changes that could be made in the future to further protect stream health from the impacts of new development include:

- Promotion of incentive-based, voluntary landowner development practices that will protect streams adjacent to properties vested under less stringent stream protection regulations.
- Implementation of the education and outreach programs proposed in the Key Peninsula-Gig Harbor-Islands Watershed Characterization and Action Plan in an effort to help to reduce negative impacts to streams from future development in the basin.
- Incorporation of LID standards for new development and significant redevelopment, infrastructure expansion, and maintenance.

- Use of incentives to promote LID standards implementation as comprehensively as possible.

Most of the new development standards apply primarily to new development. Although the Key Peninsula - Islands Basin is not considered built out, minimal new development is projected to occur in the upcoming years. Therefore, to protect water quality and stream health it would be desirable to implement these measures on private and previously developed areas to the extent practicable, encouraged through the implementation of public education and outreach measures previously discussed.

Programmatic and regulatory measures that could be considered to protect stream health in already developed areas include the following:

- Education on limiting pesticide and fertilizer use in stream corridors.
- Limitations on domestic animal access to streams.
- Basin-specific stream protection measures.
- Implementation of the education and outreach programs proposed in the Key Peninsula-Gig Harbor-Islands Watershed Characterization and Action Plan in an effort to help to reduce negative impacts to streams from existing development in the basin.
- Financial incentives to property owners for revegetation of current stream buffer areas.

Each sub-basin in the Key Peninsula - Islands Basin has particular land uses that pose specific problems for stream health. For example, golf courses and significant residential developments in the headwater area of the Schoolhouse Creek-Islands sub-basin contribute pesticides, herbicides, and fertilizers to receiving waters. Limiting quantities and types of chemicals used in this and other comparable areas could control the water quality degradation occurring in these sub-basins.

Agricultural and pasture lands along a majority of streams in the upper Key Peninsula sub-basins contribute to excessive nutrient and bacteria levels. Encouraging buffers for existing developed and/or private lands may reduce the discharge of bacteria and chemicals, to streams, limiting the access of animals in streams, would also improve water quality. Implementation of education and outreach programs is likely to be more successful and better received by the public than using enforcement.

A combination of capital improvement programs and programmatic improvements discussed in this chapter, when implemented, will meet the County’s goals of optimizing resources while reducing flooding, protect water quality and natural resources.

REFERENCES:

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2003 Sub-County (Small Area) Forecasts of Population and Employment, Central Puget Sound Region, Puget Sound Regional Council;

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Key Peninsula Community Plan Project, "Key Peninsula Community Plan Survey Results, September 2004;
http://www.co.pierce.wa.us/pc/services/home/property/pals/landuse/keypeninsula.htm

Pierce County Development Regulation Amendments, Ordinance 2004-56s, Exhibit B – Amendments to the Pierce County Stormwater Management and Site Development Manual, Version March 1, 2005;

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Pierce County Development Regulation Amendments, Ordinance 2004-58s, Exhibit A – Amendments to Title 18, Development Regulations – General Provisions, Version March 1, 2005;

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Water Type Map Database Data Dictionary, Washington Department of Natural Resources – Forest Practices Application and Review System (FPARS), March 1, 2005. Provided by Pierce County Water Programs.

Table 9-1 Pierce County Capital Improvement Project Prioritization
EVALUATION OF PROJECT BENEFITS

Name:	
Location:	
Subbasin:	
Project:	

		Score	
	1. FLOOD REDUCTION (Maximum Score 185)	**Maximum**	**Assigned**
a	*Level of Flooding (score all that apply)*		
	Prevents inconvenience flooding	5	
	Prevents hazard to public safety	25	
	Prevents risk to critical facilities (hospitals, etc.)	20	
	Prevents severe property damage (> $100,000/year)	15	
	Prevents minor property damage (< $100,000/year)	10	
b	*Frequency of Flooding (score one)*		
	Prevents annual flooding	20	
	Prevents flooding every 1 to 5 years	15	
	Prevents flooding every 5 to 25 years	10	
	Prevents flooding less than one in 25 years	5	
c	Required due to flooding liability	20	
d	Increases capacity of flood plain	20	
e	Corrects non-compliance with County design standard (H/D ratio < 1.5)	20	
f	*Future Flooding: level of increase in peak discharge that is expected due to landuse changes within the project area (score one)*		
	High	15	
	Medium	10	
	Low	5	
g	*Estimated benefit to doing the project now (in feasibility and cost benefit) versus waiting and doing project later (score one)*		
	High	15	
	Medium	10	
	Low	5	
*	**Total Flooding Score**	185	
	2. WATER QUALITY IMPROVEMENT (Maximum Score 160)		
a	Reduces sources of or impacts from emission of fine sediments	20	
b	Reduces sources of or impacts from emission of heavy metals	20	
c	Reduces sources of or impacts from emission of excess nutrients	20	
d	Reduces sources of or impacts from excess oxygen demanding conditions	20	
e	Reduces sources of or impacts from emission of oil and grease	20	
f	Reduces sources of emission of pathogens such as fecal coliform	30	
g	Lowers water temperature, provides more shade	30	
*	**Total Water Quality Score**	160	
	3. NATURAL RESOURCE IMPROVEMENT & PROTECTION (Maximum Score 160)		
a	Improves and/or protects habitat for aquatic species	30	
b	Improves and/or protects habitat for terrestrial species	20	
d	Increases proportion of native plant species	10	
f	Improves flow regime and/or natural hydrology	10	
g	Increases channel stability/reduces erosion	5	
h	*Increases extent of salmonid spawning habitat (score one - score weighted based on quality "Q"**)*		
	Opens passage to long reach of habitat (>4000 ft)	80*Q	
	Opens passage to medium reach of habitat (1000 - 4000 ft)	65*Q	
	Opens passage to short reach of habitat (<1000 ft)	50*Q	
i	Salmonids other than cutthroat trout present	5	
	** Q = [Good (ft) + Fair (ft)] / [Total (ft)]		
*	**Total Natural Resource Improvement Score**	160	
	4. OTHER FACTORS (Maximum Score 40)		
a	Provides recreational or multiple use opportunities	10	
b	Enhances visual aesthetic of area	10	
c	Provides public education opportunities	10	
d	Is a highly visible project or has been on the CIP needs list multiple years	10	
*	**Total Other Factors Score**	40	
***	**Total Project Score**	**545**	**0**

Table 9-2: Evaluation of Culvert Replacements and Fish Passage Projects

Row #	Subbasin	CIP name	Location	Problem Addressed: Future flood hazard	Fish passage barrier	Potential fish passage barrier (Level B)	Not in compliance with County Design Standard	Owner-ship	Down stream fish passage barriers	Estimated Cost ($)	Score
1	Purdy Creek	PR-CR02	144th	X	X		X	Public		718,272	280
3	Schoolhouse Ck. (AI)	AI-CR03	Oro Bay Road	X	X		X	Public		35,070	240
2	Schoolhouse Ck. (AI)	AI-CR02	Eckenstam Johnson Road, Near Oro Bay Road	X		X	X	Public		43,837	235
4	Huge Creek	HG-CR06	160th St.	X			X	Public		60,837	160
5	Dutcher Creek	DU-CR04	Lackey Road	X	X			Public	X	142,158	155
6	Whiteman Creek	WH-CRNS1	Bay Road		X			Public		125,518	145
7	Whiteman Creek	WH-CRNS2	Bay Road		X			Public		125,518	145
8	Rocky West Creek	RW-CR01	Driveway off 144th St.	X	X		X	Private	X	32,951	145
9	Dutcher Creek	DU-CR06	Driveway east of 70th Avenue	X	X			Private	X	18,672	140
10	Dutcher Creek	DU-FP01	Driveway west of Lackey Rd.		X			Private		81,000	140
16	Schoolhouse Ck. (AI)	AI-CR08	Eckenstam Johnson Road and 108th St.		X		X	Public		190,452	135
11	Purdy Creek	PR-CR07	160th St.	X	X			Public		66,198	130
14	Filucy Bay	FBT-CR02	South of 56th St.	X	X			Public		82,377	125
12	Rocky Creek	RC-CR03	144th St.	X	X			Public		143,388	120
13	Purdy Creek	PR-CR04	Driveway on 62nd Ave.		X			Private	X	85,108	120
15	Knackstedt Creek	HE-CR01	Driveway off 21st St.		X			Private		52,099	120
17	Filucy Bay	FBT-CR01	Erickson Road		X			Public		91,692	115
18	Schoolhouse Ck. (KP)	SC-CR01	East of KP Hwy, west of 148th Ave, on Reeves Rd.		X			Public		98,825	110
19	Vaughn Creek	VAT-CR01	Hall Road		X			Public		316,755	105
20	Whiteman Creek	WH-CR03	Whiteman Road		X			Public	X	154,200	100
21	Schoolhouse Ck. (KP)	SCT-CR01	Mahnke Rd, East of the Reeves Rd./158th Ave. Intersection		X			Public		122,974	95
22	Schoolhouse Ck. (KP)	SCT-CR02	Mahnke Rd,SE of the Reeves Rd./158th Ave. Intersection	X	X			Public		54,822	90
23	Schoolhouse Ck. (AI)	AI-CR09	Driveway North of 108th St. Crossing		X			Private	X	5,000	90
24	Devil's Head	DHT-CR01	88th Street	X	X			Public		54,369	80
25	Glen Cove	GCT-CR01	Thomas Road		X			Public		81,672	70

Table 9-2: Evaluation of Culvert Replacements and Fish Passage Projects

Row #	Subbasin	CIP name	Location	Problem Addressed: Future flood hazard	Fish passage barrier	Potential fish passage barrier (Level B)	Not in compliance with County Design Standard	Owner-ship	Down stream fish passage barriers	Estimated Cost ($)	Score
26	Glen Cove	GCT-CR02	Thomas Road		X			Public		69,336	70
27	Whiteman Creek	WH-CR02	Whiteman Cove Road		X			Public	X	119,188	70
28	Herron Lake	HL-FP01	South of Herron Rd., mouth of Herron Lake Creek		X			Private		150,000	70
29	Vaughn Creek	VAT-FP02	Driveway off Wright-Bliss Rd. south of 104th St. Ct.		X			Private		150,000	70
30	Dutcher Creek	DU-CR05	Driveway west of Lackey Road		X			Private	X	5,000	65
									Total	**3,477,288**	

Note:

Table 9-2 was developed assuming that fish passage problems created by culverts would be permanently corrected by replacing the existing culverts with “fish-friendly” culverts. Some of the fish passage problems could be temporarily solved by measures such as culvert cleaning, installation of baffles or installation of fish ladders. Capital projects are listed in descending order of benefit score. The benefit to cost ratio of each project is also shown. A summary of the evaluation of each potential capital improvement project and detailed evaluation forms and cost estimates are contained in Appendix I.

Table 9-3 Property Acquisition Capital Improvement Projects

Row #	Stream	CIP Name	Aquatic Habitat	Riparian Corridor	Length of Reach (ft)	Acquire Land to **Improve** Reach	Acquire Land to **Protect** Reach	Zoning[1]	Cost / acre [2]	Estimated acreage to acquire [3]	Estimated acq. Cost	Score[4]	Score/ Cost (points/ $10,000
1	Huge Creek	HG-AC01	"Good"	"Fair"	2,435	X			$ 60,000	17	$ 1,006,198	285	2.8
2	Huge Creek	HG-AC02	"Good"	"Good"	2,820		X		$ 60,000	19	$ 1,165,289	280	2.4
3	Rocky Creek	RC-AC04	"Good"	"Good"	3,780		X		$ 60,000	26	$ 1,561,983	275	1.8
4	Vaughn Creek	VA-AC05	"Good"	"Good"	1,500		X		$ 60,000	10	$ 619,835	270	4.4
5	East Fork Rocky	EF-AC04			1,452		X		$ 60,000	10	$ 600,000	265	4.4
6	Huge Creek	HG-AC03	"Good"	"Good"	1,000		X		$ 60,000	7	$ 413,223	265	6.4
7	Rocky Creek	RC-AC01	"Good"	"Good"	1,430		X		$ 60,000	10	$ 590,909	265	4.5
8	Rocky Creek	RC-AC06	"Fair"	"Fair"	700		X		$ 60,000	5	$ 289,256	265	9.2
9	Rocky Creek	RC-AC02	"Good"	"Good"	4,875		X		$ 60,000	34	$ 2,014,463	260	1.3
10	Rocky Creek	RC-AC03	"Good"	"Good"	4,195		X		$ 60,000	29	$ 1,733,471	260	1.5
11	Rocky Creek	RC-AC05	"Good"	"Good"	2,100		X		$ 60,000	14	$ 867,769	260	3.0
12	Rocky Creek	RC-AC07	"Good"	"Good"	2,000		X		$ 60,000	14	$ 826,446	260	3.1
13	Vaughn Creek	VA-AC03	"Good"	"Good"	700		X	Resource	$ 60,000	5	$ 289,256	260	9.0
14	East Fork Rocky	EF-AC01	"Good"	"Good"	1,720		X		$ 60,000	12	$ 710,744	255	3.6
15	East Fork Rocky	EF-AC02	"Good"	"Good"	1,250		X		$ 60,000	9	$ 516,529	255	4.9
16	Huge Creek	HG-AC04	"Good"	"Good"	880		X		$ 60,000	6	$ 363,636	255	7.0
17	East Fork Rocky	EF-AC03	"Good"	"Good"	1,515		X		$ 60,000	10	$ 626,033	245	3.9
	TOTAL										**$ 14,195,041**		

Property Acquisition Capital Improvement Projects

NOTES:

[1] "Residential" zoning (Res) includes High Density Residential, Moderate Density Single Family, Master Planned Community, Rural Seperator, Rural and Reserve residential designations

[2] Cost/acre based on Pierce County Cost Estimating Guidance (high value residential land = $60,000/acre)

[3] Estimated acquistion area based on the following assumptions: average width of land acquisition a total of 300 ft, with stream in middle at 150 ft. length of land acquisition would be "estimated % of reach bordered by vacant land" multiplied by "length of reach".

[4] Stream restoration project benefits were evaluated using the Capital Improvement Project benefit score sheets, shown in Appendix I.

Table 9-4 Stream Restoration and Wetland Restoration Capital Improvement Program Projects

Row #	Stream	CIP Name	Fish Habitat	Riparian Habitat	**Improve** Aquatic Habitat	**Improve** Riparian Habitat	Also Identified for **Land Acquisition**	Wetland Restor-ation	Length (ft)	Cost/ ft.[1]	Total	Score[2]	Score/ Cost (points/$ 10,000)
1	East Fork Rocky	EF-RST04			X	X	X		1,575	$400	$ 630,000	270	4.3
2	Purdy Creek	PR-RST01	"Fair"	"Poor"		X			300	$200	$ 60,000	255	42.5
31	Purdy Creek	PR-RST02	"Fair"	"Fair"	X	X			320	$400	$ 128,000	230	18.0
3	Huge Creek	HG-RST01	"Good"	"Fair"	X	X	X		2,435	$200	$ 487,000	225	4.6
23	Schoolhouse AI	AI-WTRST04[3]						X	640	$460	$ 294,400	225	7.6
28	Vaughn Creek	VA-WTRST04						X	500	$460	$ 230,000	225	9.8
17	Whiteman Crk.	WH-WTRST01						X	595	$460	$ 273,700	220	8.0
4	Little Minter	LM-RST01	"Poor"	"Poor"	X	X			1,860	$400	$ 744,000	190	2.6
5	Minter Creek	MN-RST07	"Good"	"Poor"		X			1,027	$200	$ 205,400	190	9.3
6	Rocky West	RW-RST02	"Poor"	"Poor"		X			840	$200	$ 168,000	190	11.3
7	Little Minter	LM-RST02	"Poor"	"Poor"	X	X			1,120	$400	$ 448,000	185	4.1
8	Minter Creek	MN-RST01	"Poor"	"Poor"	X	X			1,200	$400	$ 480,000	185	3.9
9	Purdy Creek	PR-RST05	"Poor"	"Poor"		X			690	$200	$ 138,000	185	13.4
10	Purdy Creek	PR-RST07	"Fair"	"Good"	X	X			770	$200	$ 154,000	185	12.0
11	Minter Creek	MN-RST09	"Poor"	"Poor"	X	X			2,900	$400	$ 1,160,000	180	1.6
12	Purdy Creek	PR-RST06	"Fair"	"Poor"	X	X			1,070	$400	$ 428,000	180	4.2
13	Vaughn Creek	VA-RST02	"Poor"	"Poor"	X	X			1,100	$400	$ 440,000	175	4.0
14	Minter Creek	MN-RST05	"Good"	"Poor"		X			1,000	$200	$ 200,000	170	8.5
16	Whiteman Crk.	WH-RST01	"Poor"	"Poor"					595	$200	$ 119,000	170	14.3
15	Taylor Bay	TB-RST01	"Fair"	"Good"	X	X			2,100	$200	$ 420,000	165	3.9
18	Schoolhouse KPI	SC-RST03	"Poor"	"Poor"		X			550	$200	$ 110,000	165	15.0
19	Little Minter	LM-RST08	"Poor"	"Poor"		X			750	$200	$ 150,000	150	10.0
20	Minter Creek	MN-RST08	"Fair"	"Poor"		X			703	$200	$ 140,600	150	10.7
21	Minter Creek	MN-RST11	"Fair"	"Poor"		X			200	$200	$ 40,000	150	37.5
24	Herron Lake	HL-RST01	"Poor"	"Fair"	X				2,100	$200	$ 420,000	135	3.2
22	Schoolhouse AI	AI-RST04	"Poor"	"Poor"	X	X			640	$200	$ 128,000	130	10.2
25	Home Creek - #150044	HM-RST01				X			1,000	$200	$ 200,000	130	6.5
26	Vaughn Creek	VA-RST01	"Fair"	"Fair"	X				300	$200	$ 60,000	125	20.8
27	Vaughn Creek	VA-RST04	"Fair"	"Fair"	X				500	$200	$ 100,000	120	12.0
29	Home Creek - #150043	HM-RST02				X			600	$200	$ 120,000	120	10.0
30	Little Minter	LM-RST03	"Fair"	"Good"	X				1,350	$200	$ 270,000	115	4.3
32	Huge Creek	HG-RST06	"Poor"	"Poor"	X				950	$200	$ 190,000	105	5.5

33	Huge Creek	HG-RST05	"Fair"	"Fair"	X				530	$200	$ 106,000	95	9.0
	Total								**32,810**		**$ 9,242,100**		

NOTES:

[1] Stream restoration costs can vary significantly depending on the level of work necessary at a given site. These cost estimates are based on per lineal foot of stream, 10 foot wide. Cost estimates are $200/ft for riparian corridor improvements (streambank stabilization, riparian area planting, etc.) and $200/ft. for instream aquatic habitat improvements (placement of large woody debris, improving channel substrate, etc.). Costs are based two sources: "A Primer on Habitat Project Costs" Prepared for the Puget Sound Shared Strategy by Evergreen Funding Consultants, Spring 2003, and review of bid documents for three recent restoration projects in the State of Washington. These costs include a contingency. If both in-stream aquatic habitat improvements and riparian corridor improvements are needed, the cost estimate is $400/ft.

[2] Stream restoration project benefits were evaluated using the Capital Improvement Project benefit score sheets, shown in Appendix I.

[3] Wetland Restoration (WTRST) costs can vary considerably. These estimates assume $100,000/acre.

Table 9-5
SUMMARY OF KEY PENINSULA SUBBASIN WATER TYPES AND BUFFER WIDTHS

Basin	Subbasin	Water Characteristics	Pierce County Water Type	Pierce County Buffer Width	Fish Passage Barriers?	Flood Problems?	Water Quality Limited?	Predominant Land Use	Current Impermeable Surface
Key Peninsula	Dutcher (DU)	Drainage area - 3.2 square miles; Gradient - moderate; Discharge - to Dutcher Cove; Contains Fish - supports coho, steelhead presence is also reported.	Primarily F1	150 feet	Yes	Yes	No	space; 26% in low density residential	8%
Key Peninsula	Herron/ Knackstedt (HE)	Drainage area - 1.9 square miles; Gradient - moderate to shallow; Discharge - to Case Inlet; Contains Fish - supports coho and chum and cutthroat distribution is presumed.	N1 and N6 for select upstream tributaries; F1 for downstream reaches	115 feet for N1 and N6 reaches; 150 feet for F1 reaches	Partial	No	No	30% in low-density residential; 30% in open space	9%
Key Peninsula	Kingsman (KG)	Drainage area - 2.0 square miles, includes Herron Lake tributary area; Gradient - moderate to shallow, Discharge - to lake before presumably discharging to Case Inlet; Contains Fish - supports coho and chum and chinook are released annually.	Primarily F1	150 feet	Yes	No	No	53% in open space; 15% in resource land	8%
Key Peninsula	Lackey (LA)	Drainage area - 2.8 square miles; Gradient - shallow; Discharge - to Glen Cove; Contains Fish - supports coho and cutthroat distribution is presumed.	N2 and N6 for select upstream tributaries; F1 for downstream reaches	65 feet for N2 and N6 reaches; 150 feet for F1 reaches	No	No	No	43% in open space; 37% in low density residential	10%
Key Peninsula	East Fork Rocky (Fork Muck) (EF)	Drainage area - 12.2 square miles; Gradient - moderate; Discharge - to Rocky Creek before entering Rocky Bay; Contains Fish - supports coho and chum.	N2 and N6 for select upstream tributaries; F1 for downstream reaches	65 feet for N2 and N6 reaches; 150 feet for F1 reaches	No	No	No	45% in resource land; 28% in open space	9%
Key Peninsula	Rocky (RC)	Drainage area - 6.3 square miles, includes Rocky West tributary area; Gradient - moderate; Discharge - to Rocky Bay; Contains Fish - Rocky Creek supports coho, chum, Chinook, steelhead, and cutthroat salmon and Rocky West supports coho and cutthroat.	Primarily F1	150 feet	Partial	Yes	Yes - dissolved oxygen	62% in resource land; 17% in open space	9%
Key Peninsula	Schoolhouse-Key Peninsula (SC)	Drainage area - 1.8 square miles; Gradient - variable- shallow (<1%) to steep (8%) to shallow(1%); Discharge - to Filucy Bay; Contains Fish - supports coho, cutthroat, and chum salmon.	N1 and N6 for select upstream tributaries; F1 for downstream reaches	115 feet for N1 and N6 reaches; 150 feet for F1 reaches	Yes	No	No	42% in open space; 25% in low density residential	7%
Key Peninsula	Taylor Bay (TB)	Drainage area - 1.2 square miles; Gradient - moderate; Discharge - to Taylor Bay; Contains Fish - supports coho and cutthroat salmon.	F1	150 feet	Unknown		No	31% in open space; 24% in low density residential	9%
Key Peninsula	Vaughn (VA)	Drainage area - 6.1 square miles; Gradient - shallow; Discharge - to Vaughn Bay; Contains Fish - supports coho and chum, cutthroat trout are present.	Primarily F1	150 feet	Yes	No	No	35% in open space; 25% in low density residential	8%
Key Peninsula	Whiteman (WH)	Drainage area - 4.6 square miles; Gradient - shallow; Discharge - to Whiteman Cove; Salmonid fish passage barrier at mouth precludes use of Creek by andromous fish.	N1 for upstream tributaries; F1 for downstream reaches	115 feet for N1 reach; 150 feet for F1 reaches	Yes	No	No	50% in open space; 16% in low density residential	7%

Table 9-5
SUMMARY OF KEY PENINSULA SUBBASIN WATER TYPES AND BUFFER WIDTHS

Basin	Subbasin	Water Characteristics	Pierce County Water Type	Pierce County Buffer Width	Fish Passage Barriers?	Flood Problems?	Water Quality Limited?	Predominant Land Use	Current Impermeable Surface
Islands	Schoolhouse - Anderson Island (AI)	Drainage area - 1.9 square miles; Gradient - shallow; Discharge - to Oro Bay; Contains Fish - supports anadromous salmonids.	Primarily F1	150 feet	Unknown	Yes	No	58% in open space; 20% in low density residential	6%
Burley-Minter	Huge (HG)	Drainage area - 7.3 square miles; Gradient - shallow; Discharge - to Minter Creek, eventually into Minter Bay and Case Inlet; Contains Fish - coho and cutthroat to headwaters, steelhead for a portion.	N6 for upstream tributaries; F1 for downstream reaches	150 feet for F1 reaches (upstream to N6 designations if applicable)	Yes	Yes	Yes - dissolved oxygen, fecal coliform	28% in low density residential; 24% in open space	9%
Burley-Minter	Minter (MN)	Drainage area - 10.4 square miles, includes Little Minter tributary area; Gradient - shallow to moderate; Discharge - to Minter Bay and Case Inlet; Contains Fish - Minter Creek supports coho, cutthroat, Chinook, chum, and steelhead and releases of chum and coho; Little Minter supports coho, cutthroat, and chum.	F1 for upstream reaches; S1 downstream of confluence with Huge Creek	150 feet	Yes	Yes	Yes - dissolved oxygen, fecal coliform	37% in open space; 32% in low-density residential	9%
Burley-Minter	Purdy (PR)	Drainage area - 3.4 square miles; Gradient - shallow; Discharge - to Burley Lagoon; Contains Fish - supports Chinook, coho, chum, and steelhead, and cutthroat trout present.	Primarily F1	150 feet	Yes	Yes	Yes - dissolved oxygen, fecal coliform	30% in open space; 30% in low-density residential	9%

Table 9-6: Evaluation of Programmatic Recommendations

Row #	Prog. Number	Programmatic Name	Cost Estimate One-time	10-year	Countywide	Basin-specific	Estimated Cost ($)	Score
1	PG-01	Implement Low Impact Development Program		x	x		100,000	351
2	PG-02	Increase Inspections for Compliance with Stormwater Requirements and NPDES Permit		x	x		208,800	403
3	PG-03	Develop & Implement a Land Management Program		x	x		9,570	407
4	PG-04	Develop & Implement Program to Enhance Degraded Riparian Habitat & Water Quality		x	x		34,500	310
5	PG-05	Develop & Implement an Education, Outreach & Technical Assistance Program		x	x		104,000	388
6	PG-06	Develop & Implement Surface Water Quality Monitoring Program		x	x		162,000	154
7	PG-07	Develop & Implement Stormwater Education Program for Shoreline Property Owners		x		x	600,000	281
8	PG-08	Develop & Implement BMP Manual for Water Programs Maintenance Activities	x		x		71,000	426
9	PG-09	Provide Technical Assistance to Nonprofit Groups Installing Fish-Friendly Culverts		x	x		8,700	294
10	PG-10	Develop & Implement Habitat Monitoring Program		x	x		7,750	194
11	PG-11	Encourage Installation of Permanent Buffer Markings and/or Signage	x		x		7,750	193
12	PG-12	Establish a Wetlands Banking or Advanced Mitigation Program	x		x		50,000	298
13	PG-13	Develop & Implement an Invasive Species Management Program		x	x		7,000	285
14	PG-14	Implement Elements of Shellfish Protection Program		x		x	6,200,000	368
							7,571,070	

CHAPTER TEN
Basin Plan

This chapter describes the recommended plan for the Key Peninsula-Islands Basin. The plan includes proposals for both capital and programmatic improvements.

10.1 RECOMMENDATIONS

The Key Peninsula-Islands Basin Plan contains 83 capital improvement projects and 14 programmatic measures to remedy flooding, erosion, water quality, and stream habitat problems resulting from surface water runoff in the Basin.

Capital improvement projects and programmatic measures have been divided into "High-Priority," "Medium-Priority," and "Low-Priority"[1] groups. Priorities were not established for studies. Estimated costs of recommendations by priority group are as follows:

"High-Priority" Recommendations:	**$19,026,000**
"Medium-Priority" Recommendations:	**$13,136,000**
"Low-Priority" Recommendations:	**$2,683,000**

Table 10.1 presents the estimated cost of the Key Peninsula-Islands Basin Plan recommendations by project type and priority group.

Table 10.1 Estimated Costs of Plan Recommendations

Project Type	High Priority	Medium-Priority	Low-Priority
Capital Improvement Projects	$11,632,000	$12,958,500	$2,683,000
Programmatic Measures	$7,394,000	$177,500	$0
Total Estimated Cost	**$34,845,000**		

[1] "Low-Priority" does not mean "not a priority." "No Priority" actions have already been excluded from this Basin Plan. Rather, "Low-Priority" means the project rated lower than other needs in the Basin. Examples of these include projects with only a single-benefit; the rating system is weighted toward multiple benefits.

Most of the actions provide multiple benefits; for example, stream restoration can reduce downstream flooding; reduce erosion, and thus protects water quality; provide improved habitat and improve aesthetics.

Priority Ranking. The recommended CIPs and programmatic measures have been sorted into high-priority, medium-priority, and low-priority groups based on scores from prioritization worksheets common to all of the basin plans. Worksheets document the project's or program's potential for various aspects of flood reduction, improvement of water quality, aquatic habitat protection, and other benefits using approximately 40 criteria. The top 25% of the projects are designated high-priority, 50% become medium-priority, and the remaining 25% are assigned low-priority. The order within each priority group reflects project cost, from least to most costly. *Appendix "J"* documents the ranking system and its application to each recommended project. It contains a spreadsheet summarizing the scores assigned to each CIP and individual scoring worksheets for each CIP and programmatic measure.

Recommendations are made with respect to three types of capital improvement projects: culvert replacement; land acquisition projects; and stream restoration and enhancement projects. The culvert replacement projects are intended to solve flooding and/or fish passage problems. *Tables 10-2* and *10-3* show all CIPs, sorted by priority and grouped by stream reaches, respectively.

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 the 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. This ranking system is documented in *Appendix "J"*. The appendix also contains a spreadsheet summarizing the scores assigned to each CIP and project estimating spreadsheet. 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 (project score). Then, high, medium, or low status was assigned as follows:

- High-Priority: 25% of total number of recommendations
- Medium-Priority: 50% of total number of recommendations
- Low-Priority[2]: 25% of total number of recommendations

[2] Note: "Low-Priority" does not mean "no benefit" for flood control, water quality protection, or natural resource protection. All of the recommendations in the Basin Plan .benefit the objectives. "No benefit" proposals were screened out prior to writing 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" may

Within each priority category, projects and programs were ranked from lowest cost to highest cost. This directs County financial resources to where they do the most good for the financial resources invested. *Tables 10-2 and 10-3* present the recommended capital improvement projects and programmatic measures.

Project Identification Codes

Each recommendation has a unique project identification code. The code contains the following information:

Stream Code + Project Type + Order Number

Stream Code: The Stream Code indicates the location of the project by stream. Stream Codes may be found in *Table 9-5*.

Project Type: The general category of project that best fits the project's activities.

Project Category Codes:

AC	Property Acquisition
CR	Culvert Replacement
PG	Programmatic
RST	Stream Restoration
WTRST	Wetland Restoration
FP	Fish Passage Project

The Basin Plan contains 83 capital improvement projects to solve the flooding, storm drainage, water quality, and related habitat problems in the Key Peninsula-Islands Basin. This following section presents CIP projects by creek in alphabetical order. Appendix "J" contains the Project Analysis sheets for each of the projects listed below and maps showing the general location of recommended projects.

10.2 CIP RECOMMENDATIONS

10.2.1 Culvert Replacement and Fish Passage Improvement Projects

A prioritized list of recommended culvert replacement and fish passage projects for Pierce County Water Programs is shown in *Table 9-2,* and *Figure 10-1*. The recommended projects correspond with the potential flooding and fish passage problems shown in *Figures 4-7* through *4-21*. The figures also show the quality of fish habitat and riparian corridor in each reach,

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be built before high-priority projects to ensure the optimal benefit from other projects, such as upstream fish habitat improvements synchronized with downstream barrier removal.

problem areas in each reach (barriers to fish passage and flooding), current land use in the basin, and vacant land parcels in the basin.

The list was developed from the projects evaluated in *Chapter 9* and includes both public and private culverts and fish passage projects. Thirty-three CIPs, thirty culvert replacements and 3 fish passage projects were identified for construction. Of the 33 total projects, 4 were due only to flooding, 18 were due only to being fish passage barriers, and 11 were both flooding concerns and fish passage barriers.

The 33 projects on the capital improvement project list are estimated to cost approximately $27,274,000, expressed in 2006 dollars.

In an effort to ensure that Pierce County's investment in fish passage barrier removal realizes the maximum benefit, all of the barriers on the list in *Appendix L* must also be removed. The culverts under the state highways are the responsibility of the Washington Department of Transportation. Fish passage barrier removal projects will only be effective if fish passage barriers are replaced starting at the downstream end and moving upstream, thus enabling fish passage into the upper watershed.

The CIP list includes all fish passage barriers identified by field survey crews or the Pierce Conservation District and identified in their database. Both public and privately owned culverts, or fish passage projects, are identified in the CIP list. Culverts requiring additional evaluation are not part of the CIP list.

10.2.2 Land Acquisition Projects

Retaining streams in a natural condition helps communities comply with the *Clean Water Act* and *Endangered Species Act* mandates. If communities had been able to foresee the advantages of maintaining streams in a natural condition during their early years, they may have prevented serious problems within floodplains and the riparian corridor. Now that the advantages are apparent, many communities are taking steps to protect or restore streamside vegetation. Pierce County has an advantage in this regard because there is little development in floodplains in the KI Basin and much streamside vegetation remains in good condition.

An important priority for Pierce County is to ensure that streamside vegetation that is still in good condition is not degraded. It is recommended that Pierce County repeat the streamside habitat survey conducted for this study in 2005 every five years, with the next survey taking place in 2010 and evaluate the ability to increase the effort to acquire streamside lands that support good habitat.

Improvement of fish habitat and the riparian corridor in degraded reaches to the maximum extent possible is a priority for Pierce County. This can be accomplished by educating and encouraging the owners of degraded sections of the riparian corridor to restore them voluntarily, or by acquiring the land for the public and restoring it. It is recommended that Pierce County implement a program to encourage private landowners to restore their riparian lands. To complement these efforts, degraded riparian lands could be acquired and restored when they provide a corridor for migration of wildlife between large blocks of good habitat and when they support rare plant or animal species.

It should be noted that voluntary action by private property owners is unlikely to result in the complete restoration of degraded riparian lands. The owners of some properties will likely be able to restore the riparian corridor without any serious inconvenience or loss of amenities if they so choose. Others may be unwilling to do so because structures, driveways and lawns already occupy the riparian zone and restoration to a natural condition would be expensive and inconvenient. Still others may simply be unwilling to incur the expense associated with riparian zone restoration regardless of whether it affects amenities or convenience. Some property owners may be willing to allow restoration of their riparian lands provided they do not have to pay for it or provide labor. This possibility is discussed in the section below entitled “Stream enhancement”.

All of the 17 land acquisition projects identified in *Table 9-3* are included in *Table 10-2*. Land acquisition projects were selected to maximize the use of County funds to address the following criteria: connectivity of parcels, existing condition of stream reaches, and size of the watershed that drains to the stream. Connectivity is important for wildlife to access and use the area. Stream reaches in good condition are important to acquire because it is more economical to preserve a stream reach than it is to rehabilitate a degraded reach.

Finally, recommendations for land acquisition are in both large and small watersheds. The larger the area, the greater the ability to absorb disturbances and provide habitat for fish and wildlife. Therefore, the smaller watersheds are important to preserve. The estimated cost of the land acquisition capital improvement projects is approximately $14,195,000.

10.2.3 Stream Enhancement Projects

As an alternative to voluntary action by private property owners or land acquisition, Pierce County could itself enhance degraded riparian lands on private property. This would require the agreement of property owners and the investment of capital by Pierce County. Property owners could grant an easement to Pierce County covering all or part of their riparian lands for habitat enhancement purposes.

It is recommended that Pierce County implement outreach, education, and incentive programs to encourage voluntary stream enhancement by private property owners that would improve degraded riparian habitat and water quality. In addition to the voluntary effort and the technical assistance, the county should consider the need for direct investment in stream enhancement on private lands. Pierce County could provide funds and staff (or assist with coordination of volunteer groups) to complete enhancement projects in degraded riparian areas where streamside property owners have given permission. This would require the agreement of property owners and the investment of capital by Pierce County. Property owners could grant an easement to Pierce County covering all or part of their riparian lands for habitat enhancement purposes.

A number of community groups are interested in enhancing streams in the Key Peninsula-Island Basin. The County already has partnerships with volunteer groups to restore or enhance riparian and estuarine areas. Stream restoration projects fall into two categories, capital improvement projects and programmatic projects. In general, stream reaches with a “Fair” designation were placed in the category of programmatic improvements that would be addressed through public education and technical assistance provided by the County. Stream reaches in “Poor” condition were placed on the CIP list. The estimated cost of the stream restoration and wetland restoration capital improvement projects is approximately $9,242,000.

Project Type by Subbasin

Subbasin	Acquisition	Wetland Restoration	Culvert Replacement	Fish Passage Project	Stream Corridor Restoration	Total Number of Projects	Est. Cost
Devil's Head			1			1	$54,369
Dutcher Creek			3	1		4	$246,830
East Fork Rocky Creek	4				1	5	$3,083,306
Filucy Bay			2			2	$174,069
Glen Cove			2			2	$151,008
Herron Lake Creek				1	1	2	$570,000
Home Creek/Unnamed Creek					2	2	$320,000
Huge Creek	4		1		3	8	$3,792,183
Knackstedt Creek			1			1	$52,099
Little Minter Creek					4	4	$1,612,000
Minter Creek					6	6	$2,226,000
Purdy Creek			3		5	8	$1,777,578
Rocky Creek	7		1			8	$8,027,685
Rocky West Creek			1		1	2	$200,951
Schoolhouse Creek/Amsterdam Bay - AI		1	5		1	7	$851,313
Schoolhouse Creek - KP			3		1	4	$386,621
Taylor Bay					1	1	$420,000
Vaughn Creek/Bay	2	1	3	1	3	10	$2,410,491
Whiteman Creek		1	4		1	6	$917,124
Basin Total	**17**	**3**	**30**	**3**	**30**	**83**	**$27,273,627**

10.2.4 Specific CIP's

Devil's Head Project

Project Number: **DHT-CR01**

Project Name: **Devil's Head/88th Street Culvert Replacement**

Cost Estimate: **$54,369**

Project Score: **80** **Low Priority**

Problem: Existing culvert presents a fish passage barrier.

Solution: Replace existing 24" diameter culvert with a 33 foot long 36" diameter culvert.

Dutcher Creek Projects

Project Number: **DU-FP01**

Project Name: **Dutcher Creek/Lackey Road Fish Passage Project**

Cost Estimate: **$81,000**

Project Score: **140** **Medium Priority**

Problem: Fish passage barrier due to fish ladder.

Solution: Repair fish ladder to remove fish passage barrier.

Project Number: **DU-CR04**

Project Name: **Dutcher Creek/Lackey Road Culvert Replacement**

Cost Estimate: **$142,158**

Project Score: **155** **Medium Priority**

Problem: Resolve flood hazard and fish passage barrier at Lackey Road.

Solution: Replace existing 5' diameter culvert with a 76 foot long 10' x 6' concrete box culvert.

Project Number: **DU-CR05**

Project Name: **Dutcher Creek/68th Street Culvert Replacement**

Cost Estimate: **$5,000**

Project Score: **65** **Low Priority**

Problem: Fish passage barrier due to slope.

Solution: Replace existing 12-inch diameter culvert with a 20 feet long 48-inch diameter culvert for fish passage.

Project Number: **DU-CR06**

Project Name: **Dutcher Creek/70th Avenue Culvert Replacement**

Cost Estimate: **$18,672**

Project Score: **140** **Medium Priority**

Problem: Fish passage barrier due to slope and outfall and potential flooding.

Solution: Replace existing 2-12-inch diameter culverts with a 17 feet long 6'x3' box culvert for fish passage and flooding.

East Fork Rocky Creek Projects:

Project Number: **EF-AC01**

Project Name: **Reach EF01 Acquisition**

Cost Estimate: **$710,744**

Project Score: **255** **Medium Priority**

Problem: Stream survey indicates 1,720 feet of good riparian and aquatic habitat.

Solution: Acquire 1,720 feet of floodplain corridor.

Project Number: **EF-AC02**
Project Name: **Reach EF02 Acquisition**
Cost Estimate: **$516, 529**
Project Score: **255** **Medium Priority**

Problem: Stream survey indicates 1,250 feet of good riparian and aquatic habitat.

Solution: Purchase 1,250 feet of floodplain corridor.

Project Number: **EF-AC03**
Project Name: **Reach EF03 Acquisition**
Cost Estimate: **$626,033**
Project Score: **245** **Medium Priority**

Problem: Stream survey indicates the presence of 1,515 feet of good aquatic and riparian habitat.

Solution: Acquire 1,515 feet of floodplain corridor along reach EF03.

Project Number: **EF-AC04**
Project Name: **Reach EF04 Acquisition**
Cost Estimate: **$600,000**
Project Score: **265** **High Priority**

Problem: Floodplain habitat appears to be at risk for development of aquatic and riparian degradation.

Solution: Acquire 1,452 feet of stream reach for floodplain preservation and habitat restoration.

Project Number: **EF-RST04**

Project Name: **Reach EF04 Stream Restoration**

Cost Estimate: **$630,000**

Project Score: **270** **High Priority**

Problem: Degraded aquatic and riparian habitat.
Solution: Restore 1,575 feet of degraded riparian and aquatic habitat.

Filucy Bay Projects:

Project Number: **FBT-CR01**

Project Name: **Filucy Bay Tributary/Erickson Rd. Culvert Replacement**

Cost Estimate: **$91,692**

Project Score: **115** **Low Priority**

Problem: Existing culvert presents a fish passage barrier.

Solution: Replace existing 4’x4’ box culvert with a 50’ long 10’x 4’ box culvert.

Project Number: **FBT-CR02**

Project Name: **Filucy Bay Tributary/South of 56th St. Culvert Replacement**

Cost Estimate: **$82,377**

Project Score: **125** **Low Priority**

Problem: Fish barrier due to slop and outfall and potential flooding.

Solution: Replace 30” diameter culvert with 50’ long 9’x4’ box culvert.

Glen Cove Bay Projects:

Project Number: **GCT-CR01**

Project Name: **Glen Cove Tributary/Thomas Rd. Culvert Replacement (a)**

Cost Estimate: **$81,700**

Project Score: **70** **Low Priority**

Problem: Existing culvert presents a fish passage barrier.

Solution: Replace existing 15-inch diameter culvert with a 45’ long 84-inch diameter culvert.

Project Number: **GCT-CR02**

Project Name: **Glen Cove Tributary/Thomas Rd. Culvert Replacement (b)**

Cost Estimate: **$69,300**

Project Score: **70** **Low Priority**

Problem: Fish passage barrier due to slope and outfall.

Solution: Replace 12” diameter culvert with 50’ long 72” diameter culvert.

Herron Lake Creek Projects:

Project Number: **HL-FP01**

Project Name: **Herron Lake Creek/Mouth of Herron Lake Creek Fish Passage Project**

Cost Estimate: **$150,000**

Project Score: **70** **Low Priority**

Problem: Fish passage barrier due to Bulkhead.

Solution: Construct new fish ladder.

Project Number: **HL-RST01**

Project Name: **Reach HL01 Stream Restoration**

Cost Estimate: **$420,000**

Project Score: **135** **Medium Priority**

Problem: Stream surveys indicates that there are 2,100 feet of poor instream habitat.

Solution: Restore 2,100 feet of aquatic habitat.

Home Creek Projects:

Project Number: **HM-RST01**

Project Name: **Home Creek Stream Restoration**

Cost Estimate: **$200,000**

Project Score: **130** **Medium Priority**

Problem: Stream survey indicates the presence of 1,000 feet of degraded floodplain habitat.

Solution: Restore 1,000 feet of degraded riparian habitat.

Project Number: **HM-RST02**
Project Name: **Unnamed Creek Stream Restoration**
Cost Estimate: **$120,000**
Project Score: **120** **Low Priority**

Problem: Stream survey indicates the presence of 600 feet of degraded floodplain habitat.

Solution: Restore 600 feet of degraded riparian habitat.

Huge Creek Projects:

Project Number: **HG-AC01**
Project Name: **Reach HG01 Floodplain Acquisition**
Cost Estimate: **$1,006,198**
Project Score: **285** **High Priority**

Problem: Stream survey indicates the presence of 2,435 feet of good aquatic habitat and fair riparian habitat.

Solution: Acquire 2,435 feet of floodplain corridor along reach HG01 for future restoration.

Project Number: **HG-RST01**
Project Name: **Reach HG01 Stream Restoration**
Cost Estimate: **$487,000**
Project Score: **225** **Medium Priority**

Problem: Stream survey indicates the presence of 2,435 feet of fair riparian habitat.

Solution: Restore 2,435 feet of degraded riparian habitat along reach HG01.

Project Number: **HG-AC02**

Project Name: **Reach HG02 Floodplain Acquisition**

Cost Estimate: **$1,165,289**

Project Score: **280** **High Priority**

Problem: Stream survey indicates the presence of 2,820 feet of good aquatic habitat and Good riparian habitat.

Solution: Acquire 2,820 feet of floodplain corridor along reach HG02 for preservation.

Project Number: **HG-AC03**

Project Name: **Reach HG03 Floodplain Acquisition**

Cost Estimate: **$413,223**

Project Score: **265** **High Priority**

Problem: Stream survey indicates the presence of 1,000 feet of good aquatic habitat and good riparian habitat.

Solution: Acquire 1,000 feet of floodplain corridor along reach HG03 for preservation.

Project Number: **HG-AC04**

Project Name: **Reach HG04 Floodplain Acquisition**

Cost Estimate: **$363,636**

Project Score: **255** **Medium Priority**

Problem: Stream survey indicates the presence of 880 feet of good aquatic habitat and good riparian habitat.

Solution: Acquire 880 feet of floodplain corridor along reach HG04 for preservation.

Project Number: **HG-RST05**

Project Name: **Reach HG05 Stream Restoration**

Cost Estimate: **$106,000**

Project Score: **95** **Low Priority**

Problem: Stream survey indicates the presence of 530 of fair aquatic habitat.

Solution: Restore 530 feet of aquatic habitat.

Project Number: **HG-CR06**

Project Name: **Huge Creek/160th St Culvert Replacement**

Cost Estimate: **$60,837**

Project Score: **160** **Medium Priority**

Problem: Existing culvert presents a flood hazard.

Solution: Replace the existing 6’ x 5’ box culvert with a 22 foot long 14’ x 6’ box culvert.

Project Number: **HG-RST06**

Project Name: **Reach HG06 Stream Restoration**

Cost Estimate: **$190,000**

Project Score: **105** **Low Priority**

Problem: Stream survey indicates the presence of 950 feet of poor aquatic habitat.

Solution: Restore 950 feet of aquatic habitat.

Knackstedt Creek

Project Number: **HE-CR01**

Project Name: **Knackstedt Creek/21st Avenue Culvert Replacement**

Cost Estimate: **$52,100**

Project Score: **120** **Low Priority**

Problem: Culvert misalignment is a fish passage barrier.

Solution: Replace 30” diameter culvert with 30’ long 84” diameter culvert for fish passage.

Little Minter Creek Projects:

Project Number: **LM-RST01**

Project Name: **Reach LM01 Stream Restoration**

Cost Estimate: **$744,000**

Project Score: **190** **Medium Priority**

Problem: Stream survey indicates the presence of 1,860 feet of poor aquatic habitat and poor riparian habitat.

Solution: Restore 1,860 feet of aquatic and riparian habitat.

Project Number: **LM-RST02**

Project Name: **Reach LM02 Stream Restoration**

Cost Estimate: **$448,000**

Project Score: **185** **Medium Priority**

Problem: Stream survey indicates the presence of 1,120 feet of poor aquatic habitat and poor riparian habitat.

Solution: Restore 1,120 feet of aquatic and riparian habitat.

Project Number: **LM-RST03**
Project Name: **Reach LM03 Stream Restoration**
Cost Estimate: **$270,000**
Project Score: **115** **Low Priority**

Problem: Stream survey indicates the presence of 1,350 feet of fair aquatic habitat.
Solution: Restore 1,350 feet of aquatic habitat.

Project Number: **LM-RST08**
Project Name: **Reach LM08 Stream Restoration**
Cost Estimate: **$150,000**
Project Score: **150** **Medium Priority**

Problem: Stream survey indicates the presence of 750 feet of poor riparian habitat.
Solution: Restore 750 feet of riparian habitat.

Minter Creek Projects:

Project Number: **MN-RST01**
Project Name: **Reach MN01 Stream Restoration**
Cost Estimate: **$480,000**
Project Score: **185** **Medium Priority**

Problem: Stream survey indicates the presence of 1,200 feet of poor aquatic habitat and poor riparian habitat.
Solution: Restore 1,200 feet of aquatic and riparian habitat.

Project Number: **MN-RST05**

Project Name: **Reach MN05 Stream Restoration**

Cost Estimate: **$200,000**

Project Score: **170** **Medium Priority**

Problem: Stream survey indicates the presence of 1,000 feet of poor riparian habitat.

Solution: Restore 1,000 feet of riparian habitat.

Project Number: **MN-RST07**

Project Name: **Reach MN07 Stream Restoration**

Cost Estimate: **$205,400**

Project Score: **190** **Medium Priority**

Problem: Stream survey indicates the presence of 1,027 feet of poor riparian habitat.

Solution: Restore 1,027 feet of riparian habitat.

Project Number: **MN-RST08**

Project Name: **Reach MN08 Stream Restoration**

Cost Estimate: **$140,600**

Project Score: **150** **Medium Priority**

Problem: Stream survey indicates the presence of 700 feet of fair aquatic habitat and poor riparian habitat.

Solution: Restore 700 feet of riparian habitat.

Project Number: **MN-RST09**

Project Name: **Reach MN09 Stream Restoration**

Cost Estimate: **$1,160,000**

Project Score: **180** **Medium Priority**

Problem: Stream survey indicates the presence of 2,900 feet of poor aquatic habitat and poor riparian habitat.

Solution: Restore 2,900 feet of aquatic and riparian habitat.

Project Number: **MN-RST11**

Project Name: **Reach MN11 Stream Restoration**

Cost Estimate: **$40,000**

Project Score: **150** **Medium Priority**

Problem: Stream survey indicates the presence of 200 feet of fair aquatic habitat and poor riparian habitat.

Solution: Restore 200 feet of riparian habitat.

Purdy Creek Projects:

Project Number: **PR-RST01**

Project Name: **Reach PR01 Stream Restoration**

Cost Estimate: **$60,000**

Project Score: **255** **Medium Priority**

Problem: Stream survey indicates the presence of 300 feet of fair aquatic habitat and poor riparian habitat.

Solution: Restore 300 feet of riparian habitat.

Project Number: **PR-CR02**

Project Name: **Purdy Creek/144th St. Culvert Replacement**

Cost Estimate: **$718,272**

Project Score: **280** **High Priority**

Problem: Existing culvert presents a flood hazard, fish passage barrier, and potential water quality concern since it may be connected to the stormwater system of a gas station.

Solution: Replace 2 existing 48" diameter culverts and 5'x 5' box culvert with one 400' long 10' x 6' box culvert. Realign culvert away from gas station.

Project Number: **PR-RST02**

Project Name: **Reach PR02 Stream Restoration**

Cost Estimate: **$128,000**

Project Score: **230** **Medium Priority**

Problem: Stream survey indicates the presence of 320 feet of fair aquatic and riparian habitat.

Solution: Restore 320 feet of aquatic and riparian habitat.

Project Number: **PR-CR04**

Project Name: **Purdy Creek/62nd Avenue Culvert Replacement**

Cost Estimate: **$85,108**

Project Score: **120** **Low Priority**

Problem: Fish passage barrier due to slope.

Solution: Replace 2-36" diameter culverts with 33' long 14'x4' box culvert.

Project Number: **PR-RST05**

Project Name: **Reach PR05 Stream Restoration**

Cost Estimate: **$138,000**

Project Score: **185** **Medium Priority**

Problem: Stream survey indicates the presence of 690 feet of poor aquatic habitat and poor riparian habitat.

Solution: Restore 690 feet of riparian habitat.

Project Number: **PR-RST06**

Project Name: **Reach PR06 Stream Restoration**

Cost Estimate: **$428,000**

Project Score: **180** **Medium Priority**

Problem: Stream survey indicates the presence of 1,070 feet of fair aquatic habitat and poor riparian habitat.

Solution: Restore 1,070 feet of aquatic and riparian habitat.

Project Number: **PR-CR07**

Project Name: **Purdy Creek/160th Street Culvert Replacement**

Cost Estimate: **$66,200**

Project Score: **130** **Medium Priority**

Problem: Existing culvert presents a flood hazard and a fish passage barrier.

Solution: Replace existing 48” culvert with a 39 foot long 8’ x 6’ box culvert.

Project Number: **PR-RST07**

Project Name: **Reach PR07 Stream Restoration**

Cost Estimate: **$154,000**

Project Score: **185** **Medium Priority**

Problem: Stream survey indicates the presence of 770 feet of fair aquatic habitat.

Solution: Restore 770 feet of aquatic habitat.

Rocky Creek Projects:

Project Number: **RC-AC01**

Project Name: **Reach RC01 Floodplain Acquisition**

Cost Estimate: **$590,909**

Project Score: **265** **High Priority**

Problem: Stream survey indicates the presence of 1,430 feet of good aquatic habitat and good riparian habitat.

Solution: Acquire 1,430 feet of floodplain corridor along reach RC01 for preservation.

Project Number: **RC-AC02**

Project Name: **Reach RC02 Floodplain Acquisition**

Cost Estimate: **$2,014,463**

Project Score: **260** **High Priority**

Problem: Stream survey indicates the presence of 4,875 feet of good aquatic habitat and good riparian habitat.

Solution: Acquire 4,875 feet of floodplain corridor along reach RC02 for preservation.

Project Number: **RC-AC03**

Project Name: **Reach RC03 Floodplain Acquisition**

Cost Estimate: **$1,733,471**

Project Score: **260** **High Priority**

Problem: Stream survey indicates the presence of 4,195 feet of good aquatic habitat and good riparian habitat.

Solution: Acquire 4,195 feet of floodplain corridor along reach RC03 for preservation.

Project Number: **RC-CR03**

Project Name: **Rocky Creek/144th St Culvert Replacement**

Cost Estimate: **$143,388**

Project Score: **120** **Low Priority**

Problem: Existing culvert presents a flood hazard and fish passage barrier.

Solution: Replace existing 7.3’ x 7.7’ box culvert with a 56’ long 12’ x 8’ box culvert.

Project Number: **RC-AC04**

Project Name: **Reach RC04 Floodplain Acquisition**

Cost Estimate: **$1,561,983**

Project Score: **275** **High Priority**

Problem: Stream survey indicates the presence of 3,780 feet of good aquatic habitat and good riparian habitat.

Solution: Acquire 3,780 feet of floodplain corridor along reach RC04 for preservation.

Project Number: **RC-AC05**

Project Name: **Reach RC05 Floodplain Acquisition**

Cost Estimate: **$867,769**

Project Score: **260** **Medium Priority**

Problem: Stream survey indicates the presence of 2,100 feet of good aquatic habitat and good riparian habitat.

Solution: Acquire 2,100 feet of floodplain corridor along reach RC05 for preservation.

Project Number: **RC-AC06**

Project Name: **Reach RC06 Floodplain Acquisition**

Cost Estimate: **$289,256**

Project Score: **265** **High Priority**

Problem: Stream survey indicates the presence of 700 feet of fair aquatic habitat and fair riparian habitat.

Solution: Acquire 700 feet of floodplain corridor along reach RC06 for preservation and restoration.

Project Number: **RC-AC07**

Project Name: **Reach RC07 Floodplain Acquisition**

Cost Estimate: **$826,446**

Project Score: **260** **Medium Priority**

Problem: Stream survey indicates the presence of 2,000 feet of good aquatic habitat and good riparian habitat.

Solution: Acquire 2,000 feet of floodplain corridor along reach RC07 for preservation.

Rocky West Creek Projects:

Project Number: **RW-CR01**

Project Name: **Rocky West/144th St. Culvert Replacement**

Cost Estimate: **$32,951**

Project Score: **145** **Medium Priority**

Problem: Fish passage barrier due to slope and potential flooding.

Solution**:** Replace 36-inch and 18-inch diameter culverts with 20' long 9'x4' box culvert.

Project Number: **RW-RST02**

Project Name: **Reach RW02 Stream Restoration**

Cost Estimate: **$168,000**

Project Score: **190** **Medium Priority**

Problem: Stream survey indicates the presence of 840 feet of poor aquatic habitat and poor riparian habitat.

Solution**:** Restore 840 feet of riparian habitat.

Schoolhouse Creek – Anderson Island Projects:

Project Number: **AI-CR02**

Project Name: **Schoolhouse Creek/Eckenstam-Johnson Rd. Culvert Replacement**

Cost Estimate: **$43,837**

Project Score: **235** **Medium Priority**

Problem: Existing culvert presents a flood hazard and may be a fish passage barrier.

Solution: Replace 2 existing 18" diameter culverts with a 30' long 8' x 4' box culvert..

Project Number: **AI-CR03**

Project Name: **Schoolhouse Creek/Oro Bay Road Culvert Replacement**

Cost Estimate: **$35,070**

Project Score: **240** **Medium Priority**

Problem: Existing culvert presents a flood hazard and a fish passage barrier.

Solution: Replace 2 existing 18” diameter culverts with a 24’ long 8’ x 3’ box culvert..

Project Number: **AI-RST04**

Project Name: **Reach AI04 Stream Restoration**

Cost Estimate: **$128,000**

Project Score: **130** **Medium Priority**

Problem: Stream survey indicates the presence of 640 feet of poor aquatic habitat and poor riparian habitat.

Solution: Restore 640 feet of riparian habitat in reach AI04 of Schoolhouse Creek.

Project Number: **AI-WTRST04**

Project Name: **Oro Bay Wetland Restoration**

Cost Estimate: **$294,400**

Project Score: **225** **Medium Priority**

Problem: 640 feet of estuarine, tidally influenced habitat has been degraded. Identified within the KGI Nearshore Habitat Assessment.

Solution: Restore 640 feet of wetland habitat in reach AI04.

Project Number: **AI-CR08**

Project Name: **Schoolhouse Creek/108th & Eckenstam-Johnson Rd. Culvert Replacement**

Cost Estimate: **$190,500**

Project Score: **135** **Medium Priority**

Problem: Existing culvert presents a fish passage barrier.

Solution: Replace an existing 36” diameter culvert with a 94’ long 10’ x 6’ box culvert.

Project Number: **AI-CR09**

Project Name: **Schoolhouse Creek/Abandoned Logging Rd. North of 108th St. Crossing Culvert Replacement**

Cost Estimate: **$5,000**

Project Score: **90** **Low Priority**

Problem: Fish passage barrier due to slope.

Solution: Remove 12-inch diameter culvert to provide fish passage.

Project Number: **AIT-CR01**

Project Name: **Sandberg Road/Amsterdam Bay Culvert Replacement**

Cost Estimate: **$154,554**

Project Score: **150** **Medium Priority**

Problem: Flooding of roadway.

Solution: Replace existing twin 12-inch diameter culverts with 3 foot by 8 foot three-sided bridge.

Schoolhouse Creek – Key Peninsula Projects:

Project Number: **SC-CR01**
Project Name: **Schoolhouse Creek/Reeves Road Culvert Replacement**
Cost Estimate: **$98,825**
Project Score: **110** **Low Priority**

Problem: Existing culvert presents a fish passage barrier.

Solution: Replace an existing 48” diameter culvert with a 59’ long 8’ x 6’ box culvert.

Project Number: **SC-RST03**
Project Name: **Schoolhouse Creek Reach SC03 Stream Restoration**
Cost Estimate: **$110,000**
Project Score: **165** **Medium Priority**

Problem: Stream survey indicates the presence of 550 feet of poor aquatic habitat and poor riparian habitat.

Solution: Restore 550 feet of riparian habitat in reach SC03 of Schoolhouse Creek.

Project Number: **SCT-CR01**
Project Name: **Schoolhouse Creek/Filucy Bay Tributary/Mahnke Rd./East Reeves Rd./158th Ave. Culvert Replacement**
Cost Estimate: **$123,000**
Project Score: **95** **Low Priority**

Problem: Existing culvert presents a fish passage barrier.

Solution: Replace existing 24-inch culvert with 80’ long 8’x4’ box culvert.

Project Number: **SCT-CR02**

Project Name: **Schoolhouse Creek/Filucy Bay Tributary/Mahnke Rd.,/SE Reeves Rd./158th Ave. Culvert Replacement**

Cost Estimate: **$54,822**

Project Score: **90** **Low Priority**

Problem: Fish passage barrier due to outfall conditions and slope, and flooding.

Solution: Replace existing 12-inch diameter culvert with 43' long 7'x3' box culvert.

Taylor Bay

Project Number: **TB-RST01**

Project Name: **Taylor Bay Reach TB01 Stream Restoration**

Cost Estimate: **$420,000**

Project Score: **165** **Medium Priority**

Problem: Stream survey indicates the presence of 2,100 feet of fair aquatic habitat and good riparian habitat.

Solution: Restore 2,100 feet of aquatic habitat in reach TB01.

Vaughn Creek Projects:

Project Number: **VB-CR01**

Project Name: **South Vaughn Rd. Culvert Replacement and outfall**

Cost Estimate: **$58,482**

Project Score: **165** **Medium Priority**

Problem: Flooding of roadway and downstream properties.

Solution: Replace existing 6-inch CMP pipe with 18-inch diameter culvert and about 100 ft. of 18-inch diameter pipe along South Vaughn Rd. to outfall to Vaughn Bay.

Project Number: **VA-RST01**

Project Name: **Reach VA01 Stream Restoration**

Cost Estimate: **$60,000**

Project Score: **125** **Low Priority**

Problem: Stream survey indicates the presence of 300 feet of fair aquatic habitat and fair riparian habitat.

Solution: Restore 300 feet of aquatic habitat in reach VA01.

Project Number: **VA-RST02**

Project Name: **Reach VA02 Stream Restoration**

Cost Estimate: **$440,000**

Project Score: **175** **Medium Priority**

Problem: Stream survey indicates the presence of 1,100 feet of fair aquatic habitat and riparian habitat.

Solution: Restore 1,100 feet of riparian and aquatic habitat in reach VA02.

Project Number: **VA-AC03**

Project Name: **Reach VA03 Floodplain Acquisition**

Cost Estimate: **$289,300**

Project Score: **260** **High Priority**

Problem: Stream survey indicates the presence of 700 feet of good aquatic habitat and good riparian habitat.

Solution: Acquire 700 feet of floodplain corridor along reach VA03 for preservation.

Project Number: **VA-CR04**

Project Name: **McFadden Road Culvert Replacement**

Cost Estimate: **$146,163**

Project Score: **165** **Medium Priority**

Problem: Flooding of roadway and potential fish passage barrier.

Solution: Replace existing twin 24-inch diameter culverts with 3 ft. x 13 ft. three sided bridge.

Project Number: **VA-WTRST04**

Project Name: **Reach VA04 Wetland Restoration**

Cost Estimate: **$230,000**

Project Score: **225** **Medium Priority**

Problem: Stream survey indicates the presence of 500 feet of degraded wetland habitat.

Solution: Restore 500 feet of wetland habitat associated with reach VA04.

Project Number: **VA-RST04**

Project Name: **Reach VA04 Stream Restoration**

Cost Estimate: **$100,000**

Project Score: **120** **Low Priority**

Problem: Stream survey indicates the presence of 500 feet of fair aquatic habitat and fair riparian habitat.

Solution: Restore 500 feet of aquatic habitat in reach VA04.

Project Number: **VA-AC05**

Project Name: **Reach VA05 Floodplain Acquisition**

Cost Estimate: **$619,800**

Project Score: **270** **High Priority**

Problem: Stream survey indicates the presence of 1,500 feet of good aquatic habitat and good riparian habitat.

Solution: Acquire 1,500 feet of floodplain corridor along reach VA05 for preservation.

Project Number: **VAT-CR01**

Project Name: **Vaughn Creek Tributary/Hall Road Culvert Replacement**

Cost Estimate: **$316,800**

Project Score: **105** **Low Priority**

Problem: Existing culvert is misaligned causing a fish passage barrier.

Solution: Replace existing 36-inch culvert with 110’ long 60-inch diameter culvert.

Project Number: **VAT-FP02**

Project Name: **Vaughn Creek Tributary/Wright-Bliss Rd. Fish Passage Project**

Cost Estimate: **$150,000**

Project Score: **70** **Low Priority**

Problem: Fish passage barrier due to concrete dam.

Solution: Construct new fish ladder to remove fish passage barrier.

Whiteman Creek Projects:

Project Number: **WH-CRNS1**

Project Name: **Whiteman Creek/Bay Road Culvert Replacement (a)**

Cost Estimate: **$125,518**

Project Score: **145** **Medium Priority**

Problem: Existing culvert presents a fish passage barrier.

Solution: Replace an existing culvert with a 40' long 16' x 6' box culvert..

Project Number: **WH-RST01**

Project Name: **Reach WH01 Stream Restoration**

Cost Estimate: **$119,000**

Project Score: **170** **Medium Priority**

Problem: Stream survey indicates the presence of 595 feet of poor aquatic habitat and poor riparian habitat.

Solution: Restore 595 feet of riparian habitat in reach WH01.

Project Number: **WH-WTRST01**

Project Name: **Reach WH01 Wetland Restoration**

Cost Estimate: **$273,700**

Project Score: **220** **Medium Priority**

Problem: Stream survey indicates the presence of 595 feet of degraded estuarine wetland habitat. Identified in KGI Nearshore Habitat Survey.

Solution: Restore 595 feet of wetland habitat associated with reach WH01.

Project Number: **WH-CR02**

Project Name: **Whiteman Cove Road Culvert Replacement**

Cost Estimate: **$119,188**

Project Score: **70** **Low Priority**

Problem: Existing culvert presents a fish passage barrier.

Solution: Replace an existing 36" diameter culvert with a 59' long 10' x 6' box culvert..

Project Number: **WH-CRNS2**

Project Name: **Whiteman Creek/Bay Road Culvert Replacement (b)**

Cost Estimate: **$125,518**

Project Score: **145** **Medium Priority**

Problem: Existing culvert presents a fish passage barrier.

Solution: Replace an existing culvert with a 40' long 16' x 6' box culvert.

Project Number: **WH-CR03**

Project Name: **Whiteman Creek/Whiteman Road Culvert Replacement**

Cost Estimate: **$154,200**

Project Score: **100** **Low Priority**

Problem: Fish passage barrier due to outfall conditions and slope.

Solution: Replace 30-inch diameter culvert with 110' long 72' diameter culvert.

10.3 RECOMMENDED PROGRAMMATIC CHANGES

10.3.1 Programmatic Changes

The Basin Plan recommends 14 programmatic (non-structural) measures. The term "programmatic" relates to a plan of action or procedure for addressing a drainage need or problem. Programmatic measures include such actions as policy guidelines, site design standards, operational policies, technical assistance, enforcement, public outreach, and educational programs. Some of the programmatic recommendations are specific to the Key Peninsula-Islands Basin.

Other programmatic activities would be undertaken with countywide applicability in mind with the Basin paying its share of program costs. The Key Peninsula-Islands Basin contributes 3.48% of the revenue from storm drainage and surface water management fees. All cost estimates are based on a ten-year life cycle. Therefore, the annual costs are 10% of those shown below.

The number of programmatic measures and the high-priority reflects a policy in the *Pierce County Comprehensive Plan* that advocates use of nonstructural solutions to storm drainage problems before committing to hard-engineered solutions. *Pierce County Code 19A.30.220.B.2* states, "Nonstructural measures should be preferred over structural measures." Recommended programmatic measures are as follows:

PG-01 Implement A Low Impact Development Program

Establish and implement a program that would work with development industry, agencies, environmental groups, and communities in the County to actively promote the use of LID in new development and redevelopment. Program activities might include developing standards for use of LID principles in public road construction and reconstruction where it makes sense, initiating and coordinating pilot projects, providing training and technical assistance in the application of LID techniques and principles, investigating regulatory and other barriers to LID and identifying solutions, and educating citizens about LID and its benefits.

Cost Assumption: Includes 0.1 FTE per year in KI Basin only
Cost: $100,000 (10-year costs for KI Basin)
Application: Countywide
Score: 351

PG-02 Increase Inspections For Compliance With Stormwater Requirements and NPDES Permit

Pierce County would increase the inspection of public and private stormwater facilities to ensure compliance with current regulations (including NPDES requirements). Both existing and new stormwater facilities would be inspected to confirm that regular maintenance is occurring and that maintenance standards and agreements are being met. When a violation is identified, inspectors would offer education and technical assistance, but enforcement actions would be taken when necessary.

Cost Assumption:	Includes 6.0 FTEs per year countywide. The estimated costs include funding to support additional inspection staff. Lifecycle cost then prorated for the Key Peninsula-Islands share of the Countywide cost (3.48%).
Cost:	$208,800 (10-year costs for KI Basin)
Application:	Countywide
Score:	403

PG-03 Develop and Implement a Land Management Program for Floodplain Habitat Protection

Water Programs would develop a system for acquiring and managing properties for floodplain, water quality, and habitat protection. The program would have the following elements:

- **Inventory Development:** 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.
- **Acquisition:** Pierce County 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.
- **Management:** 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. Prorated Key Peninsula-Islands share for Countywide cost (3.48%)

Cost:	$9,570 (10-year costs for KI Basin)
Application:	Countywide
Score:	407

PG-04 Develop and Implement Program to Enhance Degraded Riparian Habitat And Water Quality

Build internal capacity to implement restoration and enhancement projects in riparian and wetland areas to improve ecosystem functions, where property owners have given permission and on properties owned by Pierce County Water Programs. Soft bank engineering techniques, such as those contained in the WDFW's Integrated Streambank Protection Guidelines should be developed and enhanced. 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 would form partnerships with volunteer groups and other organizations such as the Pierce Conservation District, and Pierce Stream Team 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 Key Peninsula-Islands share of the Countywide cost (3.48%). The actual site restoration costs are included in the CIP element.
Cost:	$34,500 (10-year costs for KI Basin)
Application:	Countywide
Score:	310

PG-05 Develop and implement an education, outreach, and technical assistance program

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 would include an assistance program to directly aid residents in taking desired actions. This may include supporting volunteer monitoring programs, offering technical and financial assistance to floodplain residents, offering incentives for establishing buffers, and coordinating with other agencies that provide technical support such as the Conservation District. Pierce County may even consider offering financial support and assistance to other programs that support the goals and objectives of the basin plan. Additional incentives might come in the form of free native plants, discounts at local stores, free workshops, tax breaks, or other methods. Pierce County may wish to identify certain staff members to serve as outreach coordinators for specific stream reaches.
- **Coordination:** In order to efficiently communicate Water Programs messages, the education, outreach and other technical assistance program will include a coordination element with other agencies, groups, or jurisdictions. Coordination efforts will include other education providers but also technical staff.

Cost Assumption: Included costs are for 3.0 FTE extended over the 10-year plan lifecycle unless noted. They are prorated to reflect the Key Peninsula-Islands Basin portion (3.48%).
Cost: $104,000 (10-year costs for KI Basin)
Application: Countywide
Score: 388

PG-06 Develop and Implement a Surface Water Quality Monitoring Program

The Monitoring Program 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:** Many water quality monitoring aspects are already included in Pierce County's NPDES permit. However, 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 may wish to 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) developed by Professor Carr at the University of Washington. 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 five years, Pierce County would perform an in-depth analysis of available data and public 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 either continue to train existing staff, hire or consult with identified experts, work with other agency personnel with capable staff, or develop a pool of volunteers that can competently collect data.

Cost Assumption:	Assumes total of 3.75 FTE countywide plus $91,000. Lifecycle cost over 10 years then prorated for the Key Peninsula-Islands share of the Countywide cost (3.48%).
Cost:	$162,000 (10-year costs for KI Basin)
Application:	Countywide
Score:	154

PG-07 Develop and Implement Stormwater Education Program for Shoreline Property Owners

Stormwater from many areas along the coastal bluffs drains directly down the bluffs to Puget Sound. In some cases, development on the bluffs has led to excessive erosion and the creation of gullies. It is recommended that Pierce County educate shoreline residents about the influence of stormwater on erosion and actions they can take to reduce the risk of slope failures. This would occur as part of Water Programs' outreach and education activities.

Cost Assumption:	Cost for Water Programs staff to coordinate educational activities and develop materials over a 10-year period
Cost:	$600,000 (10-year costs for KI Basin)
Application:	Basin-specific
Score:	281

PG-08 Develop and Implement a BMP Manual for Pierce County Water Programs Maintenance Activities

Develop a maintenance manual containing BMPs for Pierce County's stormwater management facilities. The manual would address pond and ditch maintenance activities. The maintenance manual would be patterned after the Tri-County transportation facilities approach and the Pierce County Stormwater Management and Site Development Manual.

The manual would include practices and techniques that protect water quality and habitat while preserving the flood control functions of the facilities. The manual would provide standard operating procedures for work crews. It would also be designed to achieve compliance with Pierce County's NPDES permit.

Distribution of the manual would be accompanied by training sessions on its purpose and use. In the Key Peninsula-Islands Basin, special attention would be paid to ditch system maintenance. BMPs would include guidance on identifying ditches with high erosion risk as well as guidance on selecting and installing appropriate controls for sediment and erosion such as check dams, vegetation, and/or geo-textile fabric.

Cost Assumption:	Includes one-time cost for staff or consultants to conduct study and draft document. Prorated for the Key Peninsula-Islands share of the Countywide cost (3.48%).
Cost:	$71,000 (One-time cost for KI Basin)
Application:	Countywide
Score:	426

PG-09 Provide Technical Assistance to Non-profit Groups Installing Fish-Friendly Culverts

Water Programs would provide engineering and cost estimating assistance to non-profit and volunteer organizations working to replace fish barriers.

Cost Assumption: Includes 0.25 FTE to provide assistance for a 10-year period. Prorated for the Key Peninsula-Islands share of the Countywide cost (3.48%).
Cost: $8,700 (10-year costs for KI Basin)
Application: Countywide
Score: 294

PG-10 Develop and Implement a Habitat Monitoring Program

The purpose of Habitat Monitoring would be to evaluate the effectiveness of habitat improvement projects and to track changes in the original habitat assessments performed for the KI Basin characterization. The habitat monitoring program would reassess the aquatic and riparian habitat every 5 years.

Cost Assumption: Includes one-time cost for professional services to conduct study. Prorated for the Key Peninsula-Islands share of the Countywide cost (3.48%).
Cost: $7,750 (10-year costs for KI Basin)
Application: Countywide
Score: 194

PG-11 Encourage the Installation of Permanent Buffer Markings and/or Signage

This action would include developing an attractive, visible, durable marking system for buffer boundaries. These markers could be used by both private landowners and the county for informational purposes. They should meet the legal requirements for buffer marking but could also be installed voluntarily.

Cost Assumption: Includes one-time cost for staff or consultants to develop the signage format than ongoing costs for installation and maintenance. Prorated for the Key Peninsula-Islands share of the Countywide cost (3.48%).
Cost: $7,750 (One-time cost for KI Basin)
Application: Countywide
Score: 193

PG-12 Establish a Wetlands Banking or Advanced Mitigation Program for Water Programs

This would include creating an inventory and evaluation system for wetlands in Pierce County that could be candidates for acquisition and restoration. A wetland bank for

Water Programs projects would provide two benefits: the protection and restoration of selected wetlands will benefit the Basin by retaining hydraulic functions and preserving aquatic habitat, and restoration of these wetlands can be used as mitigation for capital improvement projects when needed.

Cost Assumption: Includes $300,000 for mitigation bank instrument, $500,000 for site acquisition, and $750,000 for restoration. Prorated for the Key Peninsula-Islands share of the County wide cost (3.48%).
Cost: $50,000 (One-time cost for KI Basin)
Application: County wide
Score: 414

PG-13 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 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 Key Peninsula-Islands share of the Countywide cost (3.48%).
Cost: $7,000 (10-year costs for KI Basin)
Application: Countywide
Score: 285

PG-14 Implement Elements of Shellfish Protection Program

A gap analysis was conducted to evaluate deficiencies in the current program in order to make programmatic recommendations, in an effort to protect shellfish resources, prevent downgrades of shellfish growing areas, and protect and improve water quality. The gap analyzed 11 program components and outline specific programmatic recommendations related to each component. The 11 program components include: education and outreach, information sharing, downgrade prevention, monitoring and sampling, source identification, technical assistance, enforcement, data management and dissemination, financial assistance, legal/regulatory support, and funding. A full memo documenting the results of the gap analysis and proposed recommendations is included in *Appendix M*.

Cost Assumption:	Includes 3.4 FTE and $280,000 per year to support the Water Programs portion of this program over a 10-year period.
Cost:	$6,200,000 (10-year costs for KI Basin)
Application:	Basin-specific
Score:	368

10.4 SUMMARY OF BASIN PLAN RECOMMENDATIONS

The 97 actions recommended in the basin plan are estimated to cost approximately $34,845,000. Of that amount:

- $19,026,000 is for actions identified as High-Priority;
- $13,136,000 is for actions identified as Medium-Priority;
- $2,683,000 is for actions identified as Low-Priority;

Of the total estimated basin plan cost of $34,845,000, about $27,273,500 is for capital improvement projects and $7,571,500 programmatic additions.

10.5 IMPLEMENTATION OF BASIN PLAN RECOMMENDATIONS

10.5.1 Implementation Strategy

In theory, implementation starts with "High-Priority" projects and activities, then "Medium-Priority," followed by "Low-Priority" projects and activities. In practice, the order of project implementation varies to reflect such factors as availability of funds: availability of staff and professional service resources; links to projects with different priorities; cooperation with private landowners; projects completed by agencies other than Pierce County Public Works and Utilities; and new information, new regulations, or new public concerns.

The annual Capital Facilities Element of the *Comprehensive Plan for Pierce County, Washington* reflects the specific annual strategy for CIP's. Programmatic measures and CIP's also appear in the annual budget for Water Programs.

Pierce County Water Programs is primarily the implementer responsible for the recommendations contained in this Basin Plan. Funding of the recommendations is mainly through Pierce County's surface water management fees collected within the Basin, but may also include state and federal grants and other local fund sources. The Key Peninsula-Islands Basin Plan anticipates full implementation over a ten-year period beginning in 2005. Actual duration of full implementation and the timing of specific projects and programs are determined through annual budget decisions of the County Council and County Executive, first in the yearly update of the Capital Facilities Element of the County Comprehensive Plan, and secondly in the operating budget for Pierce County Water Programs.

10.5.2 Preference for Non-Structural Solutions

The 1991 Pierce County Storm Drainage and Surface Water Management Plan and the Capital Facilities Element of the Comprehensive Plan for Pierce County contain the following policy: "Nonstructural measures should be preferred over structural measures". Examples of non-structural solutions and programmatic measures include:

- Adopting an updated *Stormwater Management and Site Development Manual*
- Increasing inspections for compliance with stormwater requirements and NPDES permits
- Requiring flood disclosure statements on property titles
- Upgrading and administering the county's floodplain regulations to address groundwater and pothole flooding

10.5.3 Capital Facilities Element of Pierce County Comprehensive Plan

The annually updated *Capital Facilities Element of the Comprehensive Plan for Pierce County, Washington* (Pierce County Code 19E) is the capital improvement program for Pierce County Water Programs. It lays out the capital projects over $100,000 that Water Programs intends to construct in a six-year period. It also presents the non-capital (non-structural) alternatives that can be used with capital projects to help meet the level of service standard for storm drainage and surface water management facilities. Water Programs has two entries in the Capital Facilities Plan: *19E.50.130, River Improvement Facilities*; and *19E.50.170, Surface Water Management*. The Capital Facilities Plan sets the stage for Water Programs annual budget.

10.5.4 Annual Budget for Pierce County Water Programs

The Pierce County budget each year authorizes the activities of Water Programs. Programmatic measures, studies, and capital improvement projects appear in the detailed annual budget. Capital improvement projects in the annual budget generally come from the Capital Facilities Element of the County's Comprehensive Plan or in response to an unexpected problem.

10.5.5 Order of Implementation

Implementation of the recommended actions will generally follow the prioritization groupings of "High-Priority," "Medium-Priority," and "Low-Priority" in a logical order of sequencing. To realize the full benefits of projects, implementation will not follow the exact progression of the first project to the last project in the High category, followed by the first action in the Medium category, and so forth.

Several factors exist that will result in implementation of actions that are not in the exact order of the recommended actions depicted in *Table 9.2, High-Priority Recommended Projects*; *Table 9.3, Medium-Priority Recommended Projects*; and *Table 9.4, Low-Priority Recommended Projects*. Influencing factors include the following:

- Availability of funds;
- The completion of other projects or activities on which a project relies;
- Available staff and professional services;
- Cooperation from private landowners;
- Identification of a implementing agency other than Pierce County Public Works and Utilities; and
- New information, regulations, or emerging issues.

10.5.6 Economic Development Criteria

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

- Afford resource protection as the community develops
- Preserve, enhance or protect natural floodplain functions
- Balance structural and nonstructural approaches
- Reduce potential County environmental liabilities
- Help achieve environmental compliance and long term sustainability

Collectively, these attributes help make Pierce County a livable community where quality of life issues will provide indirect, passive economic development benefits to businesses and individuals looking to locate or stay in Pierce County.

In addition, 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.

10.5.7 Voluntary Actions by Other Interested Parties

Broad, multi-stakeholder groups such as the Puyallup River Watershed Council can be instrumental in implementation of the Basin Plan. Representatives of environmental interest groups, tribes, business, economic development, and individual citizens provide valuable suggestions about specific activities. Their support of specific activities and the ongoing progress of Basin Plan implementation will be an essential component of successful implementation. For example, these groups can be instrumental in carrying out effective public education.

Businesses in the Basin can be involved in implementation of the Basin Plan recommendations. The private sector will need to comply with regulations to protect the water resources and habitat of the Key Peninsula-Islands Basin. Additionally, businesses can be partners in developing creek and natural resource protection strategies, and may also offer funding assistance for individual and/or ongoing watershed activities.

Farmers and other large landowners with extensive property along the creeks can play a critical role in addressing the temperature and sedimentation problems. The establishment and revegetation of riparian buffers is the single most important measure for improving water quality within the Basin.

Table 10-2:
All Projects in KPI Basin Plan Sorted by Priority and Cost

Row #	Priority	Subbasin	Number/Code	Type	Location/Name	Estimated Cost ($)	Score
1	High	Basin-wide	PG-13	Programmatic	Invasive Species	$ 7,000	285
2	High	Basin-wide	PG-09	Programmatic	Tech Assistance	$ 8,700	294
3	High	Basin-wide	PG-03	Programmatic	Land Management	$ 9,570	407
4	High	Basin-wide	PG-04	Programmatic	Restoration Program	$ 34,500	310
5	High	Basin-wide	PG-12	Programmatic	Wetlands Banking	$ 50,000	414
6	High	Basin-wide	PG-08	Programmatic	BMP Manual	$ 71,000	426
7	High	Basin-wide	PG-01	Programmatic	LID	$ 100,000	351
8	High	Basin-wide	PG-05	Programmatic	Education & Outreach	$ 104,000	388
9	High	Basin-wide	PG-02	Programmatic	Inspections	$ 208,800	403
10	High	Vaughn Creek	VA-AC03	Land Acquisition	Reach VA03	$ 289,256	260
11	High	Rocky Creek	RC-AC06	Land Acquisition	Reach RC06	$ 289,256	265
12	High	Huge Creek	HG-AC03	Land Acquisition	Reach HG03	$ 413,223	265
13	High	Rocky Creek	RC-AC01	Land Acquisition	Reach RC01	$ 590,909	265
14	High	Basin-wide	PG-07	Programmatic	Shoreline Education	$ 600,000	281
15	High	East Fork Rocky	EF-AC04	Land Acquisition	Reach EF04	$ 600,000	265
16	High	Vaughn Creek	VA-AC05	Land Acquisition	Reach VA05	$ 619,835	270
17	High	East Fork Rocky	EF-RST04	Stream Restoration	Reach EF04	$ 630,000	270
18	High	Purdy Creek	PR-CR02	Culvert Replacement	144th	$ 718,272	280
19	High	Huge Creek	HG-AC01	Land Acquisition	Reach HG01	$ 1,006,198	285
20	High	Huge Creek	HG-AC02	Land Acquisition	Reach HG02	$ 1,165,289	280
21	High	Rocky Creek	RC-AC04	Land Acquisition	Reach RC04	$ 1,561,983	275
22	High	Rocky Creek	RC-AC03	Land Acquisition	Reach RC03	$ 1,733,471	260
23	High	Rocky Creek	RC-AC02	Land Acquisition	Reach RC02	$ 2,014,463	260
24	High	Basin-wide	PG-14	Programmatic	Shellfish Protection	$ 6,200,000	368
				Total High Priority Projects		**$ 19,025,726**	
25	Medium	Basin-wide	PG-10	Programmatic	Habitat Monitoring	$ 7,750	194
26	Medium	Basin-wide	PG-11	Programmatic	Buffer Signs	$ 7,750	193
27	Medium	Dutcher Creek	DU-CR06	Culvert Replacement	70th Street	$ 18,672	140
28	Medium	Rocky West	RW-CR01	Culvert Replacement	144th St.	$ 32,951	145
29	Medium	Schoolhouse Ck.	AI-CR03	Culvert Replacement	Oro Bay Road	$ 35,070	240
30	Medium	Minter Creek	MN-RST11	Stream Restoration	Reach MN11	$ 40,000	150
31	Medium	Schoolhouse Ck.	AI-CR02	Culvert Replacement	Eckenstam Johnson Road,	$ 43,837	235
32	Medium	Vaughn Creek	VB-CR02	Culvert Replacement	South Vaughn Rd.	$ 58,482	165
33	Medium	Purdy Creek	PR-RST01	Stream Restoration	Reach PR01	$ 60,000	255
34	Medium	Huge Creek	HG-CR06	Culvert Replacement	160th St.	$ 60,837	160

Table 10-2:
All Projects in KPI Basin Plan Sorted by Priority and Cost

Row #	Priority	Subbasin	Number/Code	Type	Location/Name	Estimated Cost ($)	Score
35	Medium	Purdy Creek	PR-CR07	Culvert Replacement	160th St.	$ 66,198	130
36	Medium	Dutcher Creek	DU-FP01	Fish Passage	Lackey Road	$ 81,000	140
37	Medium	Schoolhouse KPI	SC-RST03	Stream Restoration	Reach SC03	$ 110,000	165
38	Medium	Whiteman Crk.	WH-RST01	Stream Restoration	Reach WH01	$ 119,000	170
39	Medium	Whiteman Creek	WH-CRNS1	Culvert Replacement	Bay Road	$ 125,518	145
40	Medium	Whiteman Creek	WH-CRNS2	Culvert Replacement	Bay Road	$ 125,518	145
41	Medium	Purdy Creek	PR-RST02	Stream Restoration	Reach PR02	$ 128,000	230
42	Medium	Schoolhouse AI	AI-RST04	Stream Restoration	Reach AI04	$ 128,000	130
43	Medium	Purdy Creek	PR-RST05	Stream Restoration	Reach PR05	$ 138,000	185
44	Medium	Minter Creek	MN-RST08	Stream Restoration	Reach MN08	$ 140,600	150
45	Medium	Dutcher Creek	DU-CR04	Culvert Replacement	Lackey Road	$ 142,158	155
46	Medium	Vaughn Creek	VA-CR04	Culvert Replacement	McFadden Rd.	$ 146,163	165
47	Medium	Little Minter	LM-RST08	Stream Restoration	Reach LM08	$ 150,000	150
48	Medium	Purdy Creek	PR-RST07	Stream Restoration	Reach PR07	$ 154,000	185
49	Medium	Amsterdam Bay	AIT-CR01	Culvert Replacement	Sandberg Rd.	$ 154,554	150
50	Medium	Basin-wide	PG-06	Programmatic	WQ Monitoring	$ 162,000	154
51	Medium	Rocky West	RW-RST02	Stream Restoration	Reach RW02	$ 168,000	190
52	Medium	Schoolhouse Ck.	AI-CR08	Culvert Replacement	Eckenstam Johnson Road	$ 190,452	135
53	Medium	Minter Creek	MN-RST05	Stream Restoration	Reach MN05	$ 200,000	170
54	Medium	Home Creek	HM-RST01	Stream Restoration	Reach HM01	$ 200,000	130
55	Medium	Minter Creek	MN-RST07	Stream Restoration	Reach MN07	$ 205,400	190
56	Medium	Vaughn Creek	VA-WTRST04	Wetland Restoration	Reach VA04	$ 230,000	225
57	Medium	Whiteman Crk.	WH-WTRST01	Wetland Restoration	Reach WH01	$ 273,700	220
58	Medium	Schoolhouse AI	AI-WTRST04	Wetland Restoration	Reach AI04	$ 294,400	225
59	Medium	Huge Creek	HG-AC04	Land Acquisition	Reach HG04	$ 363,636	255
60	Medium	Taylor Bay	TB-RST01	Stream Restoration	Reach TB01	$ 420,000	165
61	Medium	Herron Lake	HL-RST01	Stream Restoration	Reach HL01	$ 420,000	135
62	Medium	Purdy Creek	PR-RST06	Stream Restoration	Reach PR06	$ 428,000	180
63	Medium	Vaughn Creek	VA-RST02	Stream Restoration	Reach VA02	$ 440,000	175
64	Medium	Little Minter	LM-RST02	Stream Restoration	Reach LM02	$ 448,000	185
65	Medium	Minter Creek	MN-RST01	Stream Restoration	Reach MN01	$ 480,000	185
66	Medium	Huge Creek	HG-RST01	Stream Restoration	Reach HG01	$ 487,000	225
67	Medium	East Fork Rocky	EF-AC02	Land Acquisition	Reach EF02	$ 516,529	255
68	Medium	East Fork Rocky	EF-AC03	Land Acquisition	Reach EF03	$ 626,033	245
69	Medium	East Fork Rocky	EF-AC01	Land Acquisition	Reach EF01	$ 710,744	255
70	Medium	Little Minter	LM-RST01	Stream Restoration	Reach LM01	$ 744,000	190

Table 10-2:
All Projects in KPI Basin Plan Sorted by Priority and Cost

Row #	Priority	Subbasin	Number/Code	Type	Location/Name	Estimated Cost ($)	Score
71	Medium	Rocky Creek	RC-AC07	Land Acquisition	Reach RC07	$ 826,446	260
72	Medium	Rocky Creek	RC-AC05	Land Acquisition	Reach RC05	$ 867,769	260
73	Medium	Minter Creek	MN-RST09	Stream Restoration	Reach MN9	$ 1,160,000	180
				Total Medium Priority Projects		**$ 13,136,167**	
74	Low	Schoolhouse Ck.	AI-CR09	Culvert Replacement	Logging Rd. N. of 108th	$ 5,000	90
75	Low	Dutcher Creek	DU-CR05	Culvert Replacement	68th Street	$ 5,000	65
76	Low	Knackstedt Creek	HE-CR01	Culvert Replacement	21st Avenue	$ 52,099	120
77	Low	Devil's Head	DHT-CR01	Culvert Replacement	88th Street	$ 54,369	80
78	Low	Schoolhouse KP	SCT-CR02	Culvert Replacement	Mahnke Rd., Filucy Bay	$ 54,822	90
79	Low	Vaughn Creek	VA-RST01	Stream Restoration	Reach VA01	$ 60,000	125
80	Low	Glen Cove	GCT-CR02	Culvert Replacement	Thomas Rd.	$ 69,336	70
81	Low	Glen Cove	GCT-CR01	Culvert Replacement	Thomas Rd.	$ 81,672	70
82	Low	Filucy Bay	FBT-CR02	Culvert Replacement	South of 56th St	$ 82,377	125
83	Low	Purdy Creek	PR-CR04	Culvert Replacement	62nd Avenue	$ 85,108	120
84	Low	Filucy Bay	FBT-CR01	Culvert Replacement	Erickson Rd.	$ 91,692	115
85	Low	Schoolhouse Ck.	SC-CR01	Culvert Replacement	East of KP Hwy, west of	$ 98,825	110
86	Low	Vaughn Creek	VA-RST04	Stream Restoration	Reach VA04	$ 100,000	120
87	Low	Huge Creek	HG-RST05	Stream Restoration	Reach HG05	$ 106,000	95
88	Low	Whiteman Creek	WH-CR02	Culvert Replacement	Whiteman Cove Road	$ 119,188	70
89	Low	Home Creek	HM-RST02	Stream Restoration	Reach UC01	$ 120,000	120
90	Low	Schoolhouse KP	SCT-CR01	Culvert Replacement	Mahnke Rd., Filucy Bay	$ 122,974	95
91	Low	Rocky Creek	RC-CR03	Culvert Replacement	144th St.	$ 143,388	120
92	Low	Herron Lake Creek	HL-FP01	Fish Passage	Mouth of creek	$ 150,000	70
93	Low	Vaughn Creek	VAT-FP02	Fish Passage	Wright-Bliss Rd.	$ 150,000	70
94	Low	Whiteman Creek	WH-CR03	Culvert Replacement	Whiteman Road	$ 154,200	100
95	Low	Huge Creek	HG-RST06	Stream Restoration	Reach HG06	$ 190,000	105
96	Low	Little Minter	LM-RST03	Stream Restoration	Reach LM03	$ 270,000	115
97	Low	Vaughn Creek	VAT-CR01	Culvert Replacement	Hall Rd.	$ 316,755	105
				Total Low Priority Projects		**$ 2,682,805**	
				Total - All Projects		**$ 34,844,698**	

Table 10-3:
Key Peninsula Islands Basin Plan CIPs Grouped by Stream

Priority	Score	Subbasin	CIP name	CIP	Location	Estimated Cost ($)	Reach Subtotal
DEVIL's HEAD							
Low	80	Devil's Head	DHT-CR01	Culvert Replacement	88th Street	$ 54,369	$ 54,369
Stream Average Priority	**80**	**Devil's Head Total**					**$ 54,369**
DUTCHER CREEK							
Medium	140	Dutcher Creek	DU-FP01	Fish Passage Project	West of Lackey Road	$ 81,000	$ 81,000
Medium	155	Dutcher Creek	DU-CR04	Culvert Replacement	Lackey Road	$ 142,158	$ 142,158
Low	65	Dutcher Creek	DU-CR05	Culvert Replacement	68th Street	$ 5,000	$ 5,000
Medium	140	Dutcher Creek	DU-CR06	Culvert Replacement	70th Avenue	$ 18,672	$ 18,672
Stream Average Priority	**125**	**Dutcher Creek Total**					**$ 246,830**
EAST FORK ROCKY CREEK							
Medium	255	East Fork Rocky	EF-AC01	Land Acquisition	Reach EF01	$ 710,744	$ 710,744
Medium	255	East Fork Rocky	EF-AC02	Land Acquisition	Reach EF02	$ 516,529	$ 516,529
Medium	245	East Fork Rocky	EF-AC03	Land Acquisition	Reach EF03	$ 626,033	$ 626,033
High	270	East Fork Rocky	EF-RST04	Stream Restoration	Reach EF04	$ 630,000	
High	265	East Fork Rocky	EF-AC04	Land Acquisition	Reach EF04	$ 600,000	$ 1,230,000
Stream Average Priority	**258**	**East Fork Rocky Total**					**$ 3,083,306**
FILUCY BAY							
Low	115	Filucy Bay	FBT-CR01	Culvert Replacement	Erickson Road	$ 91,692	$ 91,692
Low	125	Filucy Bay	FBT-CR02	Culvert Replacement	South of 56th St.	$ 82,377	$ 82,377
Stream Average Priority	**120**	**Filucy Bay**					**$ 174,069**

Table 10-3:
Key Peninsula Islands Basin Plan CIPs Grouped by Stream

Priority	Score	Subbasin	CIP name	CIP	Location	Estimated Cost ($)	Reach Subtotal
GLEN COVE							
Low	70	Glen Cove	GCT-CR01	Culvert Restoration	Thomas Road	$ 81,672	$ 81,672
Low	70	Glen Cove	GCT-CR02	Culvert Restoration	Thomas Road	$ 69,336	$ 69,336
Stream Average Priority	**70**						**$ 151,008**
HERRON LAKE CREEK							
Medium	135	Herron Lake	HL-RST01	Stream Restoration	Reach HL01	$ 420,000	$ 420,000
Low	70	Herron Lake	HL-FP01	Fish Passage Project	Mouth of Herron Lake Cr.	$ 150,000	$ 150,000
Stream Average Priority	**103**	**Herron Lake Total**					**$ 570,000**
HOME CREEK							
Medium	130	Home Creek	HM-RST01	Stream Restoration	Reach HM01	$ 200,000	$ 200,000
Low	120	Home Creek	HM-RST02	Stream Restoration	Creek #150043	$ 120,000	$ 120,000
Stream Average Priority	**125**	**Home Creek Total**					**$ 320,000**
HUGE CREEK							
High	285	Huge Creek	HG-AC01	Land Acquisition	Reach HG01	$ 1,006,198	
Medium	225	Huge Creek	HG-RST01	Stream Restoration	Reach HG01	$ 487,000	$ 1,493,198
High	280	Huge Creek	HG-AC02	Land Acquisition	Reach HG02	$ 1,165,289	$ 1,165,289
High	265	Huge Creek	HG-AC03	Land Acquisition	Reach HG03	$ 413,223	$ 413,223
Medium	255	Huge Creek	HG-AC04	Land Acquisition	Reach HG04	$ 363,636	$ 363,636
Low	95	Huge Creek	HG-RST05	Stream Restoration	Reach HG05	$ 106,000	$ 106,000
Medium	160	Huge Creek	HG-CR06	Culvert Replacement	160th St.	$ 60,837	
Low	105	Huge Creek	HG-RST06	Stream Restoration	Reach HG06	$ 190,000	$ 250,837
Stream Average Priority	**209**	**Huge Creek Total**					**$ 3,792,183**

Table 10-3:
Key Peninsula Islands Basin Plan CIPs Grouped by Stream

Priority	Score	Subbasin	CIP name	CIP	Location	Estimated Cost ($)	Reach Subtotal
KNACKSTEDT CREEK							
Low	120	Knackstedt Creek	HE-CR01	Culvert Replacement	21St. Avenue	$ 52,099	$ 52,099
Stream Average Priority	**120**	**Knackstedt Creek Total**					**$ 52,099**
LITTLE MINTER CREEK							
Medium	190	Little Minter	LM-RST01	Stream Restoration	Reach LM01	$ 744,000	$ 744,000
Medium	185	Little Minter	LM-RST02	Stream Restoration	Reach LM02	$ 448,000	$ 448,000
Low	115	Little Minter	LM-RST03	Stream Restoration	Reach LM03	$ 270,000	$ 270,000
Medium	150	Little Minter	LM-RST08	Stream Restoration	Reach LM08	$ 150,000	$ 150,000
Stream Average Priority	**160**	**Little Minter Creek Total**					**$ 1,612,000**
MINTER CREEK							
Medium	185	Minter Creek	MN-RST01	Stream Restoration	Reach MN01	$ 480,000	$ 480,000
Medium	170	Minter Creek	MN-RST05	Stream Restoration	Reach MN05	$ 200,000	$ 200,000
Medium	190	Minter Creek	MN-RST07	Stream Restoration	Reach MN07	$ 205,400	$ 205,400
Medium	150	Minter Creek	MN-RST08	Stream Restoration	Reach MN08	$ 140,600	$ 140,600
Medium	180	Minter Creek	MN-RST09	Stream Restoration	Reach MN9	$ 1,160,000	$ 1,160,000
Medium	150	Minter Creek	MN-RST11	Stream Restoration	Reach MN11	$ 40,000	$ 40,000
Stream Average Priority	**171**	**Minter Creek Total**					**$ 2,226,000**
PURDY CREEK							
Medium	255	Purdy Creek	PR-RST01	Stream Restoration	Reach PR01	$ 60,000	$ 60,000
Medium	230	Purdy Creek	PR-RST02	Stream Restoration	Reach PR02	$ 128,000	
High	280	Purdy Creek	PR-CR02	Culvert Replacement	144th	$ 718,272	$ 846,272
Low	120	Purdy Creek	PR-CR04	Culvert Replacement	62nd Avenue	$ 85,108	$ 85,108
Medium	185	Purdy Creek	PR-RST05	Stream Restoration	Reach PR05	$ 138,000	$ 138,000
Medium	180	Purdy Creek	PR-RST06	Stream Restoration	Reach PR06	$ 428,000	$ 428,000
Medium	185	Purdy Creek	PR-RST07	Stream Restoration	Reach PR07	$ 154,000	
Medium	130	Purdy Creek	PR-CR07	Culvert Replacement	160th St.	$ 66,198	$ 220,198
Stream Average Priority	**196**	**Purdy Creek Total**					**$ 1,777,578**

Table 10-3:
Key Peninsula Islands Basin Plan CIPs Grouped by Stream

Priority	Score	Subbasin	CIP name	CIP	Location	Estimated Cost ($)	Reach Subtotal
ROCKY CREEK							
High	265	Rocky Creek	RC-AC01	Land Acquisition	Reach RC01	$ 590,909	$ 590,909
High	260	Rocky Creek	RC-AC02	Land Acquisition	Reach RC02	$ 2,014,463	$ 2,014,463
High	260	Rocky Creek	RC-AC03	Land Acquisition	Reach RC03	$ 1,733,471	
Low	120	Rocky Creek	RC-CR03	Culvert Replacement	144th St.	$ 143,388	$ 1,876,859
High	275	Rocky Creek	RC-AC04	Land Acquisition	Reach RC04	$ 1,561,983	$ 1,561,983
Medium	260	Rocky Creek	RC-AC05	Land Acquisition	Reach RC05	$ 867,769	$ 867,769
High	265	Rocky Creek	RC-AC06	Land Acquisition	Reach RC06	$ 289,256	$ 289,256
Medium	260	Rocky Creek	RC-AC07	Land Acquisition	Reach RC07	$ 826,446	$ 826,446
Stream Average Priority	**246**	**Rocky Creek Total**					**$ 8,027,685**
ROCKY WEST CREEK							
Medium	145	Rocky West	RW-CR01	Culvert Replacement	144th St.	$ 32,951	$ 32,951
Medium	190	Rocky West	RW-RST02	Stream Restoration	Reach RW02	$ 168,000	$ 168,000
Stream Average Priority	**168**	**Rocky West Total**					**$ 200,951**
SCHOOLHOUSE CREEK and AMSTERDAM BAY-ANDERSON ISLAND							
Medium	235	Schoolhouse (AI)	AI-CR02	Culvert Replacement	Eckenstam Johnson Road,	$ 43,837	$ 43,837
Medium	240	Schoolhouse (AI)	AI-CR03	Culvert Replacement	Oro Bay Road	$ 35,070	$ 35,070
Medium	225	Schoolhouse (AI)	AI-WTRST04	Wetland Restoration	Reach AI04	$ 294,400	
Medium	130	Schoolhouse (AI)	AI-RST04	Stream Restoration	Reach AI04	$ 128,000	$ 422,400
Medium	135	Schoolhouse (AI)	AI-CR08	Culvert Replacement	Eckenstam Johnson Road and 108th St.	$ 190,452	$ 190,452
Low	90	Schoolhouse (AI)	AI-CR09	Culvert Replacement	Abandoned logging road north of 108th St.	$ 5,000	$ 5,000
Medium	150	Amsterdam Bay	AIT-CR01	Culvert Replacement	Sandberg Rd.	$ 154,554	$ 154,554
Stream Average Priority	**176**	**Schoolhouse Creek (AI) Total**					**$ 851,313**

Table 10-3:
Key Peninsula Islands Basin Plan CIPs Grouped by Stream

Priority	Score	Subbasin	CIP name	CIP	Location	Estimated Cost ($)	Reach Subtotal
SCHOOLHOUSE CREEK-KEY PENINSULA							
Low	110	Schoolhouse (KP)	SC-CR01	Culvert Replacement	East of KP Hwy, west of 148th Ave, on Reeves Rd.	$ 98,825	$ 98,825
Medium	165	Schoolhouse (KP)	SC-RST03	Stream Restoration	Reach SC03	$ 110,000	$ 110,000
Low	95	Schoolhouse (KP)	SCT-CR01	Culvert Replacement	Mahnke Road, Trib. to Filucy Bay	$ 122,974	
Low	90	Schoolhouse (KP)	SCT-CR02	Culvert Replacement	Mahnke Road, Trib. to Filucy Bay	$ 54,822	$ 177,796
Stream Average Priority	**115**	**Schoolhouse (KP) Total**					**$ 386,621**
TAYLOR BAY							
Medium	165	Taylor Bay	TB-RST01	Stream Restoration	Reach TB01	$ 420,000	$ 420,000
Stream Average Priority	**165**	**Taylor Bay Total**					**$ 420,000**
VAUGHN CREEK							
Low	125	Vaughn Creek	VA-RST01	Stream Restoration	Reach VA01	$ 60,000	$ 60,000
Medium	175	Vaughn Creek	VA-RST02	Stream Restoration	Reach VA02	$ 440,000	$ 440,000
High	260	Vaughn Creek	VA-AC03	Land Acquisition	Reach VA03	$ 289,256	$ 289,256
Medium	165	Vaughhn Creek	VA-CR04	Culvert Replacement	McFadden Rd.	$ 146,163	
Medium	225	Vaughn Creek	VA-WTRST04	Wetland Restoration	Reach VA04	$ 230,000	
Low	120	Vaughn Creek	VA-RST04	Stream Restoration	Reach VA04	$ 100,000	$ 476,163
High	270	Vaughn Creek	VA-AC05	Land Acquisition	Reach VA05	$ 619,835	$ 619,835
Low	105	Vaughn Creek - Tributary to Vaughn Bay	VAT-CR01	Culvert Replacement	Hall Road	$ 316,755	
Low	70	Vaughn Creek - Tributary to Vaughn Bay	VAT-FP02	Fish Passage Project	Wright-Bliss Rd.	$ 150,000	$ 466,755
Medium	165	Vaughn Bay	VB-CR01	Culvert Replacement	South Vaughn Rd.	$ 58,482	$ 58,482
Stream Average Priority	**169**	**Vaughn Creek Total**					**$ 2,410,491**

Table 10-3:
Key Peninsula Islands Basin Plan CIPs Grouped by Stream

Priority	Score	Subbasin	CIP name	CIP	Location	Estimated Cost ($)	Reach Subtotal
WHITEMAN CREEK							
Medium	145	Whiteman Creek	WH-CRNS1	Culvert Replacement	Bay Road	$ 125,518	
Medium	145	Whiteman Creek	WH-CRNS2	Culvert Replacement	Bay Road	$ 125,518	$ 251,036
Medium	170	Whiteman Crk.	WH-RST01	Stream Restoration	Reach WH01	$ 119,000	
Medium	220	Whiteman Crk.	WH-WTRST01	Wetland Restoration	Reach WH01	$ 273,700	$ 392,700
Low	70	Whiteman Creek	WH-CR02	Culvert Replacement	Whiteman Cove Road	$ 119,188	$ 119,188
Low	100	Whiteman Creek	WH-CR03	Culvert Replacement	Whiteman Road	$ 154,200	$ 154,200
Stream Average Priority	**142**	**Whiteman Creek Total**					**$ 917,124**
				Total - All Projects		**$ 27,273,627**	

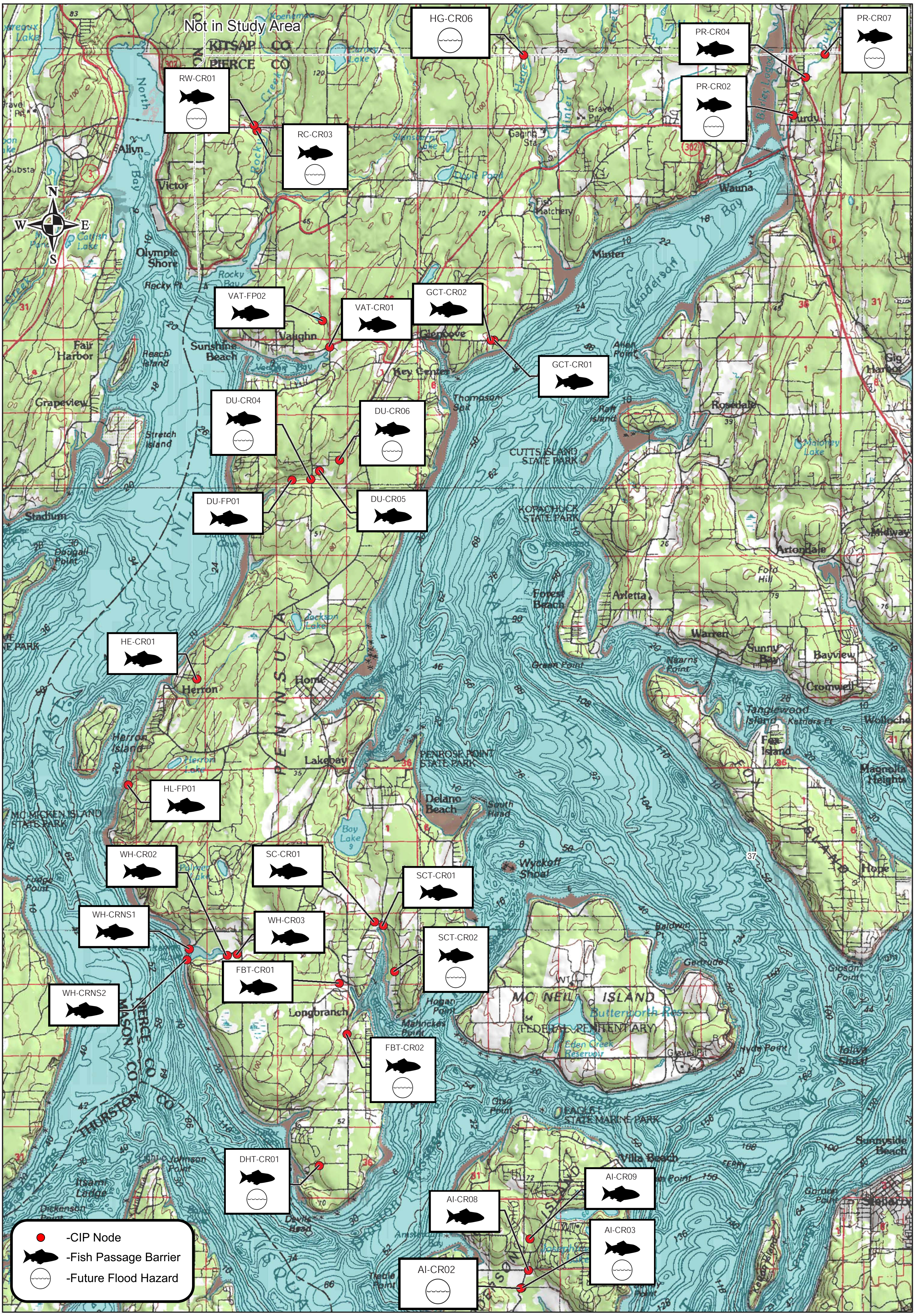

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FIGURE 10 - 1
Culvert Replacement & Fish Passage Projects

Pierce County
Water Programs

0 1 2 3 Miles

KEY PENINSULA - ISLANDS BASIN PLAN
PIERCE COUNTY, WASHINGTON

Pierce County

Department of Planning and Land Services

CHUCK KLEEBERG
Director

2401 South 35th Street
Tacoma, Washington 98409-7460
(253) 798-7210 • FAX (253) 798-3131

June 26, 2006

Dear Interested Party:

Attached is the Final Supplemental Environmental Impact Statement (Final SEIS) for the ***Proposed Key Peninsula – Islands*** (Basin Plan). The Final SEIS revises the Draft Supplemental Environmental Impact Statement (Draft SEIS) in response to comments received during the 30-day comment period. A new section called "Responses to Comments" has been added.

The Pierce County Department of Public Works and Utilities, Water Programs Division (Water Programs), proposes to update the *1991 Pierce County Storm Drainage and Surface Water Management Plan* by adopting a specific plan for unincorporated areas draining to Puget Sound on Key Peninsula, Anderson Island, Raft Island, and Ketron Island. The Proposed Basin Plan evaluates flooding, water quality, aquatic habitat, and other storm drainage-related problems and recommends capital improvement projects and non-structural measures to solve the problems.

This Final SEIS is prepared as a non-project environmental impact statement per Washington Administrative Code, Chapter 197-11-442. The non-project Final SEIS provides a general discussion of the probable significant adverse environmental impacts of implementing the Proposed Basin Plan and the No-Action Alternative. Many proposed actions covered in the Final SEIS will be subject to project-specific environmental review prior to construction or implementation.

There is no comment period for this Final SEIS. An appeal of the adequacy of the Final SEIS may be filed at the Pierce County Development Center, Pierce County Public Services Building, 2401 South 35th Street, Tacoma, WA 98409 by filing a notice of appeal together with an appeal fee of $1,323 by 4:30 p.m. on July 26, 2006. More information on the appeal of a Final SEIS may be obtained at the Development Center.

The Proposed Basin Plan and Final EIS (Chapter 11 of the Plan) are posted on the County's website at www.piercecountywa.org/kibasin. Printed copies of the Proposed Basin Plan and Final SEIS may be purchased for the cost of printing at Pierce County Public Works and Utilities, Environmental Services Building, 9850 64th Street West, University Place, Washington or at the Pierce County Planning and Land Services Department at 2401 South 35th Street, Tacoma, Washington. Copies of the Final SEIS and Proposed Basin Plan can also be reviewed at the following Pierce County Library System libraries: Key Center Library, 8905 Key Peninsula Highway North, Lakebay WA; Anderson Island Library, Anderson Island WA; Peninsula Library, 4424 Point Fosdick Drive NW.

For more information about the Final EIS, call Adonais Clark, Environmental Designee at (253) 798-7165. For questions regarding the Proposed Key Peninsula - Islands Basin Plan, contact Barbara Ann Smolko at (253) 798-6156 or Marsha Huebner, Pierce County Public Works and Utilities, Water Programs Division, at (253) 798-4662.

Sincerely,
CHUCK KLEEBURG
Director

Adonais L Clark

By: Adonais Clark
Environmental Designee

CHAPTER ELEVEN
Final Supplemental Environmental Impact Statement

FINAL

SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

For The

KEY PENINSULA-ISLANDS BASIN PLAN

Prepared in compliance with the State Environmental Policy Act (RCW 43.21C)

June 26, 2006

PIERCE COUNTY
PUBLIC WORKS AND UTILITIES DEPARTMENT
Water Programs Division

Brian Ziegler, P.E., Director
Harold Smelt, P.E, Manager, Water Programs
9850 64th Street West,
University Place, WA 98467-1078

Pierce County

Department of Planning and Land Services
2401 South 35th Street, Tacoma, Washington 98409-7460, (253) 798-7037 fax (253) 798-7425

NOTICE OF AVAILABILITY
June 26, 2006
FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT KEY PENINSULA-ISLANDS BASIN PLAN

A ***Final Supplemental Environmental Impact Statement*** **(Final SEIS)** ***for the Key Peninsula – Islands Basin Plan*** (Basin Plan) is being issued on June 26, 2006, pursuant to the State Environmental Policy Act (Revised Code of Washington 43.21C) and the Pierce County Environmental Regulations (Pierce County Code, Title 18D). The Final SEIS revises the Draft Supplemental Environmental Impact Statement (Draft SEIS) in response to comments received during the 30-day comment period. A new section called "Responses to Comments" has been added.

The Pierce County Department of Public Works and Utilities, Water Programs Division (Water Programs, proposes to update the *1991 Pierce County Storm Drainage and Surface Water Management Plan* by adopted a specific plan for unincorporated areas draining to Puget Sound on Key Peninsula, Raft Island, Anderson Island, and Ketron Island. The Proposed Basin Plan evaluates flooding, water quality, aquatic habitat, and other storm drainage problems and recommends capital improvement projects and nonstructural measures to solve the problems. For questions regarding the Basin Plan, contact Barbara Ann Smolko at 253-798-4662.

The Final SEIS is prepared as a nonproject environmental impact statement per Washington Administrative Code, Chapter 197-11-442. The nonproject Final SEIS provides a general discussion of the probable significant adverse environmental impacts of implementing the Proposed Basin Plan and the No-Action Alternative. Many proposed actions covered in the Final SEIS will be subject to project-specific environmental review prior to construction or implementation.

There is no comment period for the Final SEIS. An appeal of the adequacy of the Final SEIS may be filed at the Pierce County Development Center, 2401 South 35th Street, Tacoma, WA 98409 by filing a notice of appeal together with an appeal fee of $1,323 **by 4:30 p.m. on July 10, 2006**. More information on the appeal of a Final SEIS can be obtained at the Development Center or by calling Adonais Clark, Environmental Designee, at (253) 798-7165.

The Proposed Basin Plan and Final SEIS (Chapter 11 of the Plan) are posted at the County's website at www.piercecountywa.org/kibasin. Printed copies of the Proposed Basin Plan and Final SEIS may be purchased for the cost of printing at Pierce County Public Works and Utilities, Environmental Services Building, 9850 64th Street W, University Place, Washington or at the Pierce County Planning and Land Services Department at 2401 South 35th Street, Tacoma, Washington. Copies of the Final SEIS and Proposed Basin Plan can be reviewed at the following Pierce County Library System libraries: Key Center Library, 8905 Key Peninsula Highway North, Lakebay WA; Anderson Island Library, Anderson Island WA; Peninsula Library, 4424 Point Fosdick Drive NW.

KEY PENINSULA-ISLANDS BASIN PLAN
FINAL SEIS
TABLE OF CONTENTS

FACT SHEET

Title	***Key Peninsula-Islands Basin Plan.***
Description of Proposed Action	Pierce County Public Works and Utilities, Water Programs Division proposes to update the 1991 Storm Drainage and Surface Water Management Plan (1991 Plan) and its capital improvement program by adopting and implementing a basin-specific update for the Key Peninsula-Islands drainage basin. The 1991 Plan has guided the identification, design, construction and implementation of surface water management facilities and surface water policies and programs throughout the County. The proposed Key Peninsula-Islands Basin Plan provides specific strategic direction on solving flooding, water quality, and associated within the Key Peninsula-Islands Basin. The No-Action Alternative would continue the selection of capital projects based on the 1991 Plan or as determined annually. The Final Supplemental Environmental Impact Statement (Final SEIS) adds information to the 1991 *Final Environmental Impact Statement* for the 1991 Plan.
Location of Proposal	Unincorporated Pierce County on the Key Peninsula and on Fox, Raft , Anderson, and Ketron Islands
Proponent	Pierce County Public Works and Utilities, Water Programs Division
Proponent Contact	Barbara Ann Smolko, Senior Planner, (253)-798-6156 or Marsha Huebner, (253) 798-4662 Public Works and Utilities, Water Programs Division 9850 64th Street West, University Place, WA 98467-1078
Lead Agency	Pierce County Planning and Land Services
Responsible Official	Chuck Kleeburg, Director, Pierce County Planning and Land Services
Lead Agency Contact	Adonais Clark Environmental Designee Pierce County Planning and Land Services 2401 South 35th Street Tacoma, WA 98409-7490 (253)798-7210
List of Permits and Approvals Required	County Council approval of an ordinance adopting the Key Peninsula-Islands Basin Plan as an update to the 1991 Storm Drainage and Surface Water Management Plan specific to the Key Peninsula-Islands Basin. Permits for construction in and adjacent to water (e.g., Hydraulic Project Approvals, Section 404 permits, Shoreline Substantial Development Permits) may be required for specific capital projects.

Authors and Principal Contributors	Barbara Ann Smolko, Janine Redmond, Marsha Huebner, Dan Wrye, Ann Rees, Pierce County Water Programs; Ela Whelan, P.E., URS Corporation
Date of DSEIS Issuance	**January 19, 2006**
Written Comments Due	**February 21, 2006**
Date of FSEIS Issuance	**June 26, 2006**
Public Meetings and Hearings	A public hearing was held on February 28, 2006 at 8:30 a.m. before the Pierce County Planning Commission at the Pierce County Public Services Building, 2401 South 35th Street, Tacoma, WA 98409. A public hearing will be conducted by the Economic and Infrastructure Development Committee of the Pierce County Council during the autumn of 2006.
Date of Final Action	Action of the Pierce County Council is expected in autumn of 2006
Subsequent Environmental Review	Project specific environmental review for various construction projects and programmatic actions will be performed when site and implementation alternatives are identified.
Location of original EIS for the 1991 Plan	Pierce County Environmental Services Building 9850 64th Street West, University Place, WA 98467-1078, (253) 798-2725l; or Pierce County Planning and Land Services Department, 2401 S. 35th St., Tacoma, WA, 98409, (253) 798-7210
Cost of FSEIS	This FSEIS may be purchased for the cost of printing at the following location: Pierce County Public Works & Utilities Environmental Services Building 9580 64th Street West University Place, WA 98467-1078 A copy of the Executive Summary may be obtained at no cost from Pierce County Water Programs, (253) 798-2725 The FSEIS, Basin Plan, and other information regarding the Basin Plan are also available at the following internet address: **www.piercecountywa.org/kibasin**

FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

SUMMARY

Pierce County Public Works and Utilities, Water Programs Division (Water Programs) proposes adoption and implementation of the Key Peninsula-Islands Basin Plan (Basin Plan or Plan). If adopted, the Basin Plan will update the County's 1991 Storm Drainage and Surface Water Management Plan (1991 Plan).

The State Environmental Policy Act (SEPA), Chapter 43.21C RCW, requires that an Environmental Impact Statement (EIS) be prepared for proposed actions that could result in probable significant adverse environmental impacts. An EIS was prepared for the original 1991 Plan to provide full disclosure of potential impacts. The EIS compared a No-Action Alternative against the measures identified in the 1991 Plan.

This Final Supplemental EIS (Final SEIS) is prepared for the Key Peninsula-Islands Basin Plan to determine whether substantial changes in County programs resulting from the alternatives would result in "probable significant adverse environmental impacts" and to take into account "significant new information" that has been developed over the past 11 years (WAC 197-11-405(4)).

The FSEIS compares implementation of the Key Peninsula-Islands Basin Plan with a "No-Action" Alternative. The "No-Action" Alternative would be the continued implementation of capital projects based on the 1991 Plan or as otherwise determined annually.

The Basin Plan identifies existing and expected conditions influencing surface water and storm drainage within the Key Peninsula-Islands Basin. The Plan identifies problems, analyzes factors contributing to problems, and identifies and recommends both structural and nonstructural solutions to address the problems.

The Final SEIS is based on information provided in the 1991 Plan EIS. However, because some of the information provided in the 1991 EIS has changed, this Final SEIS provides new and additional information to assess the effects of the Basin Plan. Many potential impacts from 1991 Plan implementation were evaluated within the original 1991 EIS and will not be addressed again here. Copies of the 1991 Storm Drainage and Surface Water Management Plan and the 1991 Environmental Impact Statement are available for review at the Pierce County Water Programs office located at 9850 64th Street West, University Place, WA 98467-1078, 253-798-2725 and at Pierce County Planning and Land Services Department, located at 2401 S. 35th St., Tacoma, WA, 98409, 253-798-7210.

This Final SEIS addresses only the Key Peninsula-Islands Basin Plan. As other basin plans are developed, separate environmental review will occur to evaluate the specific drainage basins.

This Plan is considered a non-project proposal per WAC 197-11-704 and WAC 197-11-774. The environmental review in this Final SEIS is programmatic. Future project-specific SEPA review may be required, as appropriate, as specific recommendations are implemented.

The Key Peninsula-Islands Basin Plan is one of several basin plans Pierce County is preparing to update the 1991 Plan. The 1991 Plan evaluated 26 drainage basins comprising non-federal lands and unincorporated areas of Pierce County. The basins were evaluated at different levels, depending upon whether they were considered urban or rural. The eight urban and urbanizing areas were studied in more detail. The Key Peninsula-Islands Basin was studied as a rural area.

Since the 1991 Plan was prepared, surface water management has increased in complexity. Growth in the County has made development impacts more widespread and obvious. In the early 1990s the State Growth Management Act led to the establishment of "Critical Areas", such as wetlands and streams, a requirement for protection of adjacent buffer areas, and the adoption of the Pierce County Comprehensive Plan. In 2005, land use of the study area was characterized as 36% low-density residential, 19% resource-use, and 29% vacant and/or open space Most of the development consists of residential subdivisions replacing existing vacant areas.

Since 1991, there has been a growing emphasis on the protection of water quality and streams, wetlands and other environmentally sensitive areas. In the mid-1990's, jurisdictions with populations over 100,000, including Pierce County, were required to create stormwater programs under the federal Clean Water Act's National Pollutant Discharge Elimination System (NPDES) program. In the late 1990s, the federal government listed Chinook salmon, bull trout, and other fish species found in Pierce County waters under the "Endangered Species Act." Any adverse impact to a listed species is considered to be significant.

These factors led Water Programs to prepare the Key Peninsula-Islands Basin Plan, along with a number of other basin plans for similar areas. The Basin Plan evaluates current conditions and problems and prioritizes recommended projects. It recommends capital improvement projects and changes in policies and planning efforts needed to meet the requirements of the "Clean Water Act," the "Endangered Species Act", and the "Growth Management Act."

The Key Peninsula-Islands Basin Plan includes both structural and non-structural measures to address flood and drainage problems, improve fish passage, improve water quality conditions, and improve stream and riparian habitat in the basin. Structural measures included in the Basin Plan address flooding and drainage problems, and they improve associated fish passage and water quality conditions in the basin. Non-structural measures are included to improve water quality conditions and improve stream and riparian habitat. Some measures would be implemented as a part of Water Programs' Capital Improvement Program, others as part of the division's maintenance program, through existing plans such as the *Key Peninsula-Gig Harbor-Islands Watershed Characterization and Action Plan*, or by other agencies.

Capital improvement project recommendations in the Basin Plan consist of replacing 27 culverts and constructing three (3) fish passage projects, for a total of 30 projects, including the following:

- 10 culverts that are both flood hazards and fish passage barriers.

- 2 culverts that are potential flood hazards
- 15 culverts and 3 fish passage projects that are primarily fish passage barriers.

Non-structural ("programmatic") recommendations in the Basin Plan include:

- Increased inspections for compliance with stormwater and NPDES permit requirements;
- Implementation of a program to enhance degraded riparian habitat and water quality;
- Implementation of public education, technical assistance and outreach programs;
- Implementation of a low impact development (LID) program;
- Implementation of basin-specific stream protection measures (such as coordination on fencing for livestock, installation of permanent markings for stream buffer areas);
- Implementation of a land management program for floodplain habitat protection;
- Implementation of a shellfish protection program,
- Development and implementation of a surface water quality monitoring program.
- Development and implementation of a stormwater education program for shoreline property owners;
- Development and implementation a best management practices (BMP) manual for Water Programs' maintenance activities;
- Development and implementation of a habitat monitoring program;
- Establishing a wetlands banking or advance mitigation program for Water Programs;
- Provide technical assistance to non-profit groups installing fish passage projects; and
- Development and implementation of an invasive species management program.

Table 11-1 summarizes and compares impacts on environmental elements anticipated from the Proposed Key Peninsula-Islands Basin Plan and the No-Action Alternative.

Table 11-1: Comparison of Impacts

Element	"Proposed Action"	Probable Significant Adverse Environ-mental Impact?	"No-Action" Alternative	Probable Significant Adverse Environ-mental Impact?
Water Resources	• Short-term adverse impacts to water quality may occur, associated with construction of capital improvement projects. Mitigation for these impacts would be in the form of construction-related Best Management Practices to reduce erosion and sediment transport. • Implementation of the KI Plan is expected to result in long-term benefits for water resources.	No	• Flooding problems may continually occur at the undersized culvert locations throughout the Basin, without replacement efforts as identified in the KI Basin Plan. • Long-term adverse impacts to salmonids may occur, as extensive portions of the streams in the Basin could remain inaccessible because of culverts that form fish passage barriers. • Long-term adverse impacts to riparian habitat and water quality could occur without implementation of programmatic measures such as water quality monitoring and increased buffer widths. • Long-term impacts to streamside vegetation could continue with development, despite recently implemented buffer regulations, due to vested rights of developers.	Potential
Fishery Resources	• Short-term, adverse impacts to water quality may occur during construction of culvert replacements and stream restoration projects. Such projects may increase stream sediment loads. Mitigation for these impacts would be in the form of construction-related Best Management Practices to reduce erosion and sediment transport. • Implementation of the KI Plan is expected to result in long-term benefits for fishery resources.	No	• Probable, long-term adverse impacts related to fish migration may occur because there is no assurance of the timely removal of fish passage barriers. • Long-term impacts to streamside vegetation could continue with development, despite recently implemented buffer regulations, due to vested rights of developers. • Long-term, adverse impacts to fish habitat may occur because of the lack of riparian habitat protection and probable, ongoing water quality degradation.	Potential

Element	"Proposed Action"	Probable Significant Adverse Environ-mental Impact?	"No-Action" Alternative	Probable Significant Adverse Environ-mental Impact?
Vegetation	• Existing, low-growth vegetation (e.g. grasses, shrubs) throughout project areas may temporarily be adversely impacted by the movement of equipment and materials during construction of capital improvement projects. • Implementation of the KI Plan is expected to result in long-term benefits for vegetation. When feasible, existing beneficial native vegetation will be left in place and protected during projects. Additional beneficial native vegetation will be added, and non-native vegetation with little or no habitat, cover, or food benefit will be removed.	No	• Long-term impacts to streamside vegetation could continue with development, despite recently implemented buffer regulations, due to vested rights of developers. • Riparian corridor conditions in the Basin may continually degrade because of the lack of protection or improvement of riparian habitat. • Because no activities will specifically target removal of non-native vegetation, long-term adverse impacts related to wildlife habitat, stream cover, and food supply may occur.	Potential
Wildlife	• Short-term, adverse impacts may result from construction activities that temporarily displace wildlife. • Short-term, adverse impacts may result from the removal of invasive and non-native plants species, which could temporarily displace wildlife due to loss of cover. • Implementation of the KI Plan is expected to result in long-term benefits for wildlife.	No	• Over the long-term, wildlife could be adversely impacted by not ensuring protection or improvement of riparian habitat and water quality. • Implementation of ongoing riparian restoration projects (per the Pierce Conservation District's activities) may result in modest improvements to the riparian areas and wildlife habitat.	Potential
Land and Shoreline Use	• No adverse impacts are expected.	No	• No adverse impacts are expected, but continued implementation of 1991 Plan, which pre-dates County Comprehensive Plan, would continue to promote the inherent inconsistencies between the two Plans.	Possible
Aesthetic, Historic & Cultural Resources	• No adverse impacts are expected.	No	• No adverse impacts are expected.	No
Public Services, Utilities, Transportation, and Recreation	• Short-term adverse impacts may occur as a result of construction activities on culverts. Impacts include temporary road and lane closures, which results in potential delays for emergency vehicles. • Implementation of the KI Plan is expected to result in long-term benefits for overall public services.	No	• Flooding problems could occur in the basin at the undersized culverts identified in the basin plan analysis. • Long-term public safety could deteriorate as a result of these potential flooding problems.	Potential
Soils	• There is increased potential for short-term adverse water quality impacts as a result of construction activities that increase instream sediment loads during culvert replacement and stream restoration projects.	No	• No adverse impacts are expected.	No

Element	"Proposed Action"	Probable Significant Adverse Environ-mental Impact?	"No-Action" Alternative	Probable Significant Adverse Environ-mental Impact?
	Mitigation for these impacts would be in the form of construction-related Best Management Practices to reduce erosion and sediment transport. • Implementation of the KI Plan is expected to result in long-term benefits for soils.			
Air Quality	• No adverse impacts are expected.	No	• No adverse impacts are expected.	No

This Final SEIS is a subsection of the overall Key Peninsula-Islands Basin Plan. Because the Plan includes detailed descriptions of the environmental components of the Plan, much of the FSEIS summarizes and/or refers to other sections in the Plan. The Basin Plan is organized as follows.

Chapter 1 contains an introduction to the Basin Planning program, the goals and objectives of the program, and a summary of the report's organization. Chapter 2 provides a description of the regulatory context in which the Basin Plan was prepared including existing and related planning programs. Chapter 3 describes stakeholder involvement in plan preparation.

A description of existing physical, biological, and socioeconomic conditions in the Key Peninsula-Islands Basin is contained in Chapter 4. The chapter describes the environmental resource elements throughout the basin focusing on stream reaches, associated wetlands, sensitive areas, fish habitat, areas of localized flooding, and future land use changes that could increase environmental degradation. Chapter 4 includes a detailed description of surface streams in the basin and their condition as recorded in the course of field surveys conducted in October and November of 2003.

Chapter 5 identifies various problems in the Basin including flooding, poor surface water quality, and degradation of fish and wildlife habitat. Problems are analyzed and conceptual solutions are developed in Chapters 6, 7 and 8. The development of Basin Plan recommendations is described in Chapter 9. Chapter 10 contains the Basin Plan itself.

The elements of the environment sections of the Final SEIS summarize and refer to specific sections of Chapters 4, 5, 6, 7, 8, and 9 where appropriate. Other environmental elements that are not addressed in the Basin Plan are summarized based on the 1991 EIS and updated information. The description of alternatives section in the Final SEIS summarizes and refers to Chapter 10 of the Basin Plan, where appropriate.

Citizens within the Basin provided information for the Plan at public meetings. Concerns about flooding, water quality, and habitat have been incorporated into the format and substance of the Plan's recommended actions.

ALTERNATIVES, INCLUDING THE PROPOSED ACTION

This section describes alternatives to achieve the long-term goals of the Pierce County Storm Drainage and Surface Water Management Plan (1991 Plan). The alternatives evaluated are the **Proposed Action**, adoption of the Basin Plan for the Key Peninsula-Islands Basin, and the **No-Action Alternative**, continued capital project selection based on the 1991 Plan or as otherwise determined annually. This section also provides background on the original 1991 Plan that would be altered by the Key Peninsula-Islands Basin Plan.

Introduction and Background

Background—Pierce County Storm Drainage & Surface Water Management Plan

The Pierce County Council established the County's Surface Water Management Utility in March 1988 by Ordinance 87-205. In 1991, the County adopted the original Stormwater Drainage and Surface Water Management Plan (1991 Plan). The 1991 Plan was intended to provide a comprehensive program for surface water management operations, funded by service charges. The 1991 Plan was also prepared to satisfy Washington State Department of Ecology requirements for a Comprehensive Flood Control Management Plan (WAC 173-145).

The 1991 Plan addressed all 26 of the drainage basins in Pierce County to varying degrees. Urban areas were studied in more detail than rural basins. Eight basins were studied in detail: Gig Harbor, Hylebos Creek, Clear/Clarks Creek, Clover/Steilacoom Creek, Chambers Bay, Tacoma West/Browns-Dash Point, Muck Creek and American Lake.

Non-structural recommendations in the 1991 Plan tend to be broad and county-wide rather than basin or study area specific. The 1991 Plan focused primarily on projects aimed at addressing flooding problems existing at the time. The 1991 Plan recommended specific flooding solution projects for a Capital Improvement Program (CIP). The long-term goals were to be goals for the life of the program. Table 11-2 shows the goals of the 1991 Plan.

Table 11-2: Goals of Pierce County Storm Drainage and Surface Water Management Plan (1991 Plan)

Goal	Description	Objectives
1. Prevent the Loss of Life, the Creation of Public Health or Safety Problems and the Loss or Damage of Public and Private Property	Prevent the loss of life or property due to flooding events.	Nonstructural measures should be preferred over structural measures. Protection of existing facilities and structures should take preference over the protection of undeveloped lands. Land use and related regulations and zoning should reflect the natural constraints of the streams, floodplains, meander zones, and riparian habitat zones. Together, this plan, program and codes should present consistent goals and objectives.
2. Establish and Adopt a Systematic and Comprehensive Approach	Storm water management should occur in the context of an ongoing, systematic and comprehensive approach to solving existing problems and preventing future problems.	Continue the role of the Citizens Advisory Committee or similar body in an advisory role to the Utility. The body should represent the entire County and citizens with a variety or [sic] reasons for their interest in surface water management. Strategies for surface water management should balance engineering, economic, environmental, and social factors in relationship to stated comprehensive planning goals and objective. Public understanding of the various capabilities and limitation associated with storm water management should be improved through a variety of educational efforts. The goals and objectives of the 1991 Plan should be evaluated at regular intervals (i.e., every 5 years) to maintain consistency with other related programs affecting the environment.
3. Minimize Expenditure of Public Funds	The need for emergency measures should be reduced or prevented through planning, and the use of structural and nonstructural measures.	A stable, adequate, and publicly acceptable long-term source of financing should be established and maintained for the Utility and the comprehensive management program.
4. Maintain the Varied Uses of the Existing Natural Drainage System Within the County	Storm water management in Pierce County should occur in the context of the varied uses associated with the natural drainage systems within the County. These include agricultural, commercial, industrial and residential, fish and wildlife habitat, water supply, open space, and recreation.	Storm water management measures should preserve to the fullest extent possible opportunities for other uses. Structural flood control measures should not obstruct fish passage. Structural flood control measures should preserve or enhance existing flow characteristics for fisheries, and other uses of the riparian zone. Flood control activities should not result in a net loss of, or damage to fish and wildlife resources, but wherever possible develop or improve the diversity of habitat.

Goals of Pierce County Storm Drainage and Surface Water Management Plan (1991 Plan) (continued)		
Goal	**Description**	**Objectives**
4. Maintain the Varied Uses of the Existing Natural Drainage System Within the County *(continued)*	Preserve to the fullest extent possible, the scenic, and ecological qualities of the natural drainage system in harmony with those uses which are deemed essential to the life of its citizens, and wherever possible, enhance the instream and riparian uses of the streams, wetland and lakes of Pierce County.	Changes in land use should try to restore the lands natural character to the natural state whenever possible.
5) Prevent the degradation of the quality of both surface water and the water entering the regions aquifers.	Urbanization normally leads to a degradation in the quality of storm water runoff. This can become a problem both for the wildlife which depends on the stream system and the local populace.	The use of the natural drainage system is preferred over the use of pipelines or enclosed detention systems. The preservation of natural wetland, floodplains and streams is to be actively pursued. The County will apply for a NPDES permit and will strive to be in compliance with the requirements for the preservation of water quality. All storm water runoff from impervious surfaces should be treated before it is allowed to enter the natural drainage system, infiltrate into the ground or enter Puget Sound.
6) Coordinate with Public and Private Sectors	Storm water management measures should be compatible with the various public and private sectors affected.	Planning and design/construction of storm water management measures should include opportunity for identification of acceptable storm water management measures. The Citizens Advisory Committee should provide input on existing or pending regulations which are incompatible with the goals of the 1991 Plan. Efforts should be made to work with the Cities towards standardization of regulations which impact storm water management.

Use of 1991 Plan As Principal Focus of CIP Has Evolved

The 1991 Plan has been used as a basis for Capital Improvement Program (CIP) proposals over the years since 1991. Projects are selected every year and adopted by the County Council as part of the County’s six-year Capital Facilities Plan under the County’s Comprehensive Plan. Although many of the projects still come from the original 1991 Plan, there are also many that have been developed as the result of more recent information and that were not contained within the 1991 Plan. Additionally, since the 1991 Plan was developed, the cities of University Place, Lakewood and Edgewood have incorporated. The incorporations eliminated the County’s responsibility for capital projects in those areas. Other cities such as Roy, Bonney Lake, Gig Harbor, and Fife have annexed adjoining areas, reducing the County’s area of jurisdiction. These changes have affected project funding, planning, construction, and maintenance activities.

The 1991 Plan was developed before the adoption of the County Comprehensive Plan, developed pursuant to the Growth Management Act. Zoning and other land use regulations have changed development patterns in some parts of the County, and the future growth estimates used to develop the 1991 CIP list are no longer valid.

Finally, Water Programs has constructed many of the projects proposed as part of the 1991 Plan, while others could not be constructed because development patterns have made acquisition of construction sites prohibitively expensive.

Proposed Action: Basin Plan Alternative

The proposed action is adoption and implementation of theBasin Plan for surface water management of the Key Peninsula-Islands Basin. The Plan documents the existing condition of the basin’s water resources, identifies water resource problems and issues, and recommends a plan to improve conditions in the basin. It includes recommendations for capital projects and programmatic activities to remedy existing problems and to prevent future water resource problems. Plan goals are translated into a comprehensive list of basin needs and action recommendations, including projects, programs, and policies to address the water quality, flooding, and associated habitat problems identified in the Plan.

The Basin Plan would update the 1991 Plan, including the CIP. Projects included in the Basin Plan would supplement and update the 1991 CIP. Programmatic recommendations would augment and/or replace the nonstructural recommendations contained in the 1991 Plan. The Basin Plan will provide guidance for Pierce County’s future Capital Improvement Projects (CIP's), capital expenditures, water resource protection policies, and public education programs in the Key Peninsula-Islands Basin.

The Key Peninsula-Islands Basin Plan includes both structural and non-structural measures to address flood and drainage problems, improve fish passage, improve water quality conditions, and improve stream and riparian habitat in the basin. Structural measures are included in a Capital Improvement Program (CIP) to address flood and drainage problems, improve fish passage, and improve water quality conditions in the basin. Non-structural measures are included to improve water quality conditions and improve stream and riparian habitat. Some measures will be implemented as a part of Water Programs' Capital Facilities Plan (CFP), others may be completed as part of a maintenance program, through the implementation of plans such as the *Key Peninsula-Gig Harbor-Islands Watershed Characterization and Action Plan*, or by other agencies.

The Basin Plan also contains recommendations for public education and opportunities for public involvement. The Plan also provides recommendations for long-term monitoring to document the improvements to habitat and water quality. Finally, the Plan recommends increased compliance assurance activities.

The proposed CFP includes recommendations to replace 30 culverts and to construct three (3) fish passage projects, a total of 33 projects, including the following:

- 10 culverts that are both flood hazards and fish passage barriers
- 5 culverts that are a potential flood hazards
- 15 culverts and 3 fish passage projects that are barriers to fish passage

The Basin Plan identifies the need for specific property acquisition and riparian habitat protection or enhancement activities. Specific needs will be revisited annually, based on monitoring of the effectiveness of proposed actions and existing local land development regulations.

Recommendations for programmatic activities to monitor, protect, and/or improve water quality conditions and stream and riparian habitat are discussed in Section 10.2 of the Basin Plan. Programmatic recommendations include the following activities:

- Increased inspections for compliance with stormwater requirements and NPDES permit;
- Implementation of a program to enhance degraded riparian habitat and water quality;
- Implementation of public education, technical assistance and outreach programs;
- Implementation of a low impact development (LID) program;
- Implementation of basin-specific stream protection measures (such as coordination on fencing for livestock, installation of permanent markings for buffer areas);
- Implementation of a land management program for floodplain habitat protection;
- Implementation of shellfish protection program,
- Development and implementation of a surface water quality monitoring program.
- Development and implementation of a stormwater education program for shoreline property owners;
- Development and implementation a BMP manual for Pierce County Water Programs maintenance activities;
- Development and implementation of a habitat monitoring program;
- Establishing a wetlands banking or advanced mitigation program for Water Programs;
- Provide technical assistance to non-profit groups installing fish passage projects; and
- Development and implementation of an invasive species management program.

Each project in the Basin Plan is rated and assigned a priority rating using standardized criteria. The criteria reflect policies in the 1991 Plan, the Comprehensive Plan for Pierce County, Draft Tri-County proposal for Salmon Habitat Enhancement, and Federal Emergency Management Guidelines. The prioritization involves assignment of points related to the accomplishment of program goals and objectives.

The criteria used to evaluate the assignment of points includes:

- Flood reduction (level and frequency)
- Water quality improvement (source reduction)
- Natural resource improvement (restoration and protection)
- Recreational and multiple use opportunities
- Aesthetics

No-Action Alternative

The No-Action Alternative includes the continued management of stormwater facilities using the 1991 Plan as its guide within unincorporated Pierce County. This includes continuing the activities of the Water Programs Division of the Pierce County Public Works and Utilities Department.

The Water Programs Division would continue to be responsible for planning, design, permitting, and construction of surface water management facilities in unincorporated Pierce County. Included in the Division's responsibilities are compliance with the stormwater quality management requirements of the Clean Water Act, implementation of any watershed action plans for purposes of addressing nonpoint sources of water pollution, preserving existing levels of flood protection through the use of stormwater drainage and flood reduction facilities, stream gauging and water quality monitoring, gathering rainfall data, and emergency response and public education as it relates to stormwater quality and quantity.

There were no specific capital improvement recommendations for the Key Peninsula Islands Basin in the 1991 Plan. However, the 1991 Plan identified a number of non-structural measures to improve storm water and surface water management throughout the County. These include:

- Economic incentives for resource protection
- Floodplain/wetland protection
- Floodproof existing structures
- Relocation of existing structures out of the floodplain
- Public education related to water resource issues
- Property owner purchase of flood insurance
- Land use management techniques, including floodplain zoning ordinances, building codes, clearing and grading ordinances, subdivision ordinances, stormwater management ordinances, and stream corridor density regulation
- Flood warning/preparedness system

Comparison of Alternatives

Table 11-3 summarizes major characteristics of the proposed Key Peninsula-Islands Basin Plan and the No-Action Alternative, referenced by continuing implementation of the 1991 Plan.

Table 11-3
Comparison of Alternatives

Feature	Basin Plan	No-Action Alternative
Flooding Solutions	X	
Water Quality Solutions	X	
Habitat Solutions	X	
Annual Capital Facilities Element	X	X
Comprehensive, strategic	X	
Focus on specific projects	X	X
Focus on basin problems	X	
Countywide programmatic or non-structural solutions		X
Basin-specific programmatic or non-structural solutions	X	
Prioritizes within basin	X	
Prioritizes countywide		X

AFFECTED ENVIRONMENT, SIGNIFICANT IMPACTS, AND MITIGATION MEASURES

This section discusses existing environmental conditions for those elements of the natural and built environment that may be adversely affected by adoption of the Key Peninsula-Islands Basin Plan or the No-Action Alternative. For each of the affected environment subject areas, the significant impacts that are expected to occur and the proposed mitigation measures are discussed.

Water Resources

Affected Environment
Surface water hydrology, surface water quality, groundwater hydrology and groundwater quality in the Key Peninsula-Islands Basin are discussed in detail in Chapter 4, 5, 6, and 7 of the Basin Plan.

The Key Peninsula-Islands Basin is drained by a number of fairly small streams and a few larger streams. The major streams are Huge, Little Minter, Minter, Purdy, Rocky, Burley, East Fork Rocky (Muck), Lackey, Schoolhouse, Dutcher, and Vaughn Creeks. Table 4-1 in the Basin Plan shows the stream names, stream numbers, and stream abbreviations used in the Basin Plan. The catchments of the streams vary in size from a few hundred acres to approximately 12.3 square miles. East Fork Rocky (Muck), Huge, Rocky, Minter, Purdy, and Schoolhouse Creeks drain the largest catchments. The larger creeks are perennial. Most of the land close to the tops of the bluffs drains to small, unnamed, ephemeral creeks which discharge directly to Puget Sound. The characteristics of the stream corridors in the individual basins are discussed in detail in Sections 4.6 through 4.8 of the Basin Plan.

Four types of interrelated water resources problems were identified in the Key Peninsula-Islands Basin: flooding problems, surface water quality problems, degradation of fish and wildlife habitat in stream corridors, and potential conflicts between land use and stream health. Chapter 5 of the Basin Plan provides an overview of the processes used to identify problems in the basin. Chapters 6, 7, and 8 provide detailed analyses of flooding, water quality, and habitat degradation and land use problems in the basin, respectively. A summary of the information in these chapters is provided below.

Flooding
There have been few serious flooding incidents in the Key Peninsula-Islands Basin because of the nature of the terrain and the lack of structures within floodplains. Almost all of the flooding problems that occur under existing conditions are localized and relatively minor. In general, the existing drainage system appears to have sufficient capacity to carry storm water away from structures at the current level of urban development. Most of the reported problems are likely the result of debris accumulating in culverts and ditches and probably could be

solved by improved maintenance. A few problems may be the result of deficiencies in the sizing and capacity of engineered drainage system components, primarily culverts.

Flooding problems may be exacerbated, and new problems may emerge, as development continues. Mathematical models that simulate the hydrology and hydraulics of a watershed were used in the Basin Plan to predict and describe potential future flooding problems. The locations of predicted existing and future flooding problems are shown in Chapter 6.

Due to the topography of the basin, it is expected that if flooding does occur in the future it will most likely be associated with road and driveway culverts because the culverts represent constrictions in the natural drainage system. For the Basin Plan study, modeling was focused on the hydraulic performance of publicly-owned culverts on the major streams that drain the basin. The results of these modeling efforts are described in Chapter 6. As indicated in Table 6-1, the model predicts that existing and future road flooding could occur at 13 of the 27 culverts analyzed. Modeling indicates potential road flooding at 3 of the culverts during the 100-year storm event under future land-use conditions, 4 culverts may cause flooding during the 100-year storm event under existing land-use conditions, another 4 culverts may flood during the 25-year storm event under existing land use conditions, and 2 culverts may flood during the 2-year storm event under existing conditions. Fifteen of the 27 culverts analyzed do not meet Pierce County's current design standards because they would be surcharged to a greater degree than is allowed by the standards during the 100-year event.

Water Quality

Almost all of the available data indicate that water quality in streams in the Key Peninsula-Islands Basin is generally good, with the exception of elevated bacteria levels in some locations. Waters are generally well oxygenated, and water temperature and turbidity are low. Water temperature measurements were taken by grab samples during field data collection in October and November 2003. Data from continuously reading thermographs during 2004 also indicates compliance with water temperature standards. Sources of water quality problems in the Basin are primarily related to human activities, particularly farming and riparian degradation. Much of the land adjacent to streams in the Key-Peninsula Basin is in agricultural use, and livestock typically has direct access to the water while vegetative buffers are typically reduced or eliminated to allow for more farming and grazing area.

The conclusion that freshwater systems in the Key Peninsula-Islands Basin are generally good should be viewed as provisional. Most of the data collected is from sampling locations close to the mouths of the creeks. Water quality could be worse at locations upstream in the watershed.

Macroinvertebrate samples taken in September 2003, and September and October 2004, indicate that while streams have been adversely affected by human activities, many pollution-sensitive macroinvertebrate species are present. This suggests that the streams of the basin are relatively free of toxic substances.

Habitat

Human activity in the Key Peninsula-Islands Basin has degraded the quality of fish and wildlife habitat within stream corridors. The causes of habitat degradation are several and interrelated. They include changes in basin hydrology, loss of riparian vegetation, and creation of barriers to fish passage.

A team of technical specialists assessed the condition of fish habitat and the riparian corridor along the streams of the Key Peninsula-Islands Basin. Approximately 20 miles (110,000 feet) of stream were examined. Aquatic habitat in 72% of the stream miles was rated as in “Good” condition, 14% was rated as in “Fair” condition, and 14% was rated as in “Poor” condition. The riparian corridor in 73% of the stream miles examined was rated as in “Good” condition, 13% was rated as in “Fair” condition, and 14% was rated as in “Poor” condition. The condition of the riparian corridor provides an indication of the value of streamside habitat for amphibians, birds, and mammals.

Of the creeks examined, Kingsman Creek, Lackey Creek, and East Fork Rocky (Muck) Creek are in the overall best condition with 100% of fish habitat and riparian corridor rated in “Good” condition. Other creeks in good condition include Herron Creek (Knackstedt), with more than 90% of aquatic habitat and 100% of the riparian corridor rated in “Good” condition; Rocky Creek, with more than 90% of the aquatic habitat and riparian corridor rated in “Good” condition; and Minter Creek, with more than 80% of aquatic habitat and 70% of the riparian corridor rated in “Good” condition. Rocky Creek has more linear feet of aquatic habitat and riparian corridor in good condition than any other stream in the basin.

There are a number of man-made barriers to fish passage on streams in the Key Peninsula-Islands Basin. Prior to the 1990s, fish passage on small streams was given little consideration. Public and private parties typically used culverts to convey small streams under highway and driveway fills because they were less expensive than fish–friendly bridges would be. Today, many existing road and driveway culverts prevent or hinder the movement of fish from salt water to freshwater and from one stream reach to another. Culverts represent fish barriers because they are typically installed at an improper gradient, designed for too long an expanse, or not large enough to accommodate the stream flow. Barriers to fish passage in the Key Peninsula-Islands Basin were identified by URS stream survey teams and by Pierce Conservation District.

Some creeks in the basin are relatively free of fish passage barriers. East Fork Rocky (Muck) Creek, Lackey Creek, and Taylor Bay Creek are free of barriers. Migrating salmonids can access about 14,000 feet of Minter Creek, 10,500 feet of Rocky Creek and 7,135 feet of Huge Creek before encountering a barrier to upstream movement. In all other creeks surveyed, barriers generally prevent fish obtaining access to any more than the most downstream reaches.

Land use affects both stream health and the extent and frequency of flooding. Each sub-basin in the Key Peninsula-Islands Basin has particular land uses that pose specific problems for stream health. The predominant land use type in the basin is low-density residential use and this will continue to be so in the future. Based on the stream health data gathered as a part of the Basin Plan, stream health appears to be most influenced by conditions in the stream corridor itself, with conditions in the watershed as a whole playing a secondary role.

Significant Impacts to Water Resources and Proposed Mitigation Measures

Proposed Action
The Proposed Action recommends a list of capital improvement projects to improve drainage, fish passage, and water quality in the basin streams. It includes recommendations for 30 construction projects, including replacement of 27 culverts and construction of 3 fish passage projects, 15 culverts and 3 fish passage projects are fish passage barriers, 2 culverts are projected to be a flood hazard, and 10 culverts are both flood hazards and fish passage barriers. Six of these culverts do not meet the County design standard, with headwater-to-diameter ratios ranging from 1.7 to 4.2.

The long-term effects of these projects would be a net improvement in the drainage conditions, fish passage and water quality in the basin. The culvert replacement projects at flood hazard culverts would result in stream crossings that meet current county road standards and substantially reduce the potential for road flooding in the basin. The culvert replacement projects at culverts barring fish passage would significantly increase the habitat accessible to anadromous salmonids and other fish migrating upstream and downstream.

The Key Peninsula-Islands Basin Plan (Basin Plan) also includes recommendations for implementing programmatic measures to encourage private landowners to protect and improve riparian habitat and water quality. In addition, programmatic and capital improvement projects are recommended to implement property acquisition and aquatic and riparian habitat protection or enhancement. These protection and enhancement projects would be completed to improve fish and wildlife habitat and water quality if analyses of basin conditions show that voluntary riparian habitat and water quality protection and improvement measures are not adequately meeting basin needs. Programmatic measures would help ensure that new development abides by recently implemented buffer regulations, minimizing the influence of the vested right of developers. The KI Basin Plan identifies areas where floodplain acquisition and riparian and aquatic habitat protection or enhancement could be undertaken to improve fish and wildlife habitat and water quality. Individually and comprehensively, these projects would improve the riparian corridor, providing additional filtration, sedimentation, and infiltration of runoff from adjacent lands. The effect of the additional sedimentation and filtration would be an improvement of water quality through a reduction in nutrients, pathogens, and sediments reaching the streams.

The tree cover associated with improved riparian corridors would provide shade for the streams, reducing the elevated water temperature experienced in the streams during the warmer days of the summer and early fall. Temperature fluctuations in the streams would also be reduced. The beneficial nutrient, pathogen and sediment reductions would occur in the first several years as the ground cover within the riparian buffer became established. The beneficial stream shading effects would take several decades to take full effect as the planted trees grew to maturity.

A number of short-term adverse effects may occur as a result of construction activities associated with CIP implementation. Instream water quality may be impaired as a result of various construction practices. Construction activities in close proximity to surface water bodies may result in the temporary removal of streamside vegetation, which increases streambank erosion and sediment transport. Culvert replacement would disturb the streambanks and bottom. Stream restoration, streambanks stabilization and riparian revegetation projects would also disturb streams and adjacent areas. Where these disturbed areas come in contact with flowing waters, sediment would be mobilized and quickly carried downstream, temporarily reducing water quality. Subsequent deposition of sediment could also harm fish habitat. Construction sites, regardless of proximity to surface water bodies, are typically a source of elevated sediment loads during rainfall events.

Standard erosion control measures would be implemented during construction activities to avoid serious sedimentation problems. Work adjacent to or within streams will be limited to low flow periods, typically the summertime. Stream flows could be temporarily diverted and pumped around the active project site, avoiding the disturbed areas. Standard erosion control measures such as silt fencing, coverage of exposed earth and permanent seeding of disturbed areas following construction will further reduce temporary sediment and water quality impacts. Each project will be required to meet County construction and erosion control requirements, as well as applicable state and federal requirements. For instance, those projects taking place within a stream must meet the requirements of the State Department of Fish and Wildlife for a Hydraulic Project Approval (HPA). The standard requirements for control of erosion and other construction-related pollutants, such as fuels and lubricants, assure that the water quality impacts will be short-term and not significant.

The public education program recommended in the Basin Plan would raise the level of awareness on the part of residents regarding existing and potential water resources issues in the Key Peninsula-Islands Basin. Residents would also become more aware of the effects that their personal actions can have on the streams, such as landscaping practices. Of particular importance in this basin is the education of rural residential and agricultural property owners to maintain and/or establish riparian corridors to act as buffers alongside streams that flow across their properties. This activity can prevent further degradation of water quality and has the potential to improve water quality if embraced by a substantial portion of the rural population. Enlisting residents to participate in stream and riparian restoration projects is also highly effective as an education tool. Many of the public education programs referenced in the *Key Peninsula-Gig Harbor-Islands (KGI) Watershed Characterization and Action Plan* are also referenced in the Basin Plan.

The Key Peninsula-Islands Basin is just starting the development of a community plan and development regulations to address habitat conservation have recently been adopted for all of Pierce County. Programmatic recommendations in the Key Peninsula-Islands Basin Plan are aimed at assessing the effectiveness of current programs as well as the effectiveness of surface water management structures and impacts on water resources, through a monitoring program. The plan also recommends the implementation of a low-impact development project for the Basin. As a result, water resources are expected to achieve a greater level of protection because of increased water quality and site development compliance assurance and inspection and technical assistance and education activities, as recommended in the plan.

Overall, implementation of the Basin Plan is expected to result in a major long-term benefit to the quality of the water resource conditions within the basin. No unavoidable significant adverse impacts or cumulative adverse impacts to water resources are expected to result from the implementation of the recommendations in the Basin Plan. Short-term impacts would be minor and would last only a short period following construction.

No-Action Alternative

Under the "No-Action" Alternative, stormwater would continue to be managed in the Key Peninsula-Islands Basin as it is today. County efforts would continue to focus on serious drainage complaints rather than adopting a more proactive, comprehensive approach. Periodic maintenance of ditches, culverts and other county drainage facilities by County crews would continue.

Unless other measures are identified and taken to solve existing and potential future problems not identified in the 1991 Plan, the flooding, fish passage, water quality, and riparian habitat degradation problems identified in the Basin Plan may go unsolved. Flooding problems could occur in the basin at the undersized culverts identified in the hydrologic analysis. Extensive portions of the streams in the basin could remain inaccessible to migrating salmonids due to culverts that act as fish passage barriers near the mouths of many of the streams in the basin.

Riparian habitat and water quality throughout the basin could degrade over time without the implementation of the recommended programmatic measures in the Basin Plan. Streamside vegetation loss could continue as development occurs, despite recently implemented buffer width regulations, due to vested rights of developers. The loss of streamside shade, woody debris recruitment and the accelerated input of sediment could continue to result in degraded fish habitat and degraded water quality. Without periodic water quality monitoring and stream surveys conducted as recommended in the Basin Plan, it would be difficult to assess the effectiveness of regulations and programs in protecting or improving water quality and riparian habitat.

Ongoing riparian restoration projects and fish passage barrier removal projects carried out by the Pierce Conservation District (PCD) would be expected to result in modest improvements in water quality and stream accessibility for fish over the long term. Short-term impacts and mitigation measures associated with capital facilities projects listed in the 1991 CIP are similar to those discussed under the Proposed Action.

The No-Action Alternative would result in few major long-term benefits to the quality of the water resource conditions within the basin. No mitigation has been proposed for the adverse impacts that could result from the No-Action Alternative, and over time it is expected that cumulative adverse impacts to water resources would occur.

Fishery Resources

Affected Environment
Fishery resources within the Key Peninsula-Islands Basin are discussed in detail in Chapter 8 of the Basin Plan.

Coho salmon, chum salmon, and cutthroat trout are likely present in all major streams in the Key Peninsula-Islands Basin, based on fieldwork observations made from October to November 2003. In 1999, the Puget Sound Chinook salmon and the bull trout were listed under the "Endangered Species Act." Fishery resources are greatly influenced by a number of anthropogenic factors including the loss of riparian habitat, changes to the aquatic habitat, fish passage barriers, and changes in basin hydrology. Riparian health is directly influenced by the relative amount and condition of vegetated buffer along the stream. Aquatic habitat conditions are impacted by water volume, temperature, water quality, sediment movement and storage, and food resources. Barriers to fish passage prevent migratory species from entering the upper reaches of creeks. Finally, changes in basin hydrology occur with development and increasing impervious surface. As a result of development activities, less water infiltrates, resulting in more runoff and more instream flow potential, and the water that does runoff generally travels much quicker to the discharge location, yielding more peak flow.

Significant Impacts to Fisheries and Proposed Mitigation Measures

Proposed Action
The Proposed Action recommends a list of capital improvement projects (CIP) to improve drainage, fish passage, and water quality in the basin streams. It includes recommendations to replace 27 culverts and construct 3 fish passage improvement projects. A total of 28 of the 30 projects are fish passage barriers.

The long-term effects of these projects would be a net improvement for fish passage and water quality in the basin. The culvert replacement projects at flood hazard culverts would result in stream crossings that meet current county road standards and substantially reduce the potential for road flooding in the basin. The culvert replacement projects at fish passage barrier culverts would result in a significant increase in habitat accessible to anadromous salmonids and other fish migrating upstream and downstream.

During and following construction of the proposed culvert projects, the freshly disturbed stream channel has the potential to transport additional sediment resulting from erosion processes. Erosion would be controlled through the application of BMP's. Using properly implemented and appropriate erosion control BMP's, short-term adverse impacts to fish habitat would be minor. All of the replacement culverts would be designed and constructed to meet fish passage requirements. Their installation would therefore result in a net long-term benefit to fish habitat.

The Basin Plan also includes recommendations for implementing programmatic measures to encourage private landowners to protect and improve riparian habitat and water quality. In addition, programmatic and capital improvement projects are recommended to implement floodplain acquisition and aquatic and riparian habitat protection or enhancement. Programmatic measures would help ensure new development abides by recently implemented buffer regulations, minimizing the influence of the vested right of developers. These protection and enhancement projects would be undertaken to improve fish and wildlife habitat and water quality if analyses of basin conditions show that voluntary riparian habitat and water quality protection and improvement measures are not adequately meeting basin needs. The Basin Plan identifies areas where floodplain acquisition and riparian and aquatic habitat protection or enhancement could be undertaken to improve fish and wildlife habitat and water quality. These projects would protect existing areas of high quality habitat and riparian corridor, as well as improve habitat and the riparian corridor in degraded areas. The beneficial impacts of improving the riparian corridor for water quality purposes were discussed above.

Aquatic habitat improvement and stream enhancement projects would consist of channel enhancement measures such as bank stabilization, large woody debris installation, and channel relocation (meander creation) as necessary. These projects could also include riparian vegetation planting, extending away from the streambanks for a distance of 20-40 feet. The objective of aquatic habitat improvement and stream enhancement is to create complex habitat with adequate pools and riffles in addition to instream vegetative cover in the form of large woody debris and riparian trees. Other benefits include increased shading to reduce peak water temperatures and stream bank stabilization to reduce instream sediment loads, thus improving instream water quality conditions and benefiting fishery resources.

While performing aquatic habitat improvement and stream enhancement projects, there is considerable potential for sediment delivery to streams, in the first few years following construction. Typically, when instream construction is done, flow is diverted around the construction zone. The construction zone would be isolated with upstream and downstream barriers made of sandbags in combination with membrane water barriers. Pumps would typically be employed just downstream of the upstream barrier to insure the effective de-watering of the construction zone. Instream construction is typically performed during the driest months of the year (July, August, and September) to minimize the possibility of flooding the construction area. Construction during this dry-weather period also has the least impact upon resident and migratory fish.

After earthwork is completed, additional BMP's for erosion control would be employed. For instance, jute matting, coir logs, facines, and/or hydroseeding (native wetland mix) would be used. Temporary irrigation may be employed through the summer and fall following construction to ensure a high degree of survival of grass, forbs, shrubs, and tree plantings. All of these additional BMP's are designed to minimize sediment transport. All disturbed stream bottom area would be restored to clean gravel or cobble.

Riparian planting projects differ from stream restoration projects because no disturbance actually occurs within the channel. Typical riparian planting activities include the planting of willow stakes and containerized stock such as Sitka spruce, western hemlock, red cedar, Pacific ninebark, salmonberry, red osier dogwood, and other species. Except for the willows and dogwoods, the remaining species would be planted at or above the ordinary high water mark. As the result of the noninvasive techniques used in riparian plantings, no significant short-term impacts are expected. Over the long term, substantial benefits to fishery habitat would occur. The tree and brush canopy provides cover to reduce the frequency of high summer water temperatures. Eventually, wood would fall into the stream to provide a permanent supply of large woody debris, providing additional habitat for fish species.

No unavoidable significant adverse impacts or cumulative adverse impacts to fishery resources are expected to result from the implementation of the recommendations in the Basin Plan. Implementation of the Basin Plan would result in long-term benefits to fish habitat and habitat accessibility within the Key Peninsula-Islands Basin. Short-term impacts would be minor with mitigation and would last only a short period following construction.

No-Action Alternative

Under the No-Action Alternative, removal of fish passage barriers, riparian habitat protection and improvement, and water quality protection and improvement would continue to be managed in the Key Peninsula-Islands Basin as it is today. County efforts would continue to focus on flooding and drainage complaints and large-scale water quality concerns rather than fish passage and riparian habitat problems.

Ongoing riparian restoration projects and fish passage barrier removal projects carried out by the Pierce Conservation District would be expected to result in modest improvements in water quality, fish habitat and stream accessibility over the long term. However, extensive portions of the streams in the basin could still remain inaccessible to migrating salmonids. Fish habitat and water quality throughout the basin could degrade over time without the implementation of some of the recommended programmatic measures in the Basin Plan. Streamside vegetation loss could continue as development occurs despite buffer regulations, due to vested rights of developers. The loss of streamside shade, woody debris recruitment and the accelerated addition of sediment could continue to result in degraded fish habitat. Without increased inspections, periodic water quality monitoring, and stream surveys conducted as recommended in the Basin Plan, it would be difficult to assess the effectiveness of existing programs in protecting or improving flood hazards, water quality and riparian habitat.

Short-term impacts and mitigation measures associated with capital improvement projects listed in the 1991 CIP are similar to those discussed under the Basin Plan Alternative. No unavoidable significant adverse impacts or cumulative adverse impacts to fishery resources are expected to result from the implementation of the recommendations in the Basin Plan. Implementation of the Basin Plan would result in long-term benefits to fish habitat and habitat accessibility within the Key Peninsula-Islands Basin. Short-term impacts would be minor with mitigation and would last only a short period following construction.

The No-Action Alternative would not result in any significant improvements to fishery resources within the basin and could adversely impact fishery resources by not ensuring timely removal of fish passage barriers and protection or improvement of riparian habitat and water quality. Mitigation measures for short-term impacts associated with construction are similar to those recommended in the Basin Plan.

Vegetation

Affected Environment
Before the arrival of Euro-Americans, the Key Peninsula-Islands Basin was occupied by conifer forest dominated by western hemlock, western red cedar, and Douglas fir. Virtually all of the old growth forest was logged during the nineteenth and twentieth centuries. Now the basin is occupied by unvegetated surfaces and a mosaic of vegetation types including conifer forests of varying age, pasture, shrub-scrub, and non-native plantings around suburban and rural homes. The remaining forest is dominated by stands of less-than one-hundred-year-old Douglas firs, which if left undisturbed will be gradually replaced by western hemlock and western red cedar. Hardwoods are common on recently disturbed sites and in riparian areas. They include red alder, big leaf maple, and willows. Common shrub species include Douglas maple, vine maple, Indian plum, gooseberry, huckleberry, and salmonberry. Salal, sword fern, deer fern, and Oregon grape are common low growing plant species.

The predominant land use type in the basin is low-density residential and this will continue to be so in the future. The other primary current land use categories include vacant and forest-open space. Urban land uses, comprising residential, commercial, industrial, institutional, and transportation uses, currently occupy 51% of the land surface. In the future, urban uses are estimated to occupy 80% of the land surface. The existing development of the basin has resulted in loss of vegetation in forested areas and along riparian corridors. In the 2003 stream survey, 73% of the riparian corridor surveyed was in “Good” condition, 12% was in “Fair” condition and 14% was in “Poor” condition.

To control potential impacts on stream health from new development within riparian corridors of the Key Peninsula-Islands Basin, buffer width ordinances and regulations have been developed at the regional and local level. Table 9-5 of the Basin Plan provides a summary of the plans and codes that affect Key Peninsula-Islands Basin and the corresponding range in buffer widths required.

All new development would be subject to the current critical areas and resource lands regulations (including the increased buffer widths), unless a property is vested, meaning the date used to determine which development regulations apply to the property is prior to the date that the current regulations became effective. Thus, while buffer width ordinances may protect some streamside vegetation, degradation of the riparian corridors could continue as development occurs due to vested rights of some developers.

Significant Impacts to Vegetation and Proposed Mitigation Measures

Proposed Action

During construction of the replacement culverts recommended in the Basin Plan, vegetation in the immediate vicinity of the projects could be adversely impacted due to the movement of equipment or materials along streambanks. Damage to vegetation during the construction period would be mitigated by post-construction plantings of native plants. It is not expected that any major components of the riparian corridor would be damaged or removed during culvert replacement. Trees would be left in place unless removal is absolutely required for construction. Using properly implemented mitigation plantings, short-term impacts to vegetation would be minor.

The Basin Plan includes recommendations for implementing programmatic and capital improvement measures to encourage private landowners to protect and improve riparian habitat, vegetation, and water quality. Programmatic measures would help ensure new development abides by recently implemented buffer regulations, minimizing the influence of the vested right of developers. These protection and enhancement projects would be conducted to improve fish and wildlife habitat and water quality if analyses of basin conditions show that voluntary riparian habitat and water quality protection and improvement measures are not adequately meeting basin needs. The Basin Plan identifies areas where property acquisition and riparian and aquatic habitat protection or enhancement could be conducted to improve fish and wildlife habitat and water quality. These projects would protect existing areas of high quality habitat and riparian corridor, as well as improve habitat and the riparian corridor in degraded areas.

Aquatic habitat improvement and stream enhancement projects would consist of channel enhancement measures such as bank stabilization, large woody debris installation, and channel relocation (meander creation) as necessary. These projects could also include riparian vegetation planting, extending away from the streambanks for a distance of 20 to 40 feet.

While performing aquatic habitat improvement and stream enhancement projects, existing, low-growing vegetation in the project areas (e.g. grasses, shrubs) may be impacted by the movement of equipment and materials. Larger vegetation such as trees would not be impacted. When feasible, existing beneficial native vegetation will be left in place and protected during projects. Additional beneficial native vegetation will be added, and non-native vegetation with little or no beneficial uses will be removed. Particular attention will be paid to removing extremely invasive non-native vegetation, such as English Ivy, Scotch Broom, and Himalayan Blackberry.

Riparian habitat improvement projects are likely to include the planting of willow stakes and containerized stock such as Sitka spruce, western hemlock, red cedar, Pacific ninebark, salmonberry, red osier dogwood, and other species. Except for the willows and dogwoods, the remaining species would be planted at or above the ordinary high water mark. As the result of the noninvasive techniques used in riparian plantings, no significant short-term impacts are expected to existing beneficial native vegetation.

No unavoidable significant adverse impacts or cumulative adverse impacts to vegetation are expected to result from implementation of recommendations in the Basin Plan. Implementation of the Basin Plan would result in long-term benefits to vegetation within the Key Peninsula-Islands Basin. Short-term impacts would be minor with mitigation and would last only a short period following construction.

No-Action Alternative

Under the No-Action Alternative, riparian habitat and water quality protection and improvement would continue to be managed in the Key Peninsula-Islands Basin as it is today. County efforts would continue to focus on flooding and drainage complaints and large-scale water quality concerns rather than vegetation loss and riparian habitat problems.

As discussed above, buffer width ordinances and regulations have been developed at the regional and local level in an effort to control potential impacts on stream health from new development within riparian corridors of the Key Peninsula-Islands Basin. However, while buffer width ordinances may protect some streamside vegetation, degradation of the riparian corridors could continue as development occurs due to vested rights of some developers. Future development in the basin will likely result in the loss of additional vegetation in forested areas and the continued replacement of native plants with non-native plants for landscaping. The loss of native plants will result in less wildlife habitat, food, and cover.

Ongoing riparian restoration projects carried out by the Pierce Conservation District is expected to result in modest improvements to water quality and riparian vegetation over the long term. However, without the implementation of the stream enhancement, land acquisition and other programmatic measures and capital improvement projects recommended in the Basin Plan, it is expected that overall vegetation conditions may degrade in the basin.

Short-term impacts and mitigation measures associated with capital facilities projects listed in the 1991 Plan are similar to those discussed under the Basin Plan Alternative.

The No-Action Alternative would not result in any improvements to vegetation within the basin and could adversely impact vegetation by not ensuring protection or improvement of riparian habitat and water quality.

Wildlife

Affected Environment
Most of the original fauna remains, although generally reduced in abundance except for those species that can tolerate or benefit from close association with humans and habitat fragmentation. Typical mammals inhabiting the Basin include black bear, blacktail deer, coyote, raccoon, red fox, longtail weasel, deer mouse, and shrews. Common birds of the forest canopy include several species of flycatchers and wood warblers, black-capped and chestnut-backed chickadees, and red-breasted nuthatches. Song sparrows, fox sparrows, spotted towhees, American robins, and Swainson's thrushes are found in the shrub layer. House sparrows, house finches, European starlings, Brewer's blackbirds, and Northwestern crows are found in suburban areas.

Significant Impacts to Wildlife and Proposed Mitigation Measures

Proposed Alternative

During culvert replacement activities, the movement of equipment or materials and the associated disturbances to the water, soils, and vegetation could temporarily impact wildlife in the immediate vicinity of the construction activities.. The impacts to water, soils, and vegetation will be mitigated as described in the water resources, fishery resources, and vegetation sections above. The short-term adverse impacts to wildlife would be minor as a result of these mitigation efforts.

Protection and enhancement programs recommended in the Basin Plan would be conducted to improve fish and wildlife habitat and water quality. These projects and programs would protect existing areas of high quality habitat and riparian corridor, as well as improve habitat and the riparian corridor in degraded areas. Aquatic habitat improvement and stream enhancement projects would consist of channel enhancement measures such as bank stabilization, large woody debris installation, and channel relocation (meander creation) as necessary. These projects could also include riparian vegetation planting, extending away from the streambanks for a distance of 20-40 feet.

Where property is acquired to protect existing high quality habitat and riparian corridor, long-term impacts to wildlife will generally be beneficial. Short-term adverse impacts are generally associated with construction activities during aquatic habitat improvement, stream enhancement, and riparian corridor improvement projects. During construction activities, wildlife may be temporarily displaced, but the impact is expected to be minor because construction activities would generally not last more than several days. Removal of invasive and non-native plants species may also result in temporary displacement of wildlife species due to loss of cover. This would be a short-term adverse impact to wildlife. Beneficial, long-term impacts for wildlife would occur as a result of the habitat improvement and stream enhancement projects. Removal of non-native vegetation and planting of beneficial native vegetation will provide wildlife with more food, cover, and habitat in the long-term.

No unavoidable significant adverse impacts or cumulative adverse impacts to wildlife are expected to result from the implementation of the recommendations in the Basin Plan. Implementation of the Basin Plan would result in long-term benefits to wildlife within the Key Peninsula-Islands Basin. Short-term impacts would be minor with proper mitigation efforts and would last only a short period following construction.

No-Action Alternative

Under the "No-Action" Alternative, riparian habitat and water quality protection and improvement would continue to be managed in the Key Peninsula-Islands Basin as it is today. County efforts would continue to focus on flooding and drainage complaints and large-scale water quality concerns rather than concerns to wildlife and wildlife habitat including vegetation loss and riparian habitat problems.

Future development in the basin will likely result in the loss of additional vegetation in forested areas, and the continued replacement of native plants with non-native plants used for landscaping. The loss of native plants will result in less wildlife habitat, food, and cover.

Ongoing riparian restoration projects carried out by the Pierce Conservation District would be expected to result in modest improvements in water quality and riparian vegetation over the long term. However, without the implementation of the stream enhancement, land acquisition and other programmatic measures and capital improvement projects recommended in the Basin Plan, it is expected that overall vegetation conditions may degrade in the basin which could reduce wildlife populations and the variety of species living in the basin over time.

Short-term impacts and mitigation measures associated with capital improvement projects listed in the 1991 Plan are similar to those discussed under the Basin Plan Alternative. The No-Action Alternative would not result in any improvements to vegetation or wildlife within the basin and could adversely impact vegetation and thus wildlife by not ensuring protection or improvement of riparian habitat and water quality.

Land Use

Affected Environment

The 2000 census recorded the population of the Key Peninsula-Islands Basin as approximately 20,856. The predominant land use type in the basin is low-density residential use and this will continue to be so in the future. Urban land uses, comprising residential, commercial, industrial, institutional, and transportation uses, currently occupy 51% of the land surface. In the future, urban uses are expected to occupy 80% of the land surface. Present and future land use types are shown in Tables 4-12 and 4-13 of the Basin Plan. These data were used to compute the percentages of impervious surface in each subbasin.

The *Comprehensive Plan for Pierce County Washington* (Comprehensive Plan) contains land use and planning policies for Pierce County. The following planning and stormwater management directives are derived from the policies in the Plan:

- Provide urban level facilities and services only within the designated Urban Growth Area.
- Maintain the adopted level of service standard (LOS) for stormwater facilities. According to the Capital Facilities Element of the Comprehensive Plan, stormwater conveyance is to be designed for a 25-year, 24-hour design storm. Holding facilities for runoff are to be designed for a 100-year, 24-hour design storm or a 100-year, 7-day design storm, whichever result in a larger facility. Water quality treatment is to be designed for a 6-month, 24-hour design storm. Stormwater runoff projections used for forecasting future stormwater facility and identifying non-structural alternatives in the basin plans are based on the LOS in the Comprehensive Plan.
- Maintain compatibility between facilities and adjacent land uses.
- Foster and retain community character.
- Nonstructural measures should be preferred over structural measures for stormwater management.
- Involve the public and others with a stake in the outcome in water quality and stormwater management planning.
- Use of natural drainage systems for runoff is preferred over construction of facilities.
- Manage and plan water resources on a watershed basis.
- Support community education to conserve water resources.
- Provide for buffers of undisturbed vegetation in all new facility developments next to streams, ponds, lakes and Puget Sound.
- Pursue public acquisition of critical fish and wildlife habitat areas.
- Map all flood hazard areas.
- Maintain existing flood control structures on Pierce County rivers and streams.
- Evaluate the effectiveness of existing requirements for on-site stormwater retention and detention and revise where flooding issues are not adequately addressed.
- Pursue public acquisition of flood hazard areas.
- Protect, conserve and enhance the historic and cultural heritage of Pierce County.
- Upgrade and maintain existing capital facilities.
- Prohibit new uses that attract birds or waterfowl in the clear zone and Accident Potential Zones of McChord AFB.
- Develop and implement Community Plans

Impacts to Land Use and Proposed Mitigation Measures

Proposed Action
Implementation of the Basin Plan would not be expected to significantly affect land use in the basin. The recommendations of the Basin Plan are consistent with or do not interfere with the planning and stormwater management directives from the Comprehensive Plan listed above. No unavoidable significant adverse impacts or cumulative adverse impacts to land use are expected to result from the implementation of the recommendations in the Basin Plan.

No-Action Alternative
Implementation of the No-Action Alternative would not be expected to significantly affect land use in the basin. However, there is an inherent inconsistency of the action recommended in the 1991 Plan ("No-Action") because the document was prepared before the County adopted it current Comprehensive Plan. The "No-Action" Alternative would continue that inherent inconsistency.

Aesthetic, Historic and Cultural Resources

Affected Environment
The Key Peninsula-Islands Basin is a highly scenic area with views of Mt. Rainer, the Tacoma Narrows, the Olympic Mountains, and Puget Sound. Numerous streams, lakes, and forested areas in the basin also provide aesthetically pleasing views. The basin includes a number of properties with views, and the appreciation of natural aesthetics is often reflected in the higher property values for areas with scenic views or adjacent to natural areas.

Significant Impacts to Aesthetic, Historic and Cultural Resources and Proposed Mitigation Measures

Proposed Action

The Basin Plan components that involve construction activities, such as the culvert replacement projects, may cause short-term aesthetic impacts, but impacts are not expected to be significant. Long-term beneficial impacts would results from stream and riparian habitat restoration activities that would add vegetation alongside water bodies and ultimately improve the aesthetic views of those areas.

None of the recommended Basin Plan components are expected to adversely impact known cultural or historical resources in the basin. However, there is a potential to encounter historic or cultural resources during construction. If historic or cultural resources are discovered during construction activities, the County would immediately consult with the OAHP in Olympia and other officials regarding appropriate measures to implement. These measures require additional investigations of historic and cultural resources that could be affected on the project site and identification of appropriate mitigation measures prior to any additional work that could adversely affect cultural resources.

No unavoidable significant adverse impacts or cumulative adverse impacts to aesthetic, historic, or cultural resources are expected to result from the implementation of the recommendations in the Basin Plan. Implementation of the Basin Plan would result in long-term benefits to aesthetic qualities of the Key Peninsula-Islands Basin by improving riparian corridor conditions in degraded areas.

No-Action Alternative

Implementation of the No-Action Alternative would not be expected to significantly affect aesthetic, historic, or cultural resources in the basin. If any cultural resources were discovered during construction activities, the County would immediately consult with the OAHP in Olympia and other appropriate officials regarding appropriate measures.

Public Services, Utilities, Transportation, and Recreation

Affected Environment

Public Services
All typical public services are available in the Key Peninsula-Islands Basin, including fire protection, police protection, health care, surface water management, and schools.

Utilities
Electricity, telephone, surface water, and refuse service are available throughout the Key Peninsula-Islands Basin. Due to the largely rural nature of the basin, many areas rely on private wells and septic systems. Drinking water utilities rely primarily on groundwater resources.

Transportation
Highway 302, off of State Route 16 (SR 16) is the only major highway in the Key Peninsula-Islands Basin. Highway 302 stems from SR 16, crossing Burley Lagoon and enters the Key Peninsula-Islands Basin in the northeast corner of the peninsula. This highway route runs west across the peninsula the basin to Rocky Bay. It is a four-lane, limited access highway. Aside from Highway 302, the surface transportation network in the Key Peninsula-Islands Basin is mostly comprised of two-lane county roads, the longest of which is Key Peninsula Highway that runs north–south along the peninsula.

In March 2002 the Washington State Legislature enacted legislation that allows a second bridge across the Tacoma Narrows to be built, increasing the capacity of SR 16 to carry traffic between Tacoma and the Key Peninsula-Islands Basin. The existing four-lane bridge will be reconfigured to provide two general purpose lanes and an HOV lane for westbound traffic, and the new bridge will provide two general purpose lanes and an HOV lane for eastbound traffic. The project is currently under construction by the Washington Department of Transportation plans and is expected to open to the public in 2007.

Recreation
There are a number of parks, marinas, and other recreational areas throughout the Basin. Penrose Point State Park and Joemma Beach State Park are each about 100 acres with marine access and camping facilities available. There are a number of lakes throughout the Basin, which serve as recreational areas for swimming, fishing and camping activities. Fox Island (approximately five square miles) and Anderson Island (approximately 8.1 square miles) are both primarily rural communities with a number of marinas, parks, and golf courses.

Significant Impacts to Public Services, Utilities, Transportation, and Recreation and Proposed Mitigation Measures

Proposed Action
Implementation of some identified CIPs, particularly culvert replacement projects, would require construction alongside the roadway and would have short-term adverse impacts to transportation and public safety during the construction period. Utilities could potentially be impacted during the construction period, particularly if there are buried utility lines along roadways and overhead lines near where construction equipment would be located. Local roads may be closed for limited periods of time during construction and traffic detoured along other routes. Road closures could result in potential delays for emergency vehicles. Road construction at most culvert replacement sites is not expected to last for more than a few days, although some of the culverts located deep below the roadway may require a more lengthy construction period. Short-term construction-related impacts would be mitigated according to standard road construction practices and would include use of flaggers to direct traffic along detours during heavy traffic periods and notices to local utility customers who might be affected by construction impacts to utility lines. Long-term public safety would be enhanced as a result of these projects. The potential for road flooding within the basin would be substantially reduced.

No unavoidable significant adverse impacts or cumulative adverse impacts to public services and utilities are expected to result from the implementation of the recommendations in the Basin Plan. Implementation of the Basin Plan would result in long-term benefits to the surface water management program, as well as to public safety in the Key Peninsula-Islands Basin by reducing the risk of roadway flooding.

No-Action Alternative
Under the No-Action Alternative, stormwater would continue to be managed in the Key Peninsula-Islands Basin as it is today. County efforts would continue to focus on flooding and drainage complaints rather than assuming a more proactive, comprehensive approach. Periodic maintenance of ditches, culverts and other county drainage facilities by County crews would continue.

Unless other measures are identified and taken to solve existing and potential future problems not identified in the 1991 Plan, the potential flooding problems identified in the Basin Plan may go unsolved. Flooding problems could occur in the basin at the undersized culvert locations identified in the Basin Plan analysis. Long-term public safety could deteriorate as a result of these potential flooding problems.

Soils

Affected Environment
The Key Peninsula-Islands Basin is located on a peninsula extending southward into Puget Sound. It is bounded on the east by Carr Inlet and Henderson Bay, on the west by Case Inlet, and on the south by Nisqually Reach. Several drainage divides that are located north of the Pierce/Kitsap County line within Kitsap County form the northern boundary of the basin. Much of the land surface of the peninsula lies between two and or three hundred feet above sea level and is characterized by a terrain of rolling, rather flat-topped hills and ridges. Bluffs drop to the waters of Puget Sound on all three sides of the peninsula. The steepest bluffs (45-70% slope) are found on along the bluffs at the edge of the peninsula and on the islands. Surface soils on Key Peninsula are primarily classified as the Harstine Association. The Harstine Association soils are moderately well-drained soils that have formed in glacial till and have a moderate erosion hazard.

Significant Impacts to Soils and Proposed Mitigation Measures

Proposed Alternative
Many of the proposed CIPs in the Basin Plan could have short-term construction-related impacts on soils. Culvert replacement would disturb the soils on streambanks and stream bottoms. Stream restoration, stream bank stabilization and riparian revegetation projects would also disturb soils in areas within and adjacent to construction activities. Where these disturbed areas come in contact with flowing waters, sediment would be mobilized and quickly carried downstream, temporarily increasing turbidity and reducing water quality. Subsequent deposition of sediment could also harm fish habitat. The proposed CIPs are generally intended to reduce long-term erosion and other negative impacts to soils due to stormwater runoff. No long-term adverse impacts are anticipated from the Basin Plan Alternative. Long-term positive impacts may occur from reduced erosion due to stream bank stabilization and riparian revegetation projects.

Standard erosion control measures would be implemented to avoid serious sedimentation problems. Each construction project will be required to meet County construction and erosion control requirements, as well as applicable state and federal requirements. For instance, those projects taking place within a stream will require compliance with the State Hydraulics Code. The standard requirement for control of erosion and other construction-related pollutants, such as fuels and lubricants, ensures that the impacts to soils will be short-term and insignificant. Work adjacent to or within streams will typically be limited to the summertime low-flow periods, and thus will subsequently take place during periods of less intense and frequent rainfall, reducing the likelihood of significant sediment transport during construction activity. Standard erosion control measures such as silt fencing, coverage of exposed earth, and permanent seeding of disturbed areas following construction will further reduce temporary sediment impacts.

No unavoidable, significant adverse impacts or cumulative adverse impacts to soils are expected to result from the implementation of the recommendations in the Basin Plan. Implementation of the Basin Plan would result in long-term benefits to soils in the Key Peninsula-Islands Basin by reducing erosion.

No-Action Alternative

No unavoidable significant adverse impacts or cumulative adverse impacts to soils are expected to result from the No-Action Alternative.

RESPONSE TO COMMENTS

This section of the Final SEIS documents the written comment submitted within the 30-day comment period for the Draft SEIS, from January 19, 2006 to February 21, 2006.

Comment 1 from Jim Bosch, Vaughn, Key Peninsula.. Submitted as an email on February 24, 2006.

02/24/2006 01:42 PM

To bsmolko@co.pierce.wa.us
cc ela_whelan@urscorp.com

Subject Vaughn Creek

Barbara,
I have an appointment on March 7, 2006, with Ela Whelan to meet with me to discuss and view my concerns with areas VA01, VA02 and VA03.

Briefly, these concerns are:

1) Location of the monitoring site
2) Location of the stream gauge
3) Location of culverts not mentioned in the report
4) Conditions of aquatic and riparian habitat (ratings) in the above mentioned areas
5) Fish barrier
6) Potential flooding

Hopefully, her visit will correct the misinformation in this study.

Jim Bosch
16714 Olson Dr KPN
Phone: 253-884-3320

Response to Comment 1 from Jim Bosch regarding Vaughn Creek tributary drainage areas and corresponding stream reaches VA1, VA2, and VA3.

1-1 and 1-2. The water quality monitoring site and the stream gauge location on Figure 4-15 was in the wrong location. Figure 4-15 has been changed to reflect the accurate location.

1-3 The set of twin culverts at McFadden Road were not included in Chapter 4 because flooding problems had not been reported. A culvert replacement project will be included in the Basin Plan recommendations. The culvert will also be identified in Chapter 4 as a potential fish passage barrier.

1-4 URS staff reevaluated stream reaches VA1, VA2, and VA3 on March 7, 2006 and assigned one more point to four criteria out of 14 total criteria in the stream reach assessment. The criteria include Substrate Composition, Canopy Cover, Structural Diversity and Invasive Species. This adjustment changes the rating of Reach 2 to "Fair" for both aquatic and riparian habitat. VA2 is a complex reach with a great deal of good habitat. However, within this reach, also exists armoring of the stream bank, a reduced buffer area, invasive species, and dumping of debris in the buffer area. These conditions lower habitat ratings.

Reach 3 received a rating of "Fair", even though the canopy and substrate composition appeared to be of lesser quality than Reach 2, because Reach 3 is "Palustrine" and is rated with different criteria than Reach 2, classified as "moderate gradient/mixed control". Wetland channels, beaver complexes or sloughs characterize the Palustrine. Velocity is generally slow, substrates are composed of fine sediment or organic matter, and channel morphology is sinuous or irregular and dominated by pools or glides. Reach 2, Moderate Gradient Mixed Control, has channels dominated by debris transport with moderate to high stream power. Large woody debris is important in forming pools and storing sediment, thus substrates and bedforms are highly variable. Off-channel habitats may be present, but are not abundant.

See Appendix D, Stream Survey Methods Ecosystem Diagnosis and Treatment (EDT), and Appendix E, Stream Survey Results.

1-5 Fish barriers. See 1-3 above.

1-6 See 1-3 above.

Comment 2 submitted as an email

From: <Jordanruthseto@aol.com>
To: <BSMOLKO@co.pierce.wa.us>
Date: Tue, Feb 21, 2006 11:32 AM
Subject: eis input

Dear Barbara; Here are a few comments for the record in the EIS of the Basin SWMP. Thanks, Peter Seto

For the Record : EIS Basin Plan Public Review Comments from Peter Seto, School House Creek Stream Steward

Sirs; Please consider the following comments on the Anderson Island Executive Summary and the attendant tables and maps attached thereto. While some field work was done to support the findings of this Plan, it was limited to a walk-through. The stream has been the subject of ongoing study and restoration by Islander for many years.
There are established runs of sea-run cutthroat Coho and Chum salmon in the stream.
Fry are found in all stream sections from AI-09 to salt water. The culverts up-stream to
CR-08 are passable by fish. Careful placement of rocks to keep pooling water in the
culverts allows this. 1.

CR-08 is too steep to create a durable pool backing into the culvert with our limited
reasources. The stumps observed in the stream were placed there to attempt to create a
pool in CR-08. CR-09 was blocked to create a pool which is stocked annually to allow
fry to grow in the upper stream. Please leave this "culvert" entirely alone.

I ask that all of the changes, modifications and "enhancements" be removed from the list 2.
except the addition of a step-pool at CR-08 to allow up-stream passage for salmon into
stream section AI09. Work in the stream bed, in the riparian area, and under roadways 3.
will inevitably damage the existing salmon population. The flooding hazard at Oro Bay
Rd at Ekenstam-Johnson Rd is of marginal significance. I have observed water flow in
the roadway twice in the past five years; always during exceptionally heavy rains. No 4.
structures can or will be affected by high water, and the flat topography will limit the
effectiveness of any culvert redesign. Costs to the stream habitat will far outweigh any
nominal benefit to the wetland above and below this crossing. Further, "restoration" of
the riparian vegetation is undesirable because the existing tangled blackberry provides
both shade and cover from avian predators for the fry living in this section. Please leave 5.
this riparian area and stream to regenerate through the normal secession of vegetation.
Please confine any work done in the stream to correcting the negative effects of human
road-building at CR-08.

I recommend monies spent on salmon restoration be used to enhance habitat in the
brackish Oro Bay estuary where young salmon are pounded by Herron and Kingfisher 6.
predation. Both riparian and aquatic vegetative cover are missing which would protect
fingerling by providing habitat. Large schools of Chum and Coho are observable under

the floats of docks in the bay, but predation is intense here as well. I believe the restoration of Zostera or Phylospadix grasses in the bay is critical to enhance the salmonid population in the stream.

At a minimum I recommend the placement of root balls and tree trunks in the near shore waters to give protection to the fish. Additionally, public moorings placed in the bay and a sign encouraging no anchoring in the north portion would end the "sterilization" of the bottom by the large number of visiting boats in the summer. Anchor rodes inevitably strip thousands of square feet of vegetation from the bottom as the boats swing to the tide. Please consider these alternatives to those considered in the Basin study. This bay was a fertile and productive environment prior to the siltation and sterilization by human activity killed it. Islanders remember the herring spawning noise keeping them up in the summer nights. This is a priority for the enhancement of salmonids in the stream in question. Thank you, Peter Seto

Response to Comment 2

2-1 Thank you for sharing your knowledge of the creek. Your information on salmonid use of Schoolhouse Creek has been added to Chapter 4, Schoolhouse Creek, Anderson Island (AI). See Page 4-71.

2-2 The recommended Basin Plan contains the following projects for Anderson Island's Schoolhouse Creek.

AI-CR02, culvert replacement at lower Eckenstam Johnson Road crossing
AI-CR03, culvert replacement at Oro Bay Road crossing
AI-RST04, stream restoration in Reach 04
AI- CR08, culvert replacement at upper Eckenstam Johnson Road crossing
AI – WTRST04, wetland restoration in Reach 04
AI – CR09, culvert replacement at logging road north of 108th

Culverts AI-CR02, 03, and CR08 are barriers to fish passage according to the Pierce Conservation District's (Conservation District) Key Peninsula Fish Passage Database, 2000. CR-02 is an 18-inch precast concrete culvert that is submerged at high tide. On outgoing tides a whirlpool upstream obstructs fish passage. CR-02 is passable on incoming tides. Level B analysis is needed. CR-03 consists of two six-inch corrugated steel culverts with 1.5 and 1.2 percent slopes. CR-08 consists of two five-inch pre-cast concrete culverts, with a rock weir creating backwater into the pipe. The database suggests that a Level B analysis of the culvert is needed. None of the culverts meet the Washington State Department of Fish and Wildlife (WDFW) fish passage standards.

Other conditions exist that argue for replacing the culverts listed. Flow projections indicate a future need for AI-CR02 and AI-CR03 to minimize future flood hazards and to bring the culverts current with design standards. Culvert AI-CR09 remains in the Basin Plan as a low-priority recommended project. Prior to undertaking replacement of any the culverts, detailed analysis of engineering and fish passage factors will occur. However, deleting any of the projects at this time removes opportunity to consider objectives, alternatives, and community preferences in depth.

2-3 The proposed projects will enhance fish habitat. It is unlawful for work in streambeds and riparian areas damage existing fish populations. Procedures exist to avoid or mitigate damages that would otherwise be unavoidable. For example, alternate stream channels can be built and used during instream work. Fish can be captured and moved to a protected location during construction. These and other measures are used to avoid adverse impacts to fish. Usually they are identified by project teams as alternatives develop and are documented in project-specific environmental review.

2-4 The Basin Plan recommends projects to address future flooding and storm drainage issues in addition to solving existing problems. Most of the capital improvement projects and non-structural measures are not intended to be undertaken immediately, but over a ten years or more.

2-5 Restoration of riparian vegetation does not necessarily mean clearing the riparian area of all vegetation and starting over. Sometimes restoring riparian vegetation means adding conifers to the mix of near stream vegetation. Over time, the conifers grow and shade ever-increasing areas around them. Many invasive plants such as Himalayan blackberries and reed canary grass cannot thrive or often survive in a shaded location. Invasive vegetation such as Himalayan blackberries can contribute to high fecal coliform loads because they provide habitat for nutria, rats, mice, and other rodents. When dieback occurs in autumn, decaying invasive vegetation in the stream consumes dissolved oxygen needed by aquatic life and decreases pH.

2-6 Comment acknowledged. Nearshore restoration is a critical need for the long-term sustainability of Puget Sound. This Basin Plan deals primarily with upland, freshwater issues. We have forwarded your suggestion to the Puget Sound Nearshore Restoration Group.

The *Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment, July 2003,* reports that although none of Oro Bay contains eel grass, high quality salmon habitat exists at the mouth of Schoolhouse Creek, nearshore habitat quality is rated as high. To the east, nearshore habitat quality is rated as medium. Nearshore habitat quality on the west and south sides of Oro Bay is rated as poor; however, the assessment does not describe why it is poor.

Distribution List

Draft Supplemental Environmental Impact Statement (Draft SEIS)
The Draft SEIS for the Key Peninsula-Islands Basin Plan was included in the Basin Plan and distributed with all copies of the Basin Plan. Copies of the Basin Plan were distributed to interested County Councilmember Terry Lee, the Pierce County Planning Commission, Washington State Department of Ecology, Key Peninsula-Islands Basin residents, the, Federal and State agencies with jurisdiction over Basin Plan components, Pierce County Water Programs, Key Peninsula-Gig Harbor-Islands Watershed Committee, Pierce Conservation District, Kitsap County, Pierce County Planning and Land Services – Advance Planning, Pierce County Storm Drainage and Surface Water Management Advisory Board, and members of the public who requested copies. Copies of the Basin Plan and Draft SEIS were sent to the following branches of the Pierce County Library System: Peninsula Library, Key Center Library, and Anderson Island Library. The Draft SEIS was also posted at the following website: www.piercecountywa.org/kibasin.

Notice of Availability
Notice of Availability of the Draft SEIS was published in the Peninsula Gateway, the official publication of record for Pierce County. Notice of Availability of the Final Supplemental Environmental Impact Statement (Final SEIS) will also be published in the official publication of record. Notice of Availability of the Draft SEIS and Notice of Availability of the Final SEIS were mailed to agencies, individuals, and other interested parties set out in the mailing list below. Names marked with an asterisk were sent copies of the Basin Plan and FSEIS.

Absten Roger L; Vaughn WA
Adams Margaret; Lakebay WA
Admyers Joe R & Susan L; Wauna WA
Agnew Rance P & Rhonda S; Gig Harbor WA
Aikins Kirk L; Wauna WA
Aikins Max C & Jo Ann; Wauna WA
Ainslie William D & Sherry L; Gig Harbor WA
Al Arab Muhammad & Gayla; Wauna WA
Alexander Mary J; Vaughn WA
Alfano David A & Donna L; Gig Harbor WA
Allen Family Trust; Lakebay WA
Alpine Evergreen Co Inc; Port Orchard WA
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Alvestad Paul C & Helen K Etal; Gig Harbor WA
Aman Cheri M; Tucson AZ
Andersen Mary K,Trustee; Edgewood WA
Anderson Daniel J; Tacoma WA
Anderson Elmer & Betty; Port Orchard WA
Anderson Gordon K Ttee; Gig Harbor WA
Anderson Harley D; Mossyrock WA
Anderson Michael R & A J Roos; Lakebay WA
Anderson Norman R; Tacoma WA
Anderson Randall E; Anderson Island WA
Anderson Timothy A; Boulder City Nv
Andresen Ryan G & Marta M; Lakebay WA
Angerman Keith D; Tacoma WA
Applegate Douglas K; Gig Harbor WA
Armstrong Gayle F; Gig Harbor WA
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Arnold Weldon E; Vaughn WA
Artley Joan; Tacoma WA
Ashcraft Kenneth M; Longbranch WA
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Atterton John F & Caroline L; Gig Harbor WA
Austin Kenneth & Judith L; Gig Harbor WA
Austin Ted E; Lakebay WA
Babich Nick A; Gig Harbor WA
Bailey Charles C; Tukwila WA
Bainter Ronald L & Phyllis A; Lakebay WA
Baker Robert W & Cynthia A; Seattle WA
Balberde Max L; Maple Valley WA
Balch Charles R Jr; Seattle WA
Baldwin Diana M & S J Duppenthaler; Orting WA
Baldwin Erwen B Jr & P; Lakebay WAa
Banks William J Etal; Gig Harbor WA
Bargerstock Vicki L; Wauna WA
Bartlett Brian; Longbranch WA
Baston William F; La Mesa Ca
Bauer Catherine L; Gig Harbor WA
Baumgartener Linda L & David L; Eatonville WA
Baxter Virginia J; Bremerton WA
Beal Cecil R & Wendi; Wauna WA
Beal Robert L & Betty; Vaughn WA
Beam Tina M; Wauna WA
Bean David L & Pamela A; Gig Harbor WA
Beck Darrell W & Judy F; Anderson Island WA
Bednarczyk Albert B & Linda; Steilacoom WA
Beeler Jeanne D; Wauna WA
Behlen Debra J; Vaughn WA
Beilke Clifford G & Mary M Ttee; Puyallup WA
Benjamin Joan M; Gig Harbor WA
Bennett Carl H & Winona M; Gig Harbor WA
Bennett Dianna L; Vaughn WA
Bentler Paul & Janet; Longbranch WA
Berg Paul & Marcia; Gig Harbor WA
Berg Walter E & Arlene C; Gig Harbor WA
Besaw John & Patricia Downhour; Longbranch WA
Billett Allan R & Thelma H; Anderson Island WA
Bingham David & M Christine; Gig Harbor WA
Biscegalia Chester ; Tacoma WA
Bjork Juanita M; Fox Island WA
Blair Marti E; Gig Harbor WA
Blancaflor Othniel R Jr; Tacoma WA
Boman David L & Terressa L; Gig Harbor WA
Booth Jon S Pers Rep; Milton WA
✱Bosch James & Donna; Vaughn WA
Bosch Wouter J; University Place WA
Bottcher Noel D; Gig Harbor WA
Boyd Elizabeth L; Gig Harbor WA
Boyd James E & Jeanine M; Gig Harbor WA
Boyd Tom R & Amanda Grant; Longbranch WA
Boyer Dean P & Debra L; Gig Harbor WA
Braidic W E & G B Olmstead; Vaughn WA
Bramblet Bill & Doyla; Tacoma WA
Branson Rosario G; Seattle WA
Brastad Andrew R; Lakebay WA
Breese Colleen R; Lakebay WA
Brentin Scott J & Laurie A; Tacoma WA
Bressette Edmund G Jr & Dana K; Vaughn WA
Brewer Dora E; Gig Harbor WA
Brewer Edward D & Linda K; Gig Harbor WA
Brocenos Cecilia M & James T; Vaughn WA
Brochner Perry G Etal; Bremerton WA
Brock Ronald D; Gig Harbor WA
Brody John P Jr; Port Orchard WA
Brogoitti John D; Gig Harbor WA
Brooks Marsha L; Lakebay WA
Brown Charles G Etal; Auburn WA
Brown Frank A & Karen K; Tacoma WA
Brown Gary J & Karen J; Lakebay WA
Brown Kenneth A & Mary T; Gig Harbor WA
Broz Michael A; Santa Barbara Ca
Brozie Thomas; Vaughn WA
Bujacich Jack P & Cindy; Gig Harbor WA
Burg Gerald G & Gail S; Anderson Is WA
Burg Kenneth L; Kenmore WA
Burgess Gary & Phillip; Lakebay WA
Burke Patrick K & Chelann L; Vaughn WA
Burton Jason; Wauna WA

Busek Pamela M; Gig Harbor WA
Butler Edwin W & Nancy J; Gig Harbor WA
Byzinker Frederic & Constance; Ruston WA
Cable William E; Gig Harbor WA
Campbell Frank E; Vaughn WA
Candioglos John A & Loretta J; Gig Harbor WA
Carlsen Raymond E & Dorothy M; Lakebay WA
Carlson Larry A Etux; Gig Harbor WA
Carlson Mary C; Gig Harbor WA
Carpenter Sally J; Gig Harbor WA
Carron Denise; Lakebay WA
Carson Eugene E & Katherine M; Longbranch WA
Carson Katherine M; Longbranch WA
Case Geraldine M; Wauna WA
Cedarland Northwest Inc; Burley WA
Chaffeur James M; Lakewood WA
Chambers Larry E; Tacoma WA
Chandler Laura L; Longbranch WA
Chaney Alvin Jr & Jeri; Longbranch WA
Charboneau Jeff & Jeanette L; Vaughn WA
Charnley Arthur R & Barbara J; Kent, WA
Chenoweth Mark D & Rebecca L; Gig Harbor WA
Childers David R; Wauna WA
Christensen Gloria Ttee; Bellevue WA
Christiansen Leonard; Lakebay WA
Christoffersen Jean B; Vaughn WA
Chulich Steve A; Gig Harbor WA
Church Carolyn D; Gig Harbor WA
Clark Paul R & Kristine; Lakebay WA
Clark Rufus W & Claire M; Wauna WA
Clark Thomas E; Lakebay WA
Clement Eric & Laurie F; Lakebay WA
Cline Dennis P; Gig Harbor WA
Cline Ronald D & Elise R; Gig Harbor WA
Coen Ronald L & Janice; Gig Harbor WA
Coen Thomas A & Karen L; Gig Harbor WA
Colosimo Carlyle R & Henrietta E; Puyallup WA
Comer Alan & Victoria V; Olalla WA
Conant James W & Paula E; Gig Harbor WA
Conger Marilyn F; Seattle WA
Conley Erick W & Susan M; Gig Harbor WA
Conn Gary S; Longbranch WA
Connell Bert T & Audrey A; Burley WA
Cooke Tove & Melissa J; Vaughn WA
Cooper Robert G; Gig Harbor WA
Copley Barbara A; Lakebay WA
Cottage Court Federal Way Llc; Federal Way WA
Cowan Leslie H & Kathy A; Longbranch WA
Cox David M; Kingman Az
Crawford Cynthia & Charles L Iii; Gig Harbor WA
Creswell G & F D Boone Etux; Lakebay WA
Cribbs F Phyllis; Mount Vernon IA
Crider Lee J & Jeanne M; Gig Harbor WA
Crider Russell E & Jaymie P; Gig Harbor WA
Crofut David P; Tacoma WA
Cronin Keith & Kristie; Lakebay WA
Crooks Richard W & Nancy A; San Diego Ca
Cruver Roy E Jr; Gig Harbor WA
Cultum Larry A & Mary P; Vaughn WA
Cummings Lance M & Keli; Longbranch WA
Cyr Joan F; Vaughn WA
Dahlstrom Philip G & Sharon A; Gig Harbor WA
Dailey Eben; Vaughn Wa
Dailey Thomas A & Sonnia H; Vaughn WA
Dalton Robert A & Debora A ; Longbranch WA
Dalton Robert A Sr; Longbranch WA
Dana Clair; Lakebay WA
Davidson Philip S; Mapleton Or
Davies Esther H; Gig Harbor WA
Davis Glenn C; Lynnwood WA
Davis Mansfield & Bernice; San Francisco Ca
Day Elizabeth C; Tacoma WA
De Marco Alfred M & Patsy L; Gig Harbor WA
Declerk Michael G & Misty A; Gig Harbor WA
Defronzo Michael & Lynda L; Gig Harbor WA
Denbrook Loren F; Tacoma WA

Dengler Robert Jr & Corrie L T; Gig Harbor WA
Dept of Natural Resources; Olympia WA
Dettmers Robert & Renate; Waukesha WI
Dietrich Mary S; Palm Springs Ca
Dike Virginia D; Gig Harbor WA
Dougherty Chester Jr & A M; Lakebay WA
Douglas Barney L; Gig Harbor WA
Dowling William D & Janet I; Gig Harbor WA
Downen Robert Earl & Mary A; Longbranch WA
Doyle Francis & Chiyoko; Port Orchard WA
Drews Michael O & Michelle L; Gig Harbor WA
Dudley Dennis M & Ruth J; Vaughn WA
Dukes Wilbur B; Longbranch WA
Dunbar Margaret K; Lakebay WA
Eades Jerry; Vaughn WA
Eads Thomas E & Bonnie J; Lakebay WA
Easley Walter S Jr & Julie; Gig Harbor Wash
Easterwood Carlene Trustee; Longbranch WA
Ebelt Sharon E; Gig Harbor WA
Ebert Lawrence E; Gig Harbor WA
Eichholtz Philip; Tacoma WA
Ellingson Michael W; Gig Harbor WA
Elliott Robert L & Judith R; Gig Harbor WA
Ellis Bruce G & Jacolyn J; Issaquah WA
Ellis James C; Walla Walla WA
Elms Charles & Johanna Jensen; Gig Harbor WA
Elzey Carl R & Vickei M; Lakebay WA
Emerick Brian H & Judith; Gig Harbor WA
England Clifford B & Quirina A; Lakebay WA
Ennis Harvey & Donna L; Wauna WA
Erickson & Schillinger; Eatonville WA
Eriksen Sueko; Lakebay WA
Eriksen Arnold E & Ede L; Port Orchard WA
Erwin Robert H & Kathleen; Wauna WA
Erwin Troy C & S Anne; Gig Harbor WA
Ester Robert N; Burien WA
Evans Judith L Peterson; Gig Harbor WA
Everett Dean P; Lakebay WA
Eyrish Joann; Gig Harbor WA
Fan Xiaoling & I Reverencic; P.R.
Fancher Sheldon J & Carole A; Gig Harbor WA
Farley Brady M & Gwendolyn; Gig Harbor WA
Felt Gordon C; Tacoma WA
Fenn Mark P; Gig Harbor WA
✱Fenton Byron D & Susan L; Gig Harbor WA
Ferguson Darrell D & Madeline F; Gig Harbor WA
Fhlmc; Northridge Ca
Fierling James & Gloria; Covington WA
Finch Liane D K; Fox Island WA
Fiorino David F; Lakebay WA
Fiscal Dynamics Inc Ttee Etal; Tacoma WA
Fisher Ralph R & Patricia J; Puyallup WA
Fitzgerald Howard L; Yelm WA
Fitztgerald Garry J 7 Cathleen D; Lakebay WA
Fleck Justine R; Tacoma WA
Flintoff William C & Molly C; Vaughn WA
Flores E B; Chula Vista Ca
Flynn Eric L & Kathryn E; Gig Harbor WA
Ford Lloyd L Jr; Federal Way WA
Forseth Jennifer M; Tacoma WA
Fosdick William A & Margie M; Wauna WA
Foutch Kenneth W & Helen Ttee; Gig Harbor WA
Fox Albert J; Gig Harbor WA
Fragada Anthony V; Seattle WA
Frazier Donald; Gig Harbor WA
Frederick Edward E & Debra L; Gig Harbor WA
Fredrickson Bruce W; Lakebay WA
Freeman Michael G; Vaughn WA
Freinwald Earl & Inge Ttee; Olympia WA
Friedman Wesley & D C Arterburn; Grapevine TX
Frischmann Vickie; Gig Harbor WA
Frye Kevin R; Gig Harbor WA
Fuller Francis L & Lois A; Gig Harbor WA
Gablehouse Ronald R & Peggy D; Vaughn WA
Gahard Claude F & Claudia; Lakebay WA
Gainey Allan D & Daryl L; Vaughn WA

Ganisin Joseph W Jr; Gig Harbor WA
Garmire Robert D & Sarah E; Steilacoom WA
Garratt Frank E Jr; Vaughn WA
Geehan Charles M & Thelma A; Fox Island WA
Geier Aaron G; Lakebay WA
Geisler Rebecca J & S F Schellings; Seattle WA
German Evang Luth Church; Lakebay WA
Gerou Gregory B & Donna L; Gig Harbor WA
Getty James L & Sandra J; Gig Harbor WA
Giles Gary R & Lori M; Gig Harbor WA
Gillman J Wayne & Kathy N; Bountiful Ut
Gipson Shirley L; Gig Harbor WA
Glauner Warren R & Rosalyn I; Tacoma WA
Gleason John F Jr; Vaughn WA
Gleza James J; Gig Harbor WA
Godbey Clifford L & Barbara A; Lakebay WA
Goerke Theresa A; Lakewood WA
Goforth Barbara J; Vaughn WA
Goode Gary F & Roseanna; Gig Harbor WA
Gordon Gary L & Julie A; Longbranch WA
Gordon James E Jr & Naomi L; Gig Harbor WA
Graham Emery N; Gig Harbor WA
Graham John D & Cheryl A; Vaughn WA
Grass Robert H; Des Moines WA
Great Peninsula Conservancy; Bremerton WA
Grenz Terence W & Kathleen E; Lakebay WA
Grice Stanford O & Janet M; Belfair WA
✱Grant Peninsula Conservancy, Bremerton, WA
Griffith Judith A; Gig Harbor WA
Grip Todd A & Katherine A; Vaughn WA
Grounds Billy M; Gig Harbor WA
Grubb Samuel P & Diane; Anderson Island WA
Gullstrand Wade & Susan; Vaughn Wa
Gundy Daniel A & Merle A; Lakebay WA
Gunnarson Darlene E & Mark; Gig Harbor WA
Gunns Douglas & Kim; Tacoma WA
Gust Pete; University Place WA
Hacker Danny A & Linda J; Vaughn WA
Hacker Dennis A & Cheryl L; Vaughn WA
Haden Amber L; Lakebay WA
Hager Robert W & Olga; Seattle WA
Hahn Jerry M & Susan K; Puyallup WA
Hahn John D; Vaughn WA
Hall Rosemary R & Jack M Ttee; Lakebay WA
Hall William A & Mary L; Gig Harbor WA
Halpin Joseph P & Deborah G; Vaughn WA
Hand Howard F & Dorene; Lakebay WA
Hannity Robert J & Linda M; Tacoma WA
Harris Thomas W & Kathy L; Gig Harbor WA
Harrison James C & Frances C; Lacey WA
Hart Sharon E; Vaughn WA
Hartman Joseph D & Sandra C; Gig Harbor WA
Hartzell Brian G & Alanna T; Gig Harbor WA
Hashibe Norifumi & Keiko; South Pasadena CA
Hauck Richard G; Tacoma WA
Hawkins Family Trust; Snohomish WA
Hawkins Leonard C & Loretta I; Longbranch WA
Headley Tonia J & J M Houle; Port Townsend WA
Hefty Fredrick W; Lakebay WA
Heinemann Carol L; Burley WA
Heiskell Cecil L & Barbara J; Gig Harbor WA
Heistand Howard R; Belfair WA
Hemphill Dena; Gig Harbor WA
Henderson William; Gig Harbor WA
Herbrand Company; Puyallup WA
Herridge David G & Mary T; Bellevue WA
Hetland Larry & Suzanne; Lakebay WA
Hiatt Paul; Gig Harbor WA
Hibbard Bradley J; Tacoma WA
Hickel Rodger & Sue; Gig Harbor WA
Higgins Edward M & Diane G; Gig Harbor WA
Higgins S A/F J Timlake; Lakebay WA
Hill David; Gig Harbor WA
Hill Keith M & Johelen; Gig Harbor WA
Hilliard Donald P & Rita L; Wauna WA
Hillstrom Keith A & Kathy J; Gig Harbor WA

Hinkle Larry B & Linda P; Gig Harbor WA
Hlebichuk Ann; Puyallup WA
Hodges Patricia J; Wauna WA
Hoelscher Elaine M & Michael L; Lakebay WA
Hofbauer Richard J; Gig Harbor WA
Hoff Dennis W & Gisela I; Lakebay WA
Holcom Charles D Jr & Gayle C; Tacoma WA
Holdbrook Daniel J; Tacoma WA
Holden Eloise A Ttee; Tacoma WA
Holdren Gerald L & Ruth M; Southworth WA
Holsinger Roland & Jewell Ttee; Gig Harbor WA
Holt Larry R & Linda L; Port Orchard WA
Hook Randall A & Laurie A; Gig Harbor WA
Hoover Herbert & Burna; Longbranch WA
Hosack Charles W & Kathleen; Coeur D Alene ID
Hoskin Donald L & B Jane; Gig Harbor WA
Hove Alan W & Rosalie J; Gig Harbor WA
Howell Michael F; Federal Way WA
Hoyt Michael D; Steilacoom WA
Hulda T Tate Ttee; Puyallup WA
Hunt Donald C & Nancy J; Gig Harbor WA
Hunter Barry L; Lakebay WA
Hutchins Constance; Lakebay WA
Hwang Matthew U & Maria; University Place WA
Ingils Chester R & Janet H; Longbranch WA
Isdell Velma M; Kent WA
Iversen Gregory M; Olalla WA
Jackson Larry L & Kay S; Des Moines WA
Jacobsen David & Lynne; Lynnwood WA
Jacobson Martin L & Mabel A; Longbranch WA
Jacques Jeanne M & Mary Etal; Federal Way WA
Jaeger Patrick J; Seattle WA
James John R; Lakebay WA
Jellum Steven C; Gig Harbor WA
Jeschke Matthew J; Lakebay WA
Johnson Bulldozing Company; Lakebay WA
Johnson Charles D; Lakebay WA
Johnson David L & Cheryl A; Lakebay WA
Johnson Dorothy M; Gig Harbor WA
Johnson Edyth I; Lakebay WA
Johnson Norman R; Sumner WA
Johnson Ricki A & Nancy P Hall; Vaughn WA
Johnson Robert E & Lois C; Gig Harbor WA
Johnson Robert G; Puyallup WA
Johnson Vanda K; Bremerton WA
Johnston Sarah J; Seattle WA
Jopp Lawrence E & Susan E; Longbranch WA
Jopp Marcus W & Elizabeth; Lakebay WA
Jorgenson Patrick D & Sheila E; Longbranch WA
Joyce Michael J; Wauna WA
Kaapana Patrick K & Cynthia J; Tacoma WA
Kaffer Steven E & Sharon L; Vaughn WA
Kaphahn H Jeffrey; Lakebay WA
Kapis Kimberlee M; Lakebay WA
Karney Robt E; Tacoma WA
Kay Thomas & Linda; Longbranch WA
Keck Etal; Gig Harbor WA
Kegher Donald E & Carol A; Lakebay WA
Keith Bruce G & Mae J; Palos Verdes Est CA
Keith Virginia & G Seavy Ttee; Lakebay WA
Keller Robert D; Lakebay WA
Kelly Archibald H & Nancy; Renton WA
Kelly Charles; Tacoma WA
Kelly Debra A & Kendall R; Gig Harbor WA
Kennedy Darlene G; Lakebay WA
Kepner Gladys J; Tacoma WA
Kersting Mary M Ttee; Port Orchard WA
Kester Gregory & Deborah Etal; Lakebay WA
Key Peninsula Civic Center Assn; Vaughn WA
✱Key Peninsula Community Council; Lakebay, WA
Key Peninsula Sportsman Club; Lakebay WA
Kezele Susan K Etal; Tacoma WA
Killoran John Jr & Janet Johnson; Lakebay WA
Killoran John Sr & Mildred; Lakebay WA
Kingman Kent & Donna; Lakebay WA
Kirk Kenneth Jr & Susan; Gig Harbor WA

Knackstedt Sylys; Olympia WA
Knapp Bernice V; Gig Harbor WA
Knapp Calvin H; Tacoma WA
Knapp Charles B; Gig Harbor WA
Knapp Deane & Dorine; Gig Harbor WA
Knapp Douglas S; Gig Harbor WA
Knapp Earl E & Seth A; Gig Harbor WA
Knapp Warren P; San Francisco CA
Knapp-Purdy Inc; Tacoma WA
Knisely Mark & Cynthia; Vaughn WA
Korseck Michael J; Gig Harbor WA
Kowal Dave; Gig Harbor WA
Kraft Harlan L & Ruth L; Vaughn WA
Kulien Irene L; Federal Way WA
Kunzl Paul N & Lois P; Vaughn WA
Kurz David C & Josephine; Tacoma, WA
Kuzmick Walter & Margaret; Longbranch WA
Kvamme Robert & Barbara; Gig Harbor WA
Kvinsland John & Jodi; Gig Harbor WA
L80 Llc; Gig Harbor WA
Ladenburg Michael W & Lavada; Gig Harbor WA
Lake Minterwood Beach Club; Vaughn WA
Lakebay Comm Church Inc; Lakebay WA
Lally Allen P & Terri; Lakebay WA
Lamoureux Raymond J & Stephanie R; Gig Harbor WA
Lampson Roy M & Kathy N; Tacoma WA
Landberg Kathleen L; Milton WA
Landreth Sandra L; Tacoma WA
Larson Ricky & Stephanie Carter; Gig Harbor WA
Larson William W & Linda ; Nampa Id
Lay Kour Cheng & Kim Cheang; Tacoma WA
Le Master W R & Alice W; Greenacres WA
Lee Georgia; Vaughn WA
Lee Janet P & O S Lewman; Lakewood WA
Lee Joseph H; Buckley WA
Lehmann Daniel G & Diane C; Gig Harbor WA
Lemon James H & Marcia M; Lakebay WA
Lester Matthew W & Donna K; Gig Harbor WA
Lewis David R & Ann S; Lakebay WA
Lewis Dean C & D H Martin; Gig Harbor WA
Lewis Jennifer M; Tacoma WA
Lilley Richard A; Wauna WA
Linafelter Marc R & Michelle A; Seattle WA
Lind Jerry A & Wendy Robins; Belfair WA
Lind Robert V & Nancy C Ttee; Lakebay WA
Lindel Wayne A Jr; Gig Harbor WA
Listoe David J & Margaret H; Burley WA
Litowitz Dennis J; Federal Way WA
Long Dudley E & Patricia; Vaughn WA
Long George S & Mary L; University Place WA
Longbranch Improv Club; Lakebay WA
Lonning Kriss E & Arleen E; Gig Harbor WA
Lonning Lennart B Ii; Gig Harbor WA
Lothrop Todd W & Kimm A; Gig Harbor WA
Lovett Karen L; Vaughn WA
Luebeck E Georg; Gig Harbor WA
Luebeck Susan; Gig Harbor WA
Lukin Jeannine; Gig Harbor WA
Lunore Laverne L; Gig Harbor WA
Lutz Daniel S & Seana M; Lakebay WA
Lynd Robert W; Gig Harbor WA
Mac Donald George M G & Susan; Lakebay WA
Mahoney H Spencer; Gig Harbor WA
Maldon Patricia J; Lakebay WA
Malloque Marc A & Heidi C; Gig Harbor WA
Manke Lumber Company Inc; Tacoma WA
Mann William John; Vashon WA
Manning Living Trust; Gig Harbor WA
Marchant Glenn & Joyce; Everett WA
Maricle Timothy D; Longbranch WA
Marietta Dominic & Sherlie; Lakebay WA
Marlow Homer B & Fern H; Tacoma WA
Marshall Evelyn F; Gig Harbor WA
Marvik Kim D; Gig Harbor WA
Mathiason Marvin F & Clara E; Bremerton WA
May Thomas A & Shirley E; Lakebay WA

Mayer Christopher J & Celibeth M; Tacoma WA
Mayer Lawrence H & Betty J Ttee; Lakebay WA
Mc Auley Walter E & Vivian B; Seattle WA
Mc Cart Keith D & Mitzi T; Tacoma WA
Mc Colgan Walter T; Port Orchard WA
Mc Cullough Rose K Ttee; Gig Harbor WA
Mc Fadden Michele; Wauna WA
Mc Griff Jeannie; Lakebay WA
Mc Namara John M; Tacoma WA
Mc Neill Steven G; Olalla WA
Mc Williams Frederick J & Gayle E; Tacoma WA
McAleer Michael J & Linda A; Auburn WA
McAvoy Raymond J & Rosalyn M Ttee; Des Plaines IL
McColley Myron E; Gig Harbor WA
McColm Gerald W; Gig Harbor WA
McDonald James R & Maryann C; Longbranch WA
McDonald William H; Lakebay WA
McEntire Terrence K; Gig Harbor WA
McKibben Duane B & Lois M Etal; Gig Harbor WA
McNeill Bruce T & Cynthia M; Newburgh In
McNeish Melissa M; Gig Harbor WA
Melewski Walter F & Barbara A; Anderson Island WA
Mercado Nancy A & Peter I; Gig Harbor WA
Michaels Paul R & Elise; Gig Harbor WA
Michaelson Richard B & Marcia J; Vaughn WA
Miele Kenneth V & Elena; Bremerton WA
Mifflin Keith R; Bothell WA
Miller Carl S & Karen S; Wauna WA
Miller Kevin; Vaughn WA
Miller Land & Timber Llc; Seattle WA
Miller Loyd E & Sharon M; Lakebay WA
Miller Price N Jr & Sheryl J; Gig Harbor Wa
Millhorn Sabine; Gig Harbor WA
Misich Boris; Seattle WA
Miskoski Maria & Mark L Crowley; Lakebay WA
Mitchell Ronald R & Margaret M; Gig Harbor WA
Mitton Robert W & Joan E; Gig Harbor WA
Mize James J; Belgrade Mt
Mock Kenneth V & Ellen M; Longbranch WA
Moe Kenyon C & Barbara J; Gig Harbor WA
Moe Rodney K; Gig Harbor WA
Molgard Kyle H & Terry N; Gig Harbor WA
Moore Sharon Rose; Lakebay WA
Mora Gerard M & Yvonne M; Gig Harbor WA
Moreland Gary L & Jane M; Gig Harbor WA
Morgan Larry H; Wauna WA
Morgan Samuel E & Iris L; Wauna WA
Morgan William O & M W Austin; Lakebay WA
Moriarty J Theresa, Trustee; Seattle WA
Morley Daniel R & Mary K; Gig Harbor WA
Mrosla Donald J & Pearl C; Fairfield CA
Muchmore P R & S K Gearhart; Olympia WA
Mueller Stanley A Jr; Tacoma WA
Murphy Helen C; Lakebay WA
Murphy Robert J & Dee A; Gig Harbor WA
Murphy Russell Etal; Olalla WA
Murray Budd V & Pamela J; Longbranch WA
Myers Roni G; Port Orchard WA
Myers William G & Dory S; Lakebay WA
Nadel Michael L & Rose Sacdalan; Vaughn WA
Neal Randall W & Charlene M; Lakebay WA
Nelson John D; Gig Harbor WA
Nelson Richard & Cathleen; University Place WA
Neuschwander Amos W; Gig Harbor WA
Nichols Kenneth G & Deborah A; Vaughn WA
Nicholson Frank & Patricia; Sedro-Woolley WA
Nickles Cathy A; Lakebay WA
Nicolet Steve & Terri L Belden; Wauna WA
Niemann Christopher S; Lakebay WA
Niemann Joyce Etal; Lakebay WA
Niemann Nicole J; Vaughn WA
Niemann Noel J; Tumwater WA
Nimrick Randy; Gig Harbor WA
Noble Jack & Carol Ttee; Gig Harbor WA

Nogues Steven J; Gig Harbor WA
Nolte Paul J; Tacoma WA
Norby Darwin; Enumclaw WA
Norris Carolyn D & C D Worley; Richland WA
Noyer Gary R; Lakewood WA
Nygard Harry T & Marjorie M; Longbranch WA
O'Brien Gary L; Puyallup WA
O'Connor Mary E; Vancouver WA
Ohge Charles C & Daphne H; Seattle WA
Olsen Thomas D & Janet L; Gig Harbor WA
Olson Mary A Ttee; Olympia WA
Olson Phyllis Louise; Lakebay WA
Olyal Nayareh & Ninos Z; Farmington Hills MI
Olyiai Seyed Mohammed Reza; Farmington Hills MI
Oneill Collin W; Edgewood WA
Oppelt Wm A & Betty J; Vaughn WA
O'Quinn William & Sharinda; Gig Harbor WA
Ord John & Julienne; Guide Rock NE
Ord Thomas M Ttee; Gig Harbor WA
Oronco Investment & Dev Corp; Berkeley CA
Ory Richard E & Janice M; Federal Way WA
Ostling Karl L; Langley WA
Otto Laura M; Gig Harbor WA
Ovalle Raymond J & Jo Ann; Lakewood WA
Owens Gene Trust; San Antonio TX
Paine James C; Portland OR
Palumbo Michael A & Janice M; Lakebay WA
Parker Darin R; Wauna WA
Parks John W & Karen J; Tacoma WA
Paterson Douglas & Dorene; Lakebay WA
Pattee Paul L & Nancy Dardarian; Lakebay WA
Paul Richard R; Puyallup WA
Paulik Steven J; Gig Harbor WA
Pavolka Robert & E Mc Nerthney; Tacoma WA
Payne Gary L & Michelle M; Buckley WA
Payne Robert L & Theresa; Puyallup WA
Payton Norman E; Puyallup WA
Payton Paul T & P L Newcomb; Lakebay WA
Pazzaglia Lance E; Lakebay WA
Pearson Daniels & Miller Etal; Tukwila WA
Pedee David M; Tacoma WA
Pedersen Beverly H; Lakebay WA
Peichoto George P & Barbara; Port Orchard WA
Peninsula Light Co; Gig Harbor WA
Peninsula School Dist #401; Gig Harbor WA
Penz David L; Poulsbo WA
Peot Bob & Scott Emry; Sumner WA
Perrone Richard A; Gig Harbor WA
Perrycook Jay A & Tahirih A; Gig Harbor WA
Pete David E; Seattle WA
Peterson Dianne L; Tacoma WA
Peterson Gene C; Lakebay WA
Pflugrad Jody M; Lakebay WA
Pham Theman & Tuy Nguyen; Tacoma WA
Phipps Richard W; Allyn WA
Pierce Jimmy W & Patricia J; Gig Harbor WA
Pike Raymond W & Florence Capone; Gig Harbor WA
Pinder Eric; Lakebay WA
Pinkham Lucille T Ttee; Long Beach CA
Pitt Allen D; Longbranch WA
Poes Taylor Bay Estates; University Place WA
Pomeroy Stuart J; Vancouver WA
Porad Bruce J & Carlena J; Gig Harbor WA
Potter Dale E & Michele G; Tacoma WA
Presbytery Of Olympia; Lakewood WA
Preston Steven P & Linda L; Edmonds WA
Purdy Investments Llc; Gig Harbor WA
Purdy Shopping Center Llc; Gig Harbor WA
Quinlan Thomas & Mary K; Gig Harbor WA
Radcliffe Family L P; Lakebay WA
Ramsdell Dale D; Lakebay WA
Randall Gene N & Lillian J; Gig Harbor WA
Rawlings Douglas R; Lakebay WA
Raymond Richard S & Suzanne M Etal; Port Orchard WA
Reeder Geraldine C; Lakebay WA

Reese Robert P Jr & Katherine L; Lakebay WA
Regina Bates Trustee; Port Orchard WA
Reichard Scott & Barbara Schoos; Longbranch WA
Reinke Clifford & Ona; Lakebay WA
Reynolds A Robert & Edith; Tacoma WA
Rhoads Shirlee M; Gig Harbor WA
Richardson Donald & Jessie A; Gig Harbor WA
Richardson March G & Loretta ; Longbranch WA
Rikansrud John E & Sharon L; Longbranch WA
Rikansrud Sharon; Longbranch WA
Riviera Community Club; Anderson Island WA
Roach Nokel D & Dee V; Lakebay WA
Robertson Janet C; Gig Harbor WA
Robertson Roger & Peggy; Longbranch WA
Robinson Debra F; Republic WA
Robinson Ronald & Della; Gig Harbor WA
Robinson Russell T & Danna R; Gig Harbor WA
Roddy Kurt A & Lisa R; Gig Harbor WA
Roderick David M; Tacoma WA
Roderick Phillip E; Olympia WA
Roe James S & Anna; Tacoma WA
Rogers William E; Seattle WA
Rolco Company; Seattle WA
Ronepad; Wauna WA
Rortvedt Gary & Kathy W; Lakebay WA
Rose Donald G; Lakebay Wash
Ross Michael L; Gig Harbor WA
Rossa Eric F & Paula M; Vaughn WA
Rufer L L/T S & E A Mann; Gig Harbor WA
Runkel David A; Federal Way WA
Rutherford Randall R; Port Orchard WA
Rutz Brian M; Gig Harbor WA
Ryan Hanh T; Jacksonville Fl
Saathoff Neldo; Lakebay WA
Salatino Angela M; Wauna WA
Salazer Heriberto R & B R Baily; Tukwila WA
Saldana Carlos F & Gloria M; Lakebay WA
Salscheider Douglas J & Bette D; Lakebay WA
Sanbeck Vernetta; University Place WA
Sanders Richard R & Teresa L; Vaughn WA
Sandvig Stephen E; Kingshill Vi
Sarver Michael L & Maureen O; Belfair WA
Sater Robert & Helen Etal; University Place WA
Sauro Robert L; Gig Harbor WA
Sawyer Michael S; Lakebay WA
Saxer Theodore; Lakebay WA
Saxon Kathleen L; Cherry Valley CA
Saxon Larry E Etal; Puyallup WA
Schafer Dean W & Patricia L; Vaughn WA
Schierman Victor G; Wauna WA
Schlag Cristy A; Longbranch WA
Schmidt Heinz & Alice Rt; Pleasanton CA
Schmidt Henry & Peggy D; Longbranch WA
Schmitz Gary S & Robin M; Port Orchard WA
Schneider David M & Susan M; Gig Harbor WA
Schwaiger Deanna M; Gig Harbor WA
Scott Danny Lee & Traci M; Vaughn WA
Scott John P; Lakebay WA
Seeley Le Roy & Lois L; Longbranch WA
Seelhoff Richard K & Cheryl L; Gig Harbor WA
Semon Richard L & Andrea; Everett WA
✱Seto, Paul; Anderson Island WA
Severtsen Lydia K; Gig Harbor WA
Sheppard S Gordon; Anderson Island WA
Siburg Jim H Jr & Jan M; Lakebay WA
Siefert Karen; Maple Valley WA
Silverbow Farm Llc; Gig Harbor WA
Sims Ralph D; Vaughn WA
Singer Henry J & Arleita M; Anderson Island WA
Skaggs Sharon L; Lakebay WA
Skahan Helen Etal; Gig Harbor WA
Skladany Trent J & Sherri R; Burley WA
Skrivanich Michael P & K Michelle; Wauna WA
Slater Nathan D Etal; Home WA
Slavic Christian Center; Tacoma WA
Sly John V & Karoline A; Gig Harbor WA

Smith Bradley D & Robynn E; Gig Harbor WA
Smith Delores M; Longbranch WA
Smith Julian & Johanna; Tacoma WA
Smith Michael A & Melanie J; Gig Harbor WA
Snow Randall L & Nichole M; Gig Harbor WA
Sohl Faith V; Seattle WA
Sojak Clem & Maude M; Renton WA
Solberg James; Home WA
Somerville David J; Fortuna CA
Sorsdahl William R & Carol J; Vaughn WA
Soto Edward L & Linda K; Yakima WA
Souers Orrin & Therese M; Auburn WA
Spadoni Brothers Inc; Gig Harbor WA
Sprague Victor & Vicky Crouse; Gig Harbor WA
Squire Ii Roger N; Denver CO
St of Wa Parks & Rec Comm; Olympia WA
St of Wash Dept Of Trans; Olympia WA
St of Wash Fisheries Dept; Olympia WA
Stacy Gregory & Peggy; Lakebay WA
Stacy Robert & Bonnie; Lakebay WA
Stainbrook Darren V & Christine; Gig Harbor WA
Stalder William G; Hoodsport WA
Stanford Austin H & Viola G; Shoreline WA
Stang Jeffrey L; Gig Harbor WA
Stanley Dylan T; Lakebay WA
State Of Washington; Olympia WA
Stencil Barry & Erin; Vaughn WA
Stencil Douglas H & Norma; Lakebay WA
Stevica Ivan; Seattle WA
Steward Helen L; Lakebay WA
Stewart Mark E; Lakebay WA
Stiner Bruce R & Annette C; Lakebay WA
Stiner Jane Louise; Gig Harbor WA
Stokke Barry M; Gig Harbor WA
Stracke Morrine; Tacoma WA
Sullivan Terrance S & Jean G; Lakebay WA
Summerfelt Donald A & Marjorie A; Lakebay WA
Sumner Lilly V; Lakebay WA
Swanson Joel D & Betty A Ttee; Studio City CA
Swanson Martha A; Gig Harbor WA
Sweet Matthew D; Gig Harbor WA
Swenning Shane W & Lisa M; Longbranch WA
Swinney Stephen E; Gig Harbor WA
Sykes Eugene E & Jacqueline; Gig Harbor WA
Tachell Barbara B; Burien WA
Tallman James O & Dian M; Gig Harbor WA
Talmo Inc; Gig Harbor WA
Tarabochia Nick J Jr; Gig Harbor WA
Tatman John; Tacoma WA
Taylor Bay Beach Club Inc; Longbranch WA
Taylor Timothy L & Cindy R; Longbranch WA
Telephone Utilities Of Wash; Monroe La
Theroux Gregory V; Oregon City Or
Thomas Elgin R; Vaughn WA
Thomas Leslie L; Tacoma WA
Thomas Melinda C; Lakebay WA
Thomson Kelly R; Gig Harbor WA
Thomson Marilyn M; Gig Harbor WA
Throm Harold R; Anderson Island WA
Tobin Carol L; Burley WA
Tobin Mark P & Kathleen A; Longbranch WA
Todhunter Robert; Lakebay WA
Torres Lois I; Vaughn WA
Tossavainen Rainer E & Lea; Lakebay WA
Town Sheri L; Lakebay WA
Trees William J & Jane A; Wauna WA
Ude Stephen A & Jonell D; Gig Harbor WA
Van Devanter Aaron T & Wanda L; Kirkland WA
Van Slyke Tom H; Vaughn WA
Vaughn John S & Barbara L; Lakebay WA
Vivar Isabelo F & Lea A; Sugar Land TX
Von Kanel Adolf & Dolores; Longbranch WA
Voss Jerry M & Stacy G; Lakebay WA
Waddell Barbara J; Vaughn WA
Wagner Rick; Walnut Creek CA
Wagner Robert E; Vaughn WA

Wagner Scott E & Suzanne Etal; Gig Harbor WA
Wagstaff Stephen M; Lakebay WA
Wakefield David A & Barbara L; Longbranch WA
Waldron Timothy D & Penny G; Wauna WA
Walen Edwin J & Susan E; University Place WA
Walker Myrtle; Gig Harbor WA
Walsh Donald L; Tacoma WA
Wangeman M A; Bellevue WA
Ward Anna; Tacoma WA
Ware Family Lt; Gig Harbor WA
✱Wash St Dept of Fish & Wildlife; Olympia WA
Washington State Of; Olympia WA
Weathersby William J; Olympia WA
Webster, Keith E; Gig Harbor WA
Wentworth Gene & C M Robinson; Tacoma WA
Werner Madeline A; Gig Harbor WA
West Steven B & Shirley I; Gig Harbor WA
Westby Matthew & Patti; Lakebay WA
Wheeler Nancy L; Lakebay WA
Whites Gerald & A K Cummings; Gig Harbor WA
Whitman John B, Gdn; Gig Harbor WA
Whitman Robert P; Gig Harbor WA
Wickline Margaret J; Torrance CA
Wiggins David R; Tacoma WA
Wikoff Joseph F Jr & Laura G; Wauna WA
Wilhelm Albert; Wauna WA
Wilkinson Randy & D R Engelhard; Lakebay WA
William A Eastman & Co Inc; Bainbridge Island WA
Williams Melvyn S & Antoninette M; Lakebay WA
Williams T D & J A Smith; Lakebay WA
Williams William R; Federal Way WA
Wilson Barbara A; Wauna WA
Wilson Donald F & Linda A; Livingston TX
Wilson Steven J & H J Paul; Tacoma WA
Wilson Wesley W & Sara; Lakebay WA
Wood James Melvin; Black Diamond WA
Wood Stephen E & Lora A ; Gig Harbor WA
Woods Lisa; Gig Harbor WA
Wright Robert & Vonda T; Gig Harbor WA
Wright Willard E; Port Orchard WA
Wright William A & Irma L; Lakebay WA
Wyciskala Karen A; Tacoma WA
Xavier Victoria; Walnut Creek CA
Yost Jay A & Barbara; Pasadena CA
Zenz Doris F; Gig Harbor WA
Zimmer Gregory A; Palo Alto Ca
Zueger Thomas E Sr & Toni A; Gig Harbor WA
Zuerlein Mark J; Kent WA
Zvara John T; Vaughn WA
Smith Samuel D & Carol F; Woodland WA
Ulsh Wesley C; Gig Harbor WA
Ulsh Idalaine R; Seattle WA
Anderson Isl Park & Rec; Anderson Island WA
Love Matt A & A E Sales; Tumwater WA
Beell Thomas L; Ames IA
Schaeffer James P; Tacoma WA
Shaw Richard H; Fox Island WA
✱Travis Nelson, WDFW, Orting WA
City of Gig Harbor, Gig Harbor WA
✱Mason County, Shelton WA
✱Kitsap County, Port Orchard WA
Anderson Island Citizens Advisory Board
Paul Dugger, Oro Bay Yacht Club, Anderson Island
Island General Store; Anderson Island
✱Department of Ecology, Lacey WA
Peninsula School District, Gig Harbor WA
Nisqually Tribe of Indians; Yelm WA
Squaxin Tribe of Indians; Shelton WA
Sunnycrest Nursery; Key Center WA
Home Feed & Grocery; Home WA
Key Peninsula News; Vaughn WA
Lakebay Marina; Lakebay WA
✱Terry Lee, Pierce County Council
✱Dick Muri, Pierce County Council
✱Pierce Conservation District, Puyallup, WA
✱Pierce Stream Team; Puyallup, WA

✱Pierce County Library System, Tacoma, WA

✱Steve Marek, Tacoma-Pierce County Health Dept

✱South Puget Sound Salmon Enhancement Group; Olympia, WA

✱PW & U, Transportation Planning