2009 Stormwater Needs Assessment

Lakeshore

Salmon Creek (r.m. 00.60)

Clark County Clean Water Program

Protecting water through stormwater management

2009 Stormwater Needs Assessment Program

Lakeshore/Salmon Creek (RM 00.60)
Subwatershed Needs Assessment Report

Clark County Public Works Clean Water Program

March 2010

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Responsible County Officials

Program Name:	Stormwater Needs Assessment Program
Project Code:	SNAP
Department:	Clark County Public Works Water Resources
Funding source:	Clark County Clean Water Fee
Reporting Category:	4420 000 531 534 245 011403
Client:	Ron Wierenga, Clean Water Program Manager
SNAP Lead:	Jeff Schnabel, Natural Resources Specialist III Contact: 360-397-6118 x4583 jeff.schnabel@clark.wa.gov
Subwatershed Lead:	Jeff Schnabel

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Acronyms and Abbreviations

B-IBI	Benthic Macroinvertebrate Index of Biological Integrity
BOCC	Board of County Commissioners
BMP	Best Management Practices
CCD	Clark Conservation District
CIP	Capital Improvement Program
CPU	Clark Public Utilities
CRFPO	Columbia River Fisheries Program Office
CWA	Clean Water Act
CWC	Clean Water Commission
CWP	Clean Water Program
DNR	Department of Natural Resources
EDT	Ecosystem Diagnostic and Treatment model
EIA	Effective Impervious Area
EIM	Environmental Information Management
EMAP	Environmental Mapping and Assessment
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FPIA	Focused Public Investment Area
FWS	Fall, Winter, Spring
GCEC	Gee Creek Watershed Enhancement Committee
GIS	Geographic Information System
GMA	Growth Management Act
GPS	Geographic Positioning System
HPA	Hydraulic Project Approval
IDDE	Illicit Discharge Detection and Elimination
LCFEG	Lower Columbia Fish Enhancement Group
LCFRB	Lower Columbia Fish Recovery Board
LID	Low-Impact Development
LiDAR	Light Detection and Ranging
LISP	Long-term Index Site Project
LWD	Large Woody Debris
MS4	Municipal Separate Storm Sewer System
MOP	Mitigation Opportunities Project
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NTU	Nephelometric Turbidity Unit
NWIFC	Northwest Indian Fisheries Commission
ODEQ	Oregon Department of Environmental Quality

OWQI	Oregon Water Quality Index
PFC	Properly Functioning Condition
RM	River Mile
SCIP	Stormwater Capital Improvement Program
SCIPIT	Stormwater Capital Improvement Program Involvement Team
SCMP	Salmon Creek Monitoring Project
SCWC	Salmon Creek Watershed Council
SNAP	Stormwater Needs Assessment Program
SWMP	Stormwater Management Program
SWMMWW	Stormwater Management Manual for Western Washington
TIA	Total Impervious Area
TIP	Transportation Improvement Program
TIR	Technical Information Report
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
UGA	Urban Growth Area
UIC	Underground Injection Control
USFS	U.S. Forest Service
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VBLM	Vacant Buildable Lands Model
VLWP	Vancouver Lake Watershed Partnership
WAC	Washington Administrative Code
WCC	Washington Conservation Commission
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area
WSDOT	Washington Department of Transportation
WSU	Washington State University

Executive Summary

Study Area

This Stormwater Needs Assessment report includes the Lakeshore and Salmon Creek (RM 00.60) subwatersheds in the lower Salmon Creek watershed.

Intent

Stormwater Needs Assessment reports compile and provide summary information relevant to stormwater management, propose stormwater-related projects and activities to improve stream health, and assist with adaptive management of the county's Stormwater Management Program. Assessments are conducted at a subwatershed scale, providing a greater level of detail related to stormwater management than regional Water Resource Inventory Area (WRIA) or Endangered Species Act (ESA) plans. Stormwater Needs Assessments are not comprehensive watershed plans or stormwater basin plans.

Findings

Watershed Conditions

The table on the following page summarizes conditions in the two study area subwatersheds including water quality, biological health, habitat, hydrology, and the stormwater system.

Ongoing Projects and Involvement

Vancouver-Clark Parks and Recreation, Clark County Legacy Lands, and Clark Public Utilities are actively involved in the lower Salmon Creek watershed (Salmon Creek RM 00.60). The Salmon Creek Watershed Council provides a forum for citizens and organizations to participate in on the ground restoration, water quality and advocacy. The Washington Department of Ecology coordinates local agency actions as part of ongoing TMDL implementation in Salmon Creek.

Vancouver-Clark Parks and Recreation is also active in the Lakeshore subwatershed and owns several currently vacant parcels for future parks development. The Vancouver Lake Watershed Partnership has taken an active role in coordinating local interest and supporting the development of long-term management and improvement plans for Vancouver Lake. The Lakeshore subwatershed drains directly into Vancouver Lake.

As of December 2009 there are nine potential stormwater management capital projects listed in this study area in the CWP Capital Planning database; three of these are slated for construction in 2010 (CIP-30, Felida Knolls; OS-95, Lakeshore and NW 99th; CIP-6, Teal Pointe).

There are no road improvement projects listed the 2010-1015 Clark County Transportation Improvement Program. Clark County Legacy Lands has recently purchased several parcels along lower Salmon Creek. Several additional parcels are under consideration for future acquisition.

The Clean Water Program regularly communicates and coordinates with all of these entities.

Category	Status
Water Quality	
Overall	• Poor
Fecal coliform bacteria	• TMDL implementation ongoing (SC 00.60); concentrations have declined from 1995 levels; TMDL targets partially met • Lakeshore fails state criteria at all monitored stations (2008-9)
Temperature	• In TMDL development (SC 00.60); has highest temperatures recorded in Salmon Creek watershed
Turbidity	• TMDL implementation ongoing (SC 00.60); Salmon Creek meets TMDL targets
Nutrients	• SC 00.60 decreasing; 7% of samples (2002-08) exceed EPA criteria • Lakeshore high levels; 97% of samples (2008-09) exceed EPA criteria
Biological	
Benthic macroinvertebrates	• Poor biological integrity (Lakeshore); it is unlikely that biological integrity could be increased even with habitat improvements
Anadromous fish	• Coho and winter steelhead use; presumed Chum in limited reaches
Habitat	
NOAA Fisheries criteria	• Forest cover, impervious area, and road density metrics suggest Non-Functioning habitat • Stream crossing density metric suggests Properly Functioning (SC 00.60) and marginal functioning (Lakeshore)
Riparian	• Forest cover approx. 16% (SC 00.60) and 8% (Lakeshore) • Large woody debris recruitment potential is low to medium (SC 00.60) and medium/high (Lakeshore); shade levels below state targets (both) • Opportunities for restoration on County lands in lower Salmon Cr.
Wetland	• Large areas of potential wetland in SC 00.60 along Salmon Creek floodplain; opportunities for enhancement • Ecology watershed characterization management level is Development
Hydrology and Geomorphology	
Overall hydrology	• Heavily urbanized; hydrology substantially altered from historical
Geomorphology	• Channels (Chicken Creek and SC tributaries) expected to have moderate to high erosion response potential to changes in runoff
Future condition	• Projected impervious area suggest continued very unstable channels
Stormwater (unincorporated areas)	
System description	• Primarily piped system; 123 stormwater facilities (66 public)
Inventory status	• Complete; 8700 stormwater infrastructure features mapped
System adequacy	• Inadequate treatment and flow control; retrofit opportunities common
System condition	• 45 public facilities inspected; ~80 percent of facility objects in compliance with maintenance standards; 28 referrals for maintenance
Off-site assessment	• 32 high priority outfalls assessed; 23 in compliance
Source Control	• Of 10 businesses visited, 2 had source control problems; both resolved

Opportunities

Projects listed in the SNAP report represent only a small part of those needed to protect and restore streams within the assessment area. Field work and review of existing information identified numerous projects and actions that can improve stream conditions, including the following:

- Focused stormwater outreach and education to streamside landowners based on assessment results
- Evaluation of 15 potential retrofits to existing stormwater facilities to provide additional flow control and/or treatment
- Evaluation of 7 potential locations to purchase property and construct new flow control or treatment facilities
- Evaluation of 2 potential locations for detaining and treating street runoff in the right-of-way
- Repair of one failing bioswale facility
- Inspection and maintenance of one private stormwater facility overtaken by invasive vegetation
- Evaluation of 7 locations with moderate to severe erosion issues caused by stormwater outfalls
- Evaluation of two potential wetland enhancement and/or reforestation projects; one location is on private property listed by Clark County Legacy Lands for potential acquisition
- Investigation of two potential illicit discharges
- Exploration of potential cooperative projects for combined Parks/stormwater facilities on four County-owned properties
- Numerous small and large-scale invasive plant removal and riparian restoration opportunities

Non-project stormwater management recommendations address areas where CWP programs or activities could be modified to better address NPDES permit components or promote more effective mitigation of stormwater problems. Management recommendations relevant to the assessment area include:

- Continue to coordinate with Washington Department of Ecology during Salmon Creek TMDL adaptive management (fecal coliform and turbidity), and TMDL development (temperature)
- Continue to participate in Vancouver Lake Watershed Partnership
- Coordinate and leverage opportunities with groups and agencies active in the Salmon Creek watershed and Lakeshore
- Continue to encourage and support riparian planting efforts by private landowners

- Prioritize stormwater treatment in downstream areas of Chicken Creek (Lakeshore subwatershed). Stormwater impacts to Vancouver Lake include fecal coliform bacteria, nutrients, and sediment
- Prioritize stormwater detention and infiltration in upstream areas of Chicken Creek, and in tributary streams within Salmon Creek (RM 00.60) subwatershed.
- Focus additional effort on maintenance of bioswales, particularly excessive sediment conditions
- Focus additional effort on repairing and maintaining energy dissipaters at outfalls
- Encourage or develop incentives for private landowners to disconnect downspouts and infiltrate runoff rather than piping directly to streams
- Educate private landowners concerning the importance of invasive plant removal and suggest removal techniques
- Perform targeted technical assistance responding to results of field assessments
- Clark County is implementing stormwater monitoring to measure program effectiveness under section S8.E of the NPDES permit in the Lakeshore subwatershed beginning in 2010

Introduction

This Stormwater Needs Assessment includes the Lakeshore and Salmon Creek (RM 00.60) subwatersheds. The Clean Water Program (CWP) is gathering and assembling information to support capital improvement project (CIP) planning and other management actions related to protecting water bodies from stormwater runoff.

Purpose

The Stormwater Needs Assessment Program (SNAP), initiated in 2007, creates a system for the CWP to focus activities, coordinate efforts, pool resources, and ensure the use of consistent methodologies. SNAP activities assess watershed resources, identify problems and opportunities, and recommend specific actions to help meet the CWP mission of protecting water quality through stormwater management.

The overall goals of the SNAP are to:

- Analyze and recommend the best, most cost effective mix of actions to protect, restore, or improve beneficial uses consistent with NPDES permit objectives and the goals identified by the state Growth Management Act (GMA), ESA recovery plan implementation, Total Maximum Daily Load (TMDLs), WRIA planning, floodplain management, and other local or regional planning efforts.
- Inform county efforts to address the following issues related to hydrology, hydraulics, habitat, and water quality:
    - Impacts from current or past development projects subject to lesser or non-existent stormwater treatment and flow control standards.
    - Subwatershed-specific needs due to inherent sensitivities or the present condition of water quality or habitat.
    - Potential impacts from future development.

The CWP recognizes the need to translate assessment information into on-the-ground actions to improve water quality and habitat. Facilitating this process is a key requirement for the program's long-term success.

Results and products of needs assessments promote more effective implementation of various programs and mandates. These include identifying mitigation opportunities and providing a better understanding of stream and watershed conditions for use in planning county road projects. Similar information is also needed by county programs implementing critical areas protection and salmon recovery planning under the state GMA and the federal ESA.

Scope

This report summarizes and incorporates new information collected for the SNAP, as well as pre-existing information. In many cases it includes basic summary information, or incorporates by reference longer reports which may be consulted for more detailed information.

SNAP reports produce information related to three general categories:

- Potential stormwater capital projects for county implementation or referral to other organizations.
- Management and policy recommendations.
- Natural resource information.

Descriptions of potential projects and recommended program management actions are provided to county programs, including: Department of Environmental Services Clean Water, Stormwater Capital Planning, Legacy Lands, and ESA; Public Works Operations, Development Engineering, and CIP; Community Planning and; Public Health. Potential project or leveraging opportunities are also referred to local agencies, groups, and municipalities as appropriate.

Assessment Approach

Priorities for Needs Assessment in Lakeshore and Salmon Creek (RM 00.60)

Clark County subwatersheds were placed into a five year schedule for assessment using the procedures described in Prioritizing Areas for Stormwater Basin Planning (Swanson, July 2006).

For SNAP purposes, the Lakeshore and Salmon Creek (RM 00.60) subwatersheds are categorized as "Unincorporated Vancouver Urban Growth Area".

Subwatersheds in this category typically include significant areas of development and potential re-development inside the Vancouver UGA of unincorporated Clark County where the county controls development permitting. These are high priority subwatersheds for stormwater needs assessment considering development pressure, subwatershed characteristics and NPDES permit requirements. A wide range of SNAP tools may be used in assessing subwatersheds in this category.

Assessment Tools Applied in Lakeshore and Salmon Creek (RM 00.60)

The SNAP utilizes a standardized set of tools for subwatershed assessment; including desktop mapping analyses, modeling, outreach activities, and a variety of field data collection procedures. Tools follow standard protocols to provide a range of information for stormwater management. Though not every tool is applied in every subwatershed, the use of a standard toolbox ensures the consistent application of assessment activities county-wide.

Table 1 lists the set of tools available for use in the SNAP. Tools with an asterisk (*) are those for which new data was gathered or new analyses were conducted during this needs assessment. The remaining tools or chapters were completed based on pre-existing information where available.

Table 1: Stormwater Needs Assessment Tools

Outreach And Involvement *	Geomorphology And Hydrology Assessment *
Coordination with Other Programs *	Riparian Assessment
Drainage System Inventory and Condition *	Floodplain Assessment
Source Control *	Wetland Assessment
Review Of Existing Data	Macroinvertebrate Assessment *
Illicit Discharge Screening	Fish Use And Distribution
Broad Scale GIS Characterization *	Water Quality Assessment *
Rapid Stream Reconnaissance *	Hydrologic Modeling
Physical Habitat Assessment	Hydraulic Modeling

Assessment Actions

Outreach Activities

SNAP outreach activities in 2009 focused primarily on raising awareness about the SNAP effort and following up on issues discovered in 2008. Letters were sent to landowners regarding trash accumulations and various agriculture management issues observed on their property during the 2008 SNAP effort.

The following activities were completed:

- July 2009 -- Press release to local media.
- The Clean Water Program E-Newsletter is distributed to 265 subscribers. SNAP articles and updates were included in three E-Newsletter editions in 2009:
    - April 2009 – 2008 SNAP reports available
    - August 2009 – 2009 SNAP update
    - December 2009 – Article highlighting SNAP landowner litter pick-up success.
- April 2009 -- SNAP information distributed with Clean Water Program information at Small Farm Expo: 69 participants.
- August 2009 – Letters were sent to sixty-two landowners with accumulations of trash in or near the stream on their property. Twenty-two landowners responded with phone calls to the SNAP coordinator for more information or to inform the CWP that cleanup activities had been completed. One landowner reported removing 1200 pounds of trash and another picked up three garbage bags and four five-gallon buckets or litter, six tires, three washing machines, drain pipe, and aluminum siding.
- August 2009 – Information on the SNAP was distributed at the 10-day Clark County Fair.
- November 2009 – Letters were sent to twenty-one landowners with identified agriculture-related issues on their property. The letters described the problem found (improper manure storage, livestock access to the stream, etc.) and identified a suggested management practice to lessen negative impacts on water quality (cover manure piles, fence livestock from the stream). A list of local resources and a brochure highlighting small acreage best management practices were included in the mailing. No follow-up calls or questions from landowners were received by the SNAP coordinator resulting from these letters and it is unknown whether other agencies listed as resources were contacted by property owners for technical advice.
- Clean Water Program SNAP web pages were updated as needed on an on-going basis; (note, no web visitor/download statistics are available as Clark County had (has) no tracking software during this timeframe).
- A description of the SNAP was included in Clark County's annual stormwater management program plan submitted to Ecology.

Clark County Clean Water Commission members were updated periodically on SNAP progress.

Actions available to educate in response to identified problem areas include the following:

- Site visits by CWP technical assistance staff
- Letters detailing specific problems and solutions to individual landowners
- General educational mailings to selected groups of property owners
- Workshops on best management practices, including septic maintenance and mud, manure and streamside property management
- Referral to other agencies, such as Clark Conservation District or WSU Extension, for educational follow-up

Coordination with Other Programs

Purpose

Coordination with other county departments and with local agencies or organizations helps to explore potential cooperative projects and ensure that the best available information is used to complete the assessment.

Coordination is a two-way relationship; in addition to bringing information into the needs assessment process, coordinating agencies may use needs assessment results to inform and enhance their programs.

Methods

The CWP maintains a list of potential coordinating programs for each subwatershed area. Coordination takes the form of phone conversations, meetings, or electronic correspondence, and is intended to solicit potential project opportunities, encourage data and information sharing, and promote program leveraging.

Potential opportunities for coordination exceeded the scope of CWP and SNAP resources; therefore, not all potentially relevant coordination opportunities were pursued. Coordination was prioritized to include departments and groups most likely to contribute materially to identifying potential projects and compiling information to complete the needs assessment.

Results

See Analysis of Potential Projects for an overall list and locations of potential projects identified during the needs assessment process. Projects suggested or identified through coordination with other agencies are included.

The following list includes departments, agencies, and groups contacted for potential coordination in the Lakeshore and Salmon Creek (RM 00.60) needs assessment area:

- Vancouver Lake Watershed Partnership
- Lower Columbia Fish Recovery Board
- Clark County Legacy Lands Program

- Vancouver/Clark County Parks and Recreation
- Washington Department of Ecology
- Salmon Creek Watershed Council

Review of Existing Data

Data and information review is incorporated throughout this report in pertinent sections. A standardized list of typical data sources created for the overall SNAP effort is supplemented by subwatershed-specific sources as they are discovered. Data sources consulted for this report include, but are not limited to those listed below:

- LCFRB Habitat Characterization (2004)
- LCFRB 6-Year Habitat Workplan
- Ecology Watershed Characterization and Analysis of Clark County (2009)
- Ecology 303(d) list
- Ecology EIM data
- Clark County 2004 Subwatershed summary
- Clark County 2004 Stream Health Report
- Clark County LISP/SCMP/ Project data (2002-2008)
- Clark County 6-Year TIP

Broad-Scale GIS Characterization and Metrics

The broad-scale characterization is a GIS-based exercise providing an overview of the biophysical setting for each subwatershed, background information for use in implementing other SNAP tools, and identification of potential acquisition or project sites. GIS data describes many subwatershed characteristics such as topography, geology, soils, hydrology, land cover, land use, and GMA critical areas. A standard GIS workspace, including shape files for over 65 characteristics forms the basis for the characterization.

GIS data are generally used as a tool to complete the report and not presented in the report itself. Summary metrics are taken from existing reports and data; for example, Wierenga (2005) summarized many GIS characteristics for Clark County subwatersheds. Some of these characteristics are described in greater detail in later sections.

The characterization includes three components:

- A set of four standard map products, as paper maps for SNAP use
- A summary table of selected subwatershed-scale metrics
- A brief narrative including comparison of metrics to literature values, and conclusions about general subwatershed condition and potential future changes

Map Products

The four standard SNAP map products are: 1) Stormwater Infrastructure and Hydrologic Soil Groups, 2) Critical Areas information, 3) Vacant Buildable Lands within UGAs, and 4) Orthophoto. These maps are printed out for tabletop evaluations.

General Conditions and Subwatershed Metrics

General Geography

The study area comprises two subwatersheds in urbanizing lower Salmon Creek and the Lakeshore area: Lakeshore and Salmon Creek (RM 0.60). The study area groups a number of smaller, generally unnamed urban streams draining to Salmon Creek and Vancouver Lake. The only named creek in the study area other than Salmon Creek is Chicken Creek. Several un-named creeks have headwaters at the base of steep canyons. The area is on the relatively level Willamette Valley floor (Figure 1). Land use is generally urban residential with some agricultural and rural residential areas in northern Lakeshore and north of Salmon Creek.

Topography

The study area is generally low rolling hills between 200 and 300 feet in elevation cut by streams tributary to Salmon Creek, Lake River and Vancouver Lake. The Salmon Creek floodplain is approximately 10 to 20 feet above sea level and essentially part of the Columbia River flood plain. All of the tributary streams that flow into canyons lack floodplains.

Geology and Soils

The oldest rocks in the study are sedimentary rocks deposited by the ancestral Columbia and local streams. These gravel and sandstone deposits are exposed in railroad cuts in hillsides along the Columbia River floodplain.

Fine-grained Ice Age Cataclysmic Flood deposits mantle most of the study area. These deposits are easily eroded and are prone to landslides in steep canyons.

Recent sandy alluvium deposited within the last few thousand years underlies the Salmon Creek floodplain.

Hydrology

Geology and topography play the main role in determining the study area hydrologic framework. The relatively flat lying sedimentary deposits are capable of retaining relatively large amounts of rainfall as recharge. This groundwater recharge returns to streams in summer months from seeps and springs.

Some of the Lakeshore storm systems are piped directly to Lake River or Vancouver Lake. Areas where this is not the case are very susceptible to erosion.

All tributary streams in the study area drain urbanized or urbanizing areas. Consequently, stream hydrology is altered considerably from a natural forested condition. Steep canyons are susceptible to erosion and groundwater seeps can precipitate slope failures. The chapter describing geomorphology and hydrology includes a description of hydrology and stream channel forms resulting from current land use conditions.

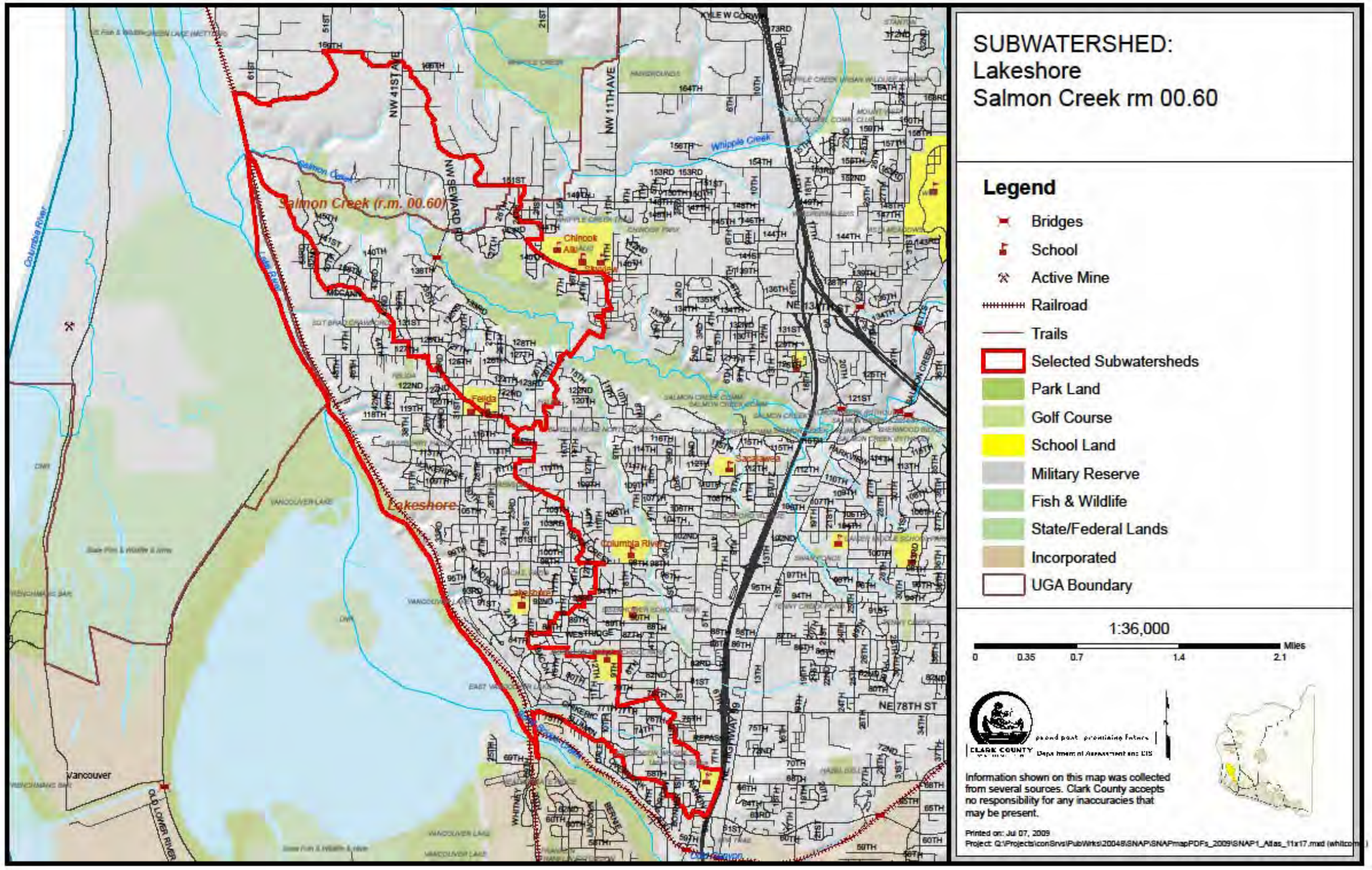


Figure 1: Subwatershed Map: Lakeshore and Salmon Creek (RM 0.60) Subwatersheds

Subwatershed Metrics
Subwatershed scale metrics provide a simple way to summarize overall conditions. Metrics are calculated from Landsat land cover analysis and current GIS data. Benchmarks for properly functioning and not properly functioning are based on NOAA fisheries standards for salmon protection and restoration (1996 and 2003).

Overall, these metrics suggest that the study area has non-functioning stream habitat (Table 2).

Table 2: Watershed Scale Metrics

Metric	Lakeshore	Salmon Creek RM 0.60	Functioning	Non-functioning
Percent Forested (2000 Landsat)	8	16	> 65 %	< 50 %
Percent TIA (2000 Landsat)	47	31	< 5 %	> 15 %
Road Density 2007 data (miles/mile2)	17	10	< 2	> 3
Stream Crossing Density (crossings per stream mile)	4.7	1.3	< 3.2/mile	> 6.4/mile
Percent EIA estimated from the Comprehensive Plan	23	14	< 10 %	> 10 %

Forest Cover
The proportion of a watershed in forest cover is known to have a profound influence on watershed processes. Forest cover estimates are taken from a report summarizing land cover for Clark County (Hill and Bidwell, January 2003). Research in the Pacific Northwest has shown that when forest cover declines below approximately 65 percent, watershed forming processes become degraded (Booth and Jackson, 1997). These include reducing riparian shade, less wood debris delivery to streams, increased stormwater runoff, and increased fine sediment delivery due to mass wasting.

Level land within the study area was cleared for agricultural use in the late 1800s. Remaining forest is on steep slopes in ravines or valley walls along Salmon Creek and Lake River.

TIA (Total Impervious Area)
Total impervious area is one of the most widely used indicators of urbanization and coincident watershed degradation (Center for Watershed Protection, March 2003). Total impervious areas are estimated from land cover data in Hill and Bidwell (January 2003). While various organizations and publications categorize stream condition based on TIA, the NOAA fisheries standard is less than five percent as fully functional and greater than 15 percent as non-functioning. Values for both subwatersheds are well beyond the threshold for non-functioning habitat.

Road Density
Road density, including all public and private roads, is an easily calculated development measure. Based on criteria set by NOAA Fisheries to protect salmon habitat, road densities are at urban levels in Lakeshore and slightly lower in Salmon Creek (RM 0.60) and classify as non-functioning (>3 road miles/mi^2)\

Stream Crossing Density
Stream crossing densities are easily measured using available road and stream channel data. The salmon protection standard considers larger fills over 60 feet wide, which would be approximately five to ten foot high road fill. The study area subwatersheds Salmon (RM 0.60) has stream crossing densities within the functioning category (<3.2 crossings/stream mile NOAA Fisheries criteria) and Lakeshore is between functioning and non-functioning.

Future Effective Impervious Area
Effective impervious area is the amount of impervious area that actually drains to a water body. Depending on factors such as soil types and level of development, effective impervious area is about half (lower intensity development) to almost equal (high intensity development) the TIA value.

The 2008 Comprehensive Plan guides development for the next few years and when used to estimate effective impervious area it can provide a metric for potential hydrologic impacts due to expected development. Expected EIA places the study area in the non-functioning category.

Estimated Channel Stability Based on Forest and EIA
In a recent publication by Booth, Hartley, and Jackson (June 2002), a relationship between forest and percent EIA was presented as a graphic (Figure 2). According to this figure, streams in both subwatersheds would be expected to have very unstable channels.

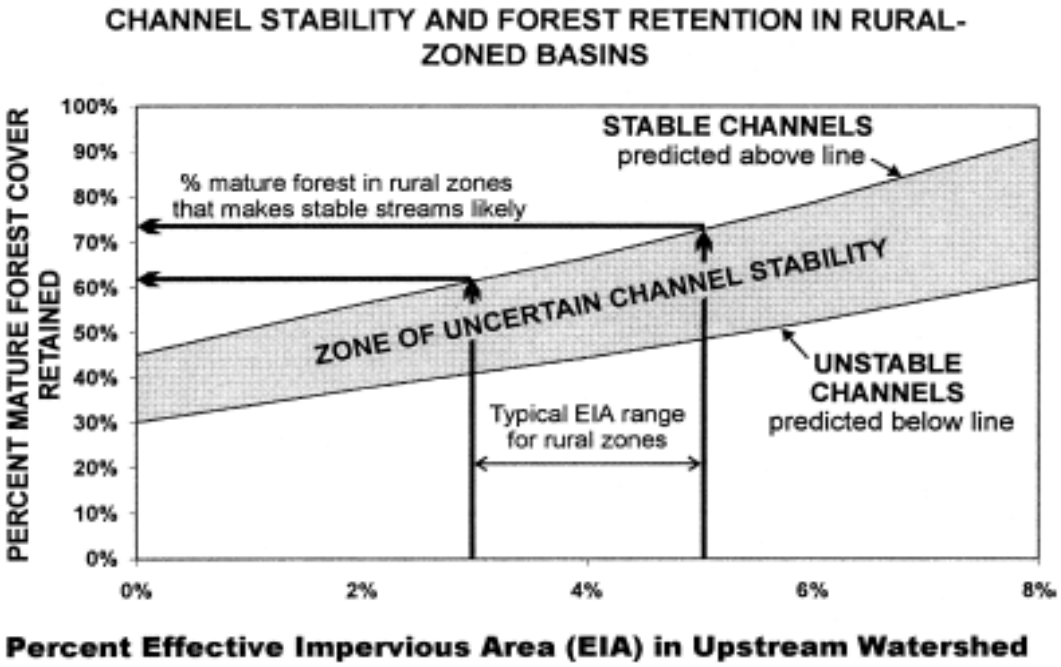


Figure 2: Channel stability in rural areas (Booth, Hartley, and Jackson, June 2002).

Water Quality Assessment

This section briefly summarizes and references available water quality data from the Lakeshore and Salmon Creek (RM 00.60) subwatersheds. A description of applicable water quality criteria is included, along with discussions of beneficial use impacts, likely pollution sources, and possible implications for stormwater management planning.

Water Quality Criteria

For a full explanation of current water quality standards see the Ecology website at: http://www.ecy.wa.gov/programs/wq/swqs/index.html

Under Washington state water quality standards, Salmon Creek below the Cougar Creek confluence, including tributaries, is to be protected for the designated uses of: "Salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values" (WAC 173-201A-600).

Many of the streams in the Lakeshore subwatershed drain directly to Vancouver Lake and therefore are to be protected for the designated uses of : "Core summer salmonid habitat; extraordinary primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values". (WAC 173-201A-600).

Table 3 summarizes currently applicable water quality criteria for the assessment area.

Table 3: Applicable Water Quality Criteria for Lakeshore and Salmon Creek (RM 00.60) Subwatersheds

Characteristic	Ecology Criteria	
Temperature	≤17.5 °C (63.5 °F)	Lakeshore: ≤ 16 °C (60.8 °F)
Dissolved Oxygen	≥8.0 mg/L	Lakeshore: ≥ 9.5 mg/L
Turbidity	shall not exceed 5 NTU over background when background is 50 NTU or less	
pH	6.5 – 8.5 units	
Fecal coliform bacteria	Salmon Creek (RM 00.60): Geometric mean fecal coliform concentration not to exceed 100 colonies/100mL, and not more than 10% of samples exceeding 200 colonies/100mL. Lakeshore: Geometric mean fecal coliform concentration not to exceed 50colonies/100mL, and not more than 10% of samples exceeding 100 colonies/100mL.	
Aesthetics	Aesthetic values must not be impaired by the presence of materials or their effects… which offend the senses of sight, smell, touch, or taste	
Toxics	Toxic substances shall not be introduced… which have the potential…to adversely affect characteristic water uses, cause acute or chronic toxicity to the most sensitive biota dependent upon those waters, or adversely affect public health	

Source: Washington Department of Ecology (http://www.ecy.wa.gov/programs/wq/swqs/index.html)

303(d) Listed Impairments

The 2008 303(d) list of impaired waters is on the Ecology website at: http://www.ecy.wa.gov/programs/wq/303d/index.html

The Salmon Creek mainstem has multiple reaches listed within or upstream of the Salmon Creek (RM 00.60) subwatershed, including Category 4a (polluted waters that have an existing TMDL) listings for fecal coliform and turbidity, Category 5 listings (polluted waters that require a TMDL) for temperature, dissolved oxygen, and pH; and additional Category 2 (waters of concern) listings for temperature, dissolved oxygen, and pH. The Salmon Creek (RM 00.60) subwatershed is included in ongoing TMDL implementation for fecal coliform and turbidity, and in TMDL development for water temperature.

There are no 303(d) listed streams or active TMDLs within the Lakeshore subwatershed. However, these small streams drain to Lake River and/or Vancouver Lake, both of which are listed for multiple parameters in both water quality and fish tissue categories.

Clark County Stream Health Report

In 2004, the CWP compiled available data and produced the first county-wide assessment of general water quality.

Based on the available dataset including fecal coliform bacteria, general water chemistry (temperature, pH, and dissolved oxygen), and benthic macroinvertebrate scores, overall stream health in the Salmon Creek (RM 00.60) subwatershed scored in the poor range. Streams in the Lakeshore subwatershed were not rated in the Stream Health Report.

The 2004 Stream Health Report may be viewed on the county website at: http://www.clark.wa.gov/water-resources/stream.html.

Available Data

A considerable dataset is available for this assessment area; however, the majority of this data comes from the Salmon Creek (RM 00.60) subwatershed. A limited dataset is available for the Lakeshore subwatershed.

A full review and summary of available data and studies relevant to Salmon Creek is beyond the scope of this document. This summary focuses primarily on recent water quality data collected by the CWP including monthly water quality data from lower Salmon Creek (2002 through 2008) and the Lakeshore area (2008-2009), and temperature data collected during the summer of 2003. Associated reports may be viewed on the CWP website at: http://www.clark.wa.gov/water-resources/documents-monitoring.html#strmac. The Lakeshore 2008-2009 report will be available in summer 2010.

In 2009, Ecology (Collyard, 2009) completed a report titled Salmon Creek Nonpoint Source Pollution Total Maximum Daily Load: Water Quality Effectiveness Monitoring (Publication No. 09-03-042). The report incorporates much of the County's available water quality data and is available on the Salmon Creek TMDL website at: http://www.ecy.wa.gov/programs/wq/tmdl/SalmonCr/SalmonCr.html.
Some information from the Ecology report is summarized in this assessment.

Data and information sources reviewed or summarized as part of this water quality characterization are listed in Table 4.

Table 4: Data Sources

Source	Data and/or Report
Clark County Clean Water Program	2002-2008 Long-term Index Site Project 2004 Stream Health Report Salmon Creek Watershed Summer 2003 Stream Temperature 2008-2009 Lakeshore Characterization data
Ecology	2009 Salmon Creek Nonpoint Source Pollution TMDL: water quality effectiveness monitoring report
Washington State University	Stream Water Quality and Predictors of Stream Nutrient Concentrations in Clark County, WA

Water Quality Summary

Figure 3 shows the location of monitoring stations referenced in this assessment. Long-term monthly data is collected at Station SMN010 (Salmon Creek @ NW 36th Avenue). Station SMN010 was also included in the Salmon Creek Watershed Summer 2003 Stream Temperature study.

Seven stations in the Lakeshore subwatershed were sampled monthly from October 2008 through September 2009. Six of these stations were surface waters or piped segments of streams, including:

- CHK007 (Chicken Creek @ BNSF Railroad)
- CHK010 (Chicken Creek upstream of NW Bacon Road)
- FL301 (Lake River trib north of NW 99th Street)
- FL302 (Lake River trib south of NW 118th Circle)
- GM14155 (StormwaterClk database gravity main #14155, near NW 120th Street and NW 42nd Avenue)
- MH414 (StormwaterClk database manhole #414, near Lakeshore and 83rd Street)

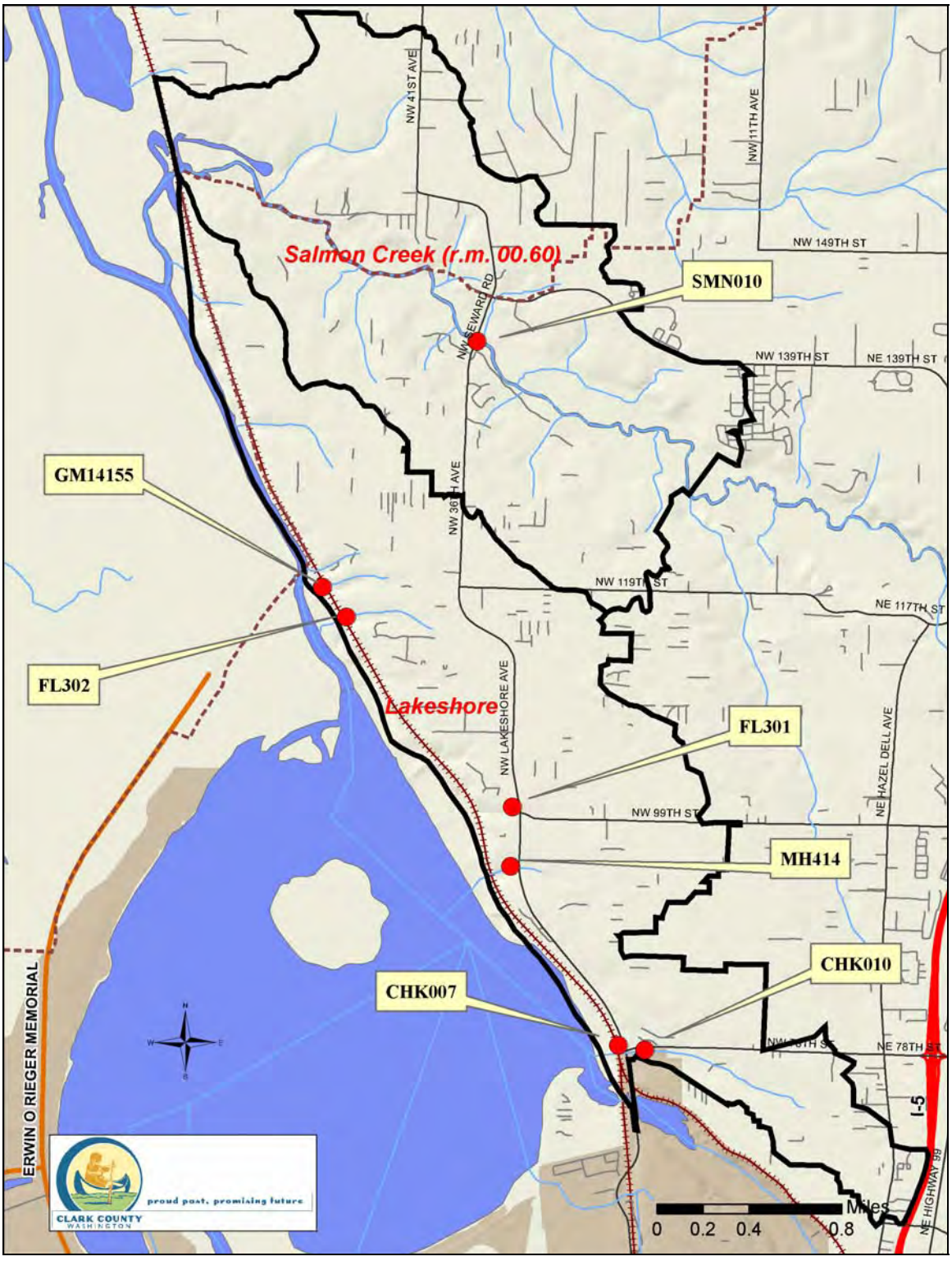


Figure 3: Location of monitoring stations

Oregon Water Quality Index (OWQI) Scores

The OWQI was developed by the Oregon Department of Environmental Quality (ODEQ) as a way to improve understanding of water quality issues by integrating multiple characteristics, and generating a score that describes water quality status (Cude, 2001). It is intended to provide a simple and concise method for expressing ambient water quality.

The OWQI integrates eight water quality variables: temperature; dissolved oxygen; biochemical oxygen demand; pH; ammonia + nitrate nitrogen; total phosphorus; total solids; and fecal coliform. For each sampling event, individual sub-index scores and an overall index score are calculated. Overall index scores are aggregated into low flow (June through September) and high flow (October through May) seasons and a seasonal mean value is then calculated.

Index scores are categorized as follows:
very poor = 0 to 59; poor = 60 to 79; fair = 80 to 84; good = 85 to 89, and; excellent = 90 to 100.

Figure 4 shows seasonal mean OWQI scores for Station SMN010 from 2002 through 2008. Among 15 long-term monitoring stations county-wide, Station SMN010 ranked tied for fifth-worst in overall water quality during this time period (Hutton and Hoxeng, 2007).

Monthly OWQI values ranged from Very Poor to Good, and tended toward the middle of this range, as 57 of 74 months had OWQI values in the poor or fair category. Monthly sub-index scores for inorganic nitrogen (73 of 74 months) and total solids (71 of 74 months) were consistently poor to very poor. Fecal coliform scores were typically good to excellent, with scattered lower scores. Scores for total phosphorus ranged widely, tending to fall in the fair to good range. Dissolved oxygen also ranged widely, with the majority of scores good to excellent. Scores for water temperature and pH were typically excellent, with occasional poor scores for temperature.

Data analysis for the Lakeshore characterization is ongoing as of February 2010. Preliminary OWQI sub-index scores indicate fecal coliform varied widely at all stations, from very poor to excellent. Total solids scores also ranged widely, with each station receiving very poor scores at some point during the study; station FL301 and MH414 scored in the excellent category on at least one occasion. The lowest scores for total solids were consistently at FL302 and GM14155. Total phosphorus scores ranged from very poor to poor at CHK010, FL302, and GM14155; very poor to fair at CHK007 and FL301, and; very poor to good at MH414.

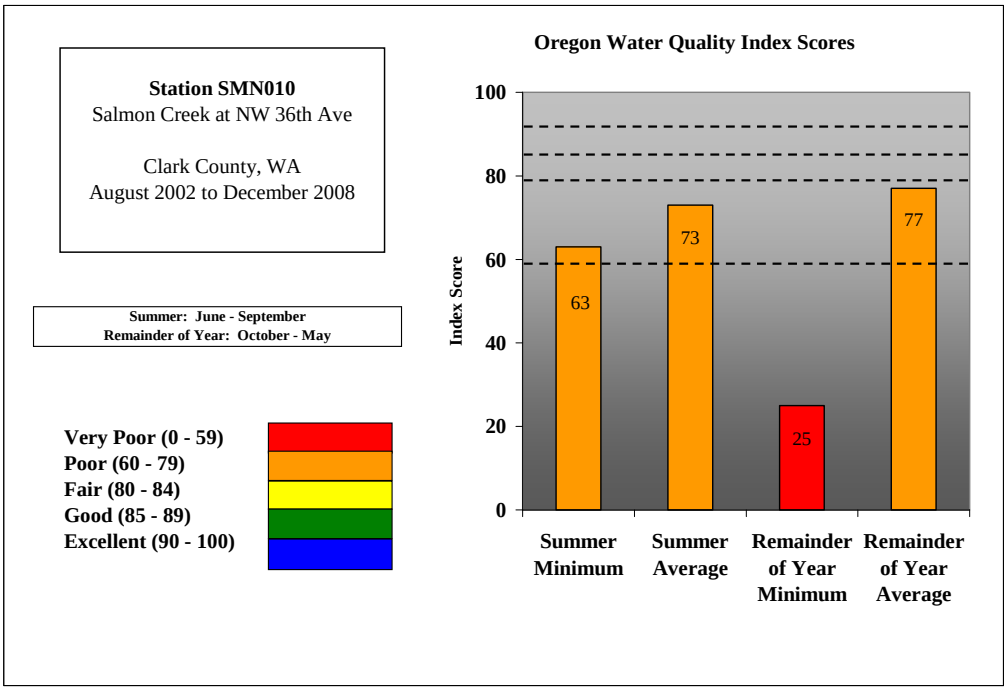


Figure 4: Average Water Quality, Salmon Creek station SMN010, 2002 through 2008, Oregon Water Quality Index

Trends Over Time

An analysis of potential statistical trends in OWQI scores based on the 2002 through 2006 dataset found no significant trends at Station SMN010 (Hutton and Hoxeng, 2007).

Ecology (Collyard, 2009) used a step-trend analysis to evaluate data collected at SMN010 between 1988 and 2007. Statistically significant decreasing trends were found in fecal coliform (wet season only), nitrate-nitrite, and total phosphorus concentration at both locations.

Nutrients

Nutrient criteria are not established for Washington streams. EPA suggests a total phosphorus criterion of 0.100 mg/L for most streams, and 0.050 mg/L for streams which enter lakes (EPA, 1986). EPA nitrate criteria are focused on drinking water standards and are not generally applicable to aquatic life issues.

Phosphorus and nitrogen in excess may contribute to elevated levels of algal or plant growth, especially in slower moving, low gradient streams, or in downstream water bodies.

Total phosphorus samples from Station SMN010 between August 2002 and December 2008 ranged from 0.020 mg/L to 0.192 mg/L; only seven percent of samples (5 of 74) exceeded the EPA criterion.

In the Lakeshore characterization, for all stations combined, 72% of samples (42 of 58) exceeded the EPA criterion for streams; 97% (56 of 58) exceeded the criteria for streams entering lakes. Individual samples ranged from 0.036 mg/L to 0.458 mg/L, with the highest levels at every

station occurring during the November 20, 2008 sampling event. Over 1/3 inch of rain fell on that day, following several days of heavy rainfall.

Turbidity

Ecology (Collyard, 2009) found that all stations on Salmon Creek and tributaries met the TMDL target levels based on a comparison between 1988-1994 and 2005-2007 data. This includes station SMN010 within this assessment area. 90th percentile values decreased by 63%.

Since June 2002, the median of 79 turbidity samples at Station SMN010 is 4.6 NTU, with individual samples ranging from 2 NTU to 31 NTU.

Fecal Coliform Bacteria

For a full analysis based on the fecal coliform TMDL, see Collyard, 2009. General results from that report are summarized below.

Based on monthly data from 2005 - 2007, geometric mean fecal coliform concentrations at Station SMN010 declined sharply during both the wet and dry seasons when compared to values from the 1995 TMDL (Table 5). Station SMN010 is one of two stations which met the geometric mean criteria during both the wet season and dry season.

90th percentile values decreased substantially during the wet season, and decreased slightly during the dry season (Table 6). Despite improvements, Station SMN010 still failed the criterion during both wet and dry seasons.

Based solely on fecal coliform data, this station ranked fourth-best among 15 long-term stations in Clark County from 2002 through 2006 (Hutton and Hoxeng, 2007).

Table 5: 1995 TMDL study fecal coliform criterion compared to 2005-7 Clark County data (from Collyard, 2009)

Geometric mean values for wet and dry seasons.

Station	Wet season					Dry season				
	TMDL	05-07	% change[1]	Meets criterion?	% Required change[2]	TMDL	05-07	% change[1]	Meets criterion?	% Required change[2]
SMN010	313	59	-82	Yes	none	129	90	-30	Yes	none
CGR020	722	143	-80	No	30	899	696	-23	No	86
SMN030	182	42	-77	Yes	none	281	151	-46	No	34
MIL010	839	50	-94	Yes	none	282	106	-62	No	6
CUR020	1155	23	-98	Yes	none	743	116	-84	No	14
SMN050	234	21	-91	Yes	none	751	106	-86	No	6
WDN	534	71	-87	Yes	none	857	184	-79	No	46
SMN080	28	6	-79	Yes	none	54	34	-35	Yes	none

[1] Percent change required to meet TMDL target limits.
[2] Additional change required to meet TMDL target limits.

Table 6: 2001 TMDL report fecal coliform criterion compared to 2005-7 Clark County data (from Collyard, 2009)

90th percentile values for wet and dry seasons.

Station	Wet season					Dry season				
	TMDL	05-07	% change[1]	Meets criterion?	% Required change[2]	TMDL	05-07	% change[1]	Meets criterion?	% Required change[2]
SMN010	1917	321	-83	No	-38	301	347	-15	No	-42
CGR020	9243	601	-93	No	-67	1803	1577	-13	No	-87
SMN030	1261	194	-85	Yes	none	806	342	-58	No	-36
MIL010	8763	381	-96	No	-48	1121	483	-57	No	-59
CUR020	4409	93	-98	Yes	none	2608	472	-82	No	-58
SMN050	1125	138	-88	Yes	none	1404	346	-75	No	-42
WDN	9204	468	-95	No	-57	6509	628	-90	No	-68
SMN080	200	22	-89	Yes	none	318	98	-69	Yes	none

[1] Percent change required to meet TMDL target limits.
[2] Additional change required to meet TMDL target limits.

Preliminary analysis indicates all but one of the stations in the Lakeshore characterization study failed both parts of the state criteria in both the wet and dry seasons. Station FL302 met the geometric mean criterion in both seasons, and met the 90th percentile criterion during summer. Monthly values in the study were highly variable both spatially and seasonally, with some stations having higher concentrations in summer and others in winter. It is likely that multiple bacteria sources are contributing to the observed variability.

Stream Temperature

One summer of continuous temperature monitoring (2003) at Station SMN010 was conducted as part of the Salmon Creek Watershed Summer 2003 Stream Temperature project.

Figure 5 shows 7-DADMax temperatures during the summer of 2003 for 15 stations throughout the Salmon Creek watershed. The 7-DADMax is the maximum of the 7-day moving average of daily maximum temperatures. Ecology standards utilize this metric to determine temperature compliance (currently the criterion for this assessment area is 60.8 degrees F. At the time of the study, the criterion was 64 degrees F).

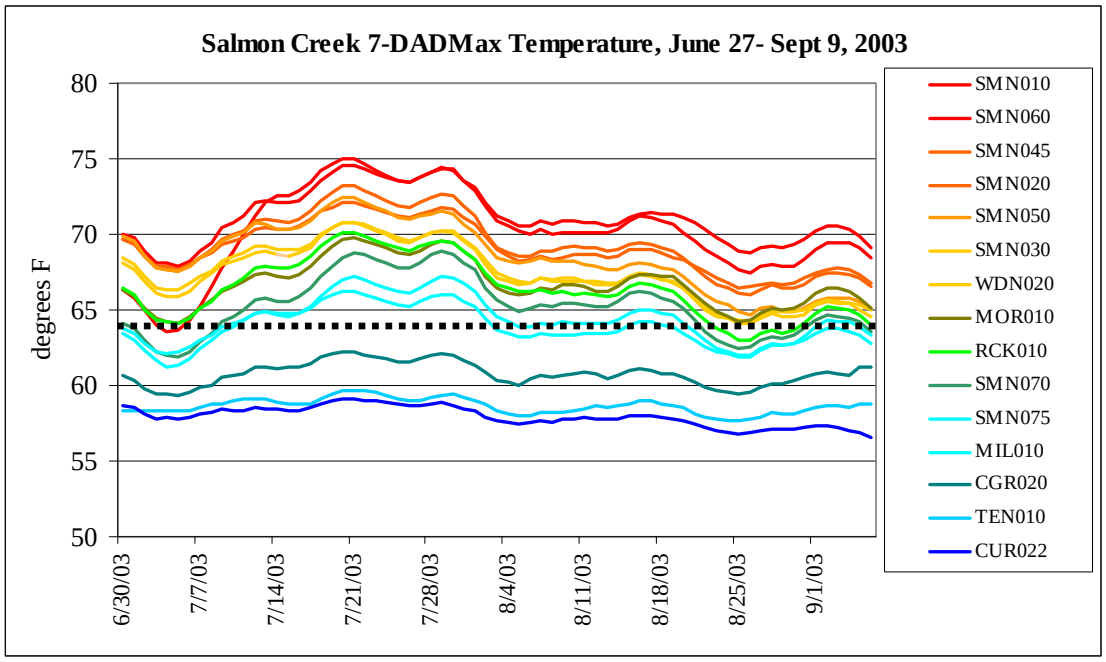


Figure 5: Time series plot of 7-DADMax temperatures, Salmon Creek, summer 2003. (from Schnabel, 2004). Dotted line at 64 F represents the pre-2006 Washington state stream temperature criterion. The current criterion is 60.8 F.

Salmon Creek at Station SMN010 exceeded the current state criterion by almost 15 degrees F. This station had the highest temperatures recorded during the study, and spent very lengthy time periods with elevated temperatures. On at least 75 days, temperatures at SMN010 exceeded 64 degrees F for an average of 19 hours per day. Water temperatures in lower Salmon Creek reflect the cumulative impact of heating throughout the watershed. Due to the width of Salmon Creek and limited shade in the lower watershed, there is significant exposure to solar heating and little opportunity for the water to cool. Even substantial inputs of cool water from Tenny, Curtin, and Cougar Creek are insufficient to lower temperatures at Station SMN010.

Impacts to Beneficial Uses and Potential Sources

General water quality in this assessment area is poor, although significant improvements have been observed throughout Salmon Creek, particularly in fecal coliform, turbidity, and nutrients. Despite improvements, impacts to listed beneficial uses in the lower creek include core summer salmonid habitat from elevated temperatures, and primary contact recreation as indicated by fecal coliform bacteria. Based on preliminary analysis, in the Lakeshore subwatershed primary contact recreation is impacted by fecal coliform; nutrient concentrations appear to be high enough to contribute to excess algal growth in downstream water bodies. Table 7 at the conclusion of this section summarizes the primary water quality impacts to beneficial uses in Salmon Creek (RM 00.60) and Lakeshore, and probable sources of the observed impact.

Implications for Stormwater Management

Table 7 lists the primary known water quality concerns and potential solutions for each. Solutions listed in bold indicate areas where CWP activities can have a positive impact. It should be noted

that CWP activities, though important, are not likely to achieve water quality improvement goals on their own. Other county departments, local agencies, and not least of all, the public must all contribute to water quality improvement.

Table 7: Known Water Quality Concerns, Sources, and Solutions for Lakeshore and Salmon Creek (RM 00.60)

Characteristic	Beneficial Use Affected	Potential Sources	Mechanism	Solutions (bold indicates direct Clean Water Program involvement)
Fecal coliform bacteria	Primary contact recreation	failing septic systems	groundwater seeps storm sewers	**Storm sewer screening for source identification and removal** **Education programs** Agricultural Best Management Practices Septic and sanitary sewer system inspection and maintenance
		sanitary sewer leaks	groundwater seeps storm sewers	
		livestock, pets, wildlife	overland runoff storm sewers direct access	
Water temperature	Core summer salmonid habitat	vegetation removal	direct solar radiation	**Stormwater infiltration to increase baseflows** **Education programs** Pond removal or limitation
		low summer flows	decreased resistance to thermal inputs	
Total phosphorus (Lakeshore only)	Aesthetic enjoyment	natural groundwater fertilizers erosion livestock, pets, wildlife	overland runoff storm sewers direct access	Erosion control regulations **Storm sewer system cleaning and maintenance** **Education programs**

Drainage System Inventory and Condition

Inventory

Clark County's drainage system inventory resides in the StormwaterClk GIS database and is available to users through the county's Department of Assessment and GIS, or viewable on the internet through the Digital Atlas located at:
http://gis.clark.wa.gov/imf/imf.jsp?site=mapsonline

Drainage system inventory is an ongoing CWP work effort focused on updating the StormwaterClk database to include all existing stormwater drainage infrastructure. During 2008 and 2009, the inventory was a significant priority for the CWP, with a major work effort focused on identifying and mapping previously unmapped infrastructure and reviewing existing records for completeness and accuracy.

Table 8 indicates the number of features currently inventoried in StormwaterClk. Of the total 123 stormwater facilities, 66 are identified as publicly owned and operated.

Table 8: Drainage System Inventory Results, Lakeshore/Salmon Creek (RM 00.60)

Database Feature Category	Inventoried prior to 2007	Added during 2007-2009	Total Features
Inlet	1540	465	2005
Discharge Point (outfall)	34	71	105
Flow Control	65	28	93
Storage/Treatment	364	170	534
Manhole	932	166	1098
Filter System	7	17	24
Channel	391	331	722
Gravity Main	3009	961	3970
Facilities	66	57	123

Condition

Stormwater system condition is assessed based on three components:

- An evaluation of retrofit opportunities at public stormwater facilities
- An inspection and maintenance evaluation at public stormwater facilities
- An off-site assessment to check for outfall-related problems in downstream receiving waters

Component 1: Retrofit Evaluation

Purpose

The purpose of this component is to identify existing public stormwater facilities that may be retrofitted to provide additional storage or treatment, beyond the level intended during original construction.

Methods

The evaluation is conducted at all public stormwater facilities that contain the following facility components: detention ponds, treatment wetlands, wet ponds, pre-settling cells, open filters, or bioswales; and discharge to surface waters or to the stormwater drainage infrastructure that eventually discharges to surface waters.

The retrofit evaluation includes a review of the drainage area, stormwater infrastructure condition, facility lot size, ownership of adjacent parcels, and the functionality of the facility objects listed above. Facilities or parcels with the potential to provide additional storage and/or treatment of stormwater are referred as "potential retrofit" opportunities for further evaluation as Capital Improvement Projects.

Results

Based on the county's StormwaterClk database, as of July 2009, there were 40 mapped public stormwater facilities in the Lakeshore subwatershed and 22 mapped public stormwater facilities in the Salmon Creek (RM 00.60) subwatershed.

Fifty-eight percent (23) of the mapped public stormwater facilities in the Lakeshore subwatershed were evaluated for retrofit opportunities. In the Salmon Creek (RM 00.60) subwatershed, ninety-one percent (20) of the mapped public stormwater facilities were evaluated for retrofit opportunities.

Figure 6 and Figure 7 summarize notable retrofit evaluation activities in the Lakeshore and Salmon Creek (RM 00.60) subwatersheds, including general facility location, evaluated facilities, and referrals for retrofit opportunities.

As listed in Table 9, fifteen public stormwater facilities were referred for further evaluation as Capital Improvement Projects in the Lakeshore and Salmon Creek (RM 00.60) subwatersheds.

The Lakeshore subwatershed generated 11 referrals for further evaluation as Capital Improvement Projects; nine of which included an increase for potential storage as part of the project description. The average age of the facility referred was 13.1 years. The majority of the facilities referred had large lots that contained little storage or minimum treatment abilities. All but one of the facilities referred contained a bioswale as a component of the facility.

The Salmon Creek (RM 00.60) subwatershed generated 4 referrals for further evaluation as Capital Improvement Projects; three included an increase for potential storage as part of the project description. The average age of the facility referred was 14.3 years.

Two of the facilities referred had detention ponds with sedimentation issues. One major defect and hazardous condition was discovered in the Salmon Creek (RM 00.60) subwatershed and included a failure of a bioswale (Eagle Ridge/Miller Est 2, facility ID 770) creating severe erosion issues. This facility was referred to a CWP engineer as well as further evaluation as a Capital Improvement Project.

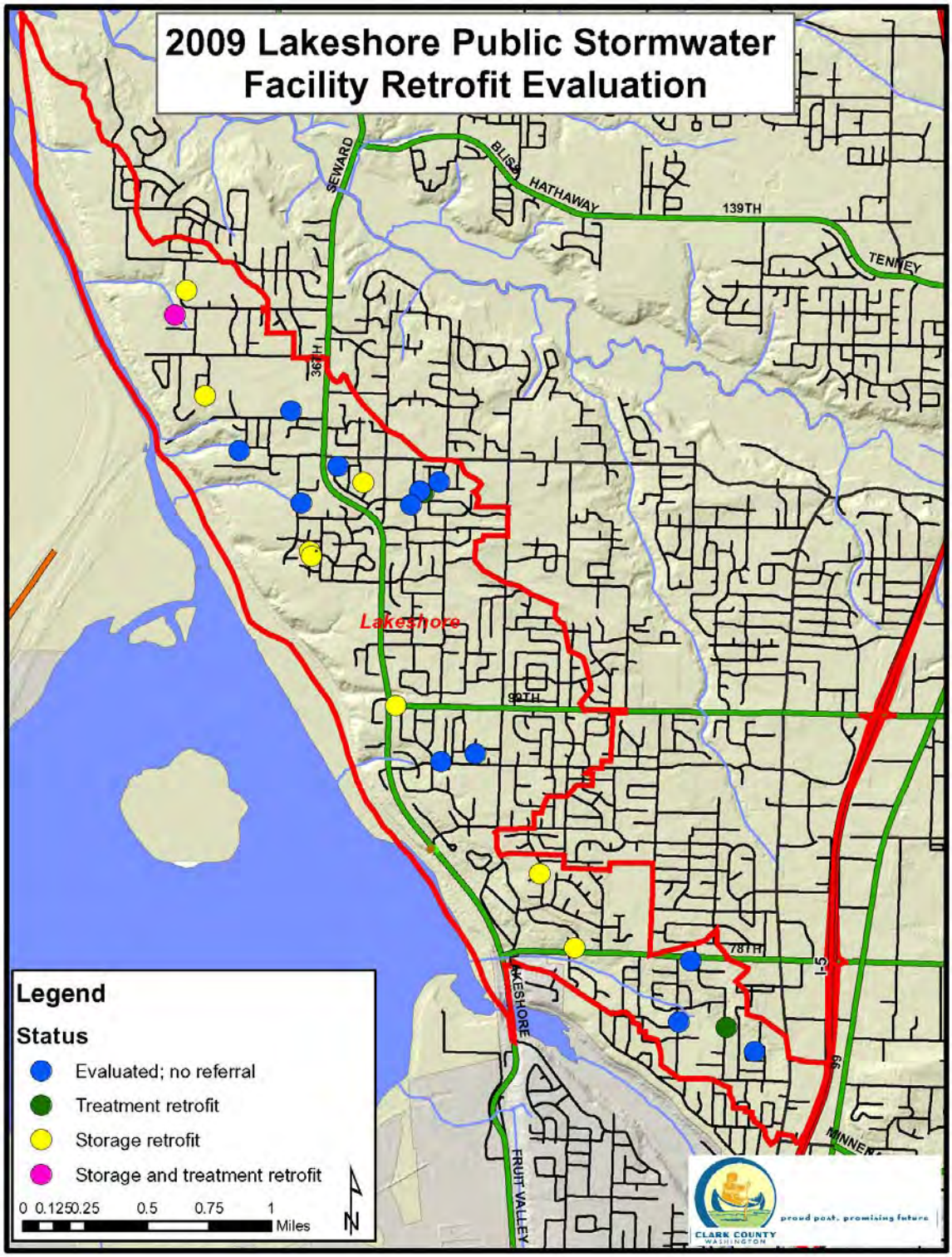


Figure 6: Summary of 2009 Retrofit Evaluation Activities in the Lakeshore subwatershed

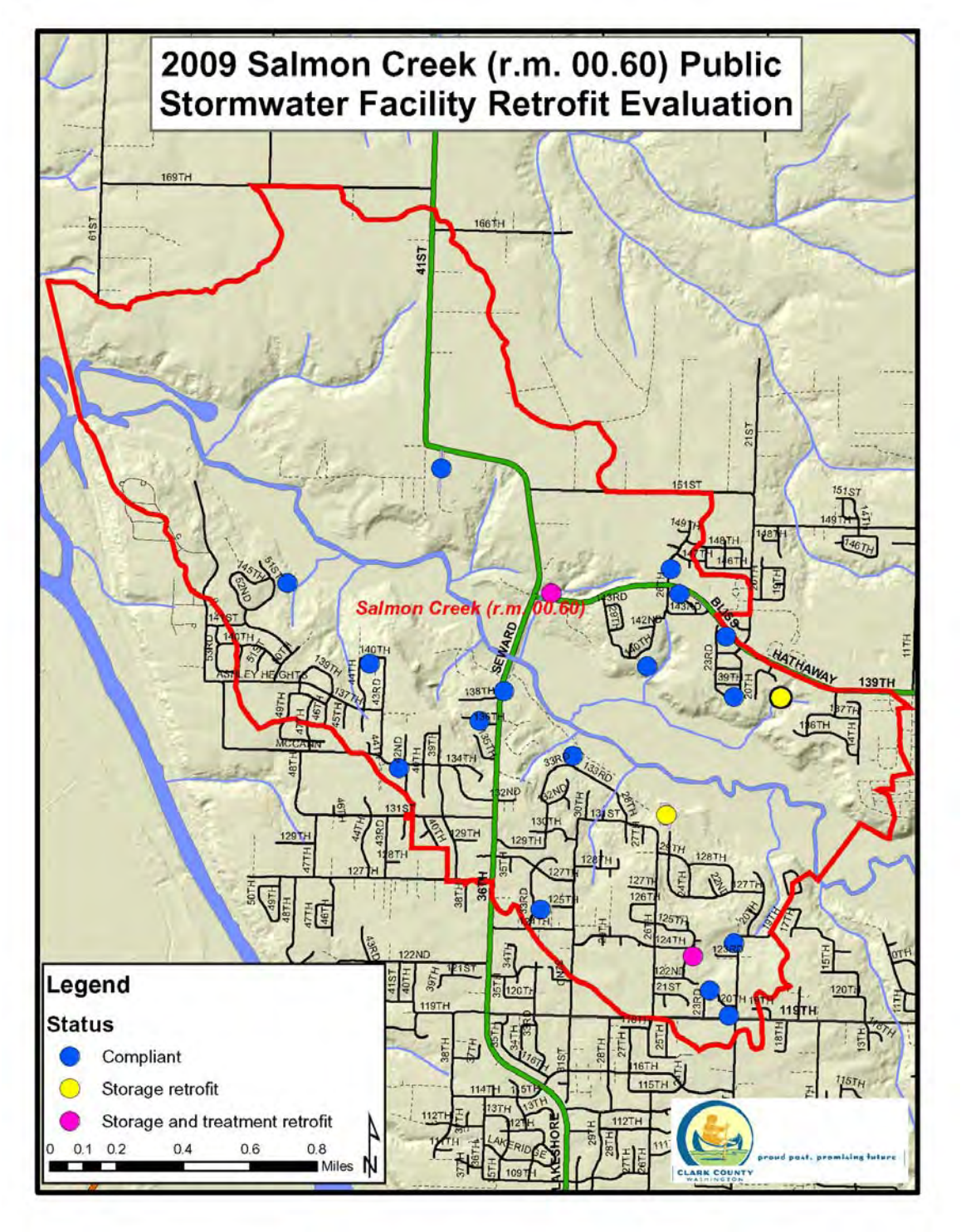


Figure 7: Summary of 2009 Retrofit Evaluation Activities in the Salmon Creek (RM 00.60) subwatershed

Table 9: Description of Potential Retrofit Opportunities in Lakeshore and Salmon Creek (RM 00.60) subwatersheds

Identifier	Facility Name	Unique ID	Install Date	Basis for Project	Project Description	Sub-watershed
CIP-32	Felida Village	8	01-Feb-99	Large lot with little infrastructure	Potential storage retrofit	Lakeshore
OS-123	Millers Edge	20	21-Dec-99	Swale and detention pond area can be enhanced to better treat stormwater	Potential storage retrofit	Lakeshore
OS-124	Lakeview Estates V	78	11-Jul-01	Large lot with little infrastructure	Potential storage retrofit	Lakeshore
OS-95	Lakeshore & NW 99th St	89	1983	Large lot with little infrastructure	Potential storage retrofit	Lakeshore
CIP-30	Felida Knolls	97	22-Jun-98	Swale is not functioning adequately.	Potential storage and treatment retrofit	Lakeshore
OS-125	Gregory Place	771	01-Nov-94	Large lot with little infrastructure	Potential storage retrofit	Lakeshore
OS-126	Celia Meadows	1509	01-Dec-98	Large lot with non-existent swale. Little detention.	Potential storage and treatment retrofit	Lakeshore
OS-127	Effinger Subdivision	1520	06-Oct-99	Large lot with little infrastructure	Potential storage retrofit	Lakeshore
OS-128	Parkside Estates	1602	25-Sep-92	Potential retrofit of bioswale or installation of LID practices	Potential treatment retrofit	Lakeshore
OS-129	West of Westmore	1871	25-Sep-98	Large lot with little infrastructure	Potential storage retrofit	Lakeshore

Identifier	Facility Name	Unique ID	Install Date	Basis for Project	Project Description	Sub-watershed
OS-131	Tiare Hills IV	1223	29-Dec-94	Potential treatment retrofit. Half of swale has been converted to yard area. Looks like it is still draining, but not functioning as designed.	Potential treatment retrofit; engineer referral	Lakeshore
OS-130	Clomont/ Miller Estates	731	01-Oct-97	Sedimentation of detention pond; large lot with little infrastructure	Potential storage and treatment retrofit	Salmon Creek (RM 00.60)
OS-	Ridge Creek West	596	10-May-90	Sedimentation of detention pond; large lot with little infrastructure	Potential storage and treatment retrofit	Salmon Creek (RM 00.60)
CIP-11	Eagle Ridge/ Miller Est 2	770	01-Aug-98	Swale failure; hole in swale and piping down hillside.	Potential treatment retrofit; Engineer referral	Salmon Creek (RM 00.60)
OS-	NW Bliss/ NW 36th Ave	1932	01-Jan-94	Large lot with little infrastructure	Potential storage and treatment retrofit	Salmon Creek (RM 00.60)

Component 2: Inspection and Maintenance Evaluation

Purpose

The inspection and maintenance evaluation verifies that maintenance activities are implemented and facilities are properly functioning.

Methods

The inspection and maintenance evaluation is conducted at public stormwater facilities in conjunction with retrofit evaluations. Public stormwater facilities that contain the following facility components are evaluated: detention ponds, treatment wetlands, wet ponds, pre-settling cells, open filters, or bioswales; and discharge to surface waters or to the stormwater drainage infrastructure that eventually discharges to surface waters.

Public stormwater facilities that contain filter systems, buried detention or retention vaults, and facilities that infiltrate stormwater are typically not included in this evaluation, but may be inspected on a case-by-case basis as resources allow.

The evaluation is conducted using county and state standards equivalent to maintenance standards specified in Chapter 4 of Volume V of the 2005 Stormwater Management Manual for Western Washington. The standards list the part or component of the facility, the condition when repair or maintenance is needed, and the results expected when maintenance is performed. Individual components of a facility are referred to as "facility objects."

The inspection and maintenance evaluation process involves inspecting all facility objects to determine if maintenance complies with the standards. If any facility object fails to meet the maintenance standards, the entire facility is not in compliance. Noncompliant stormwater facilities are referred to the appropriate department for repairs or maintenance.

Results

Maintenance evaluation activities were conducted at 43 public stormwater facilities within the Lakeshore and Salmon Creek (RM 00.60) subwatersheds.

Figure 8 summarizes notable inspection and maintenance evaluation activities in the Lakeshore subwatershed, including general facility location, compliant facilities, and referrals of noncompliant facilities.

Twenty-three public stormwater facilities were inspected in the Lakeshore subwatershed. Thirteen facilities were found to be out of compliance and ten facilities were found to be in compliance. As listed in Table 10, these facilities included a total of 138 facility objects, of which 116 (84 percent) were in compliance.

The inspection process in the Lakeshore subwatershed generated 13 referrals to Public Works Maintenance and Operations for needed maintenance activities.

No major defects or hazardous conditions were discovered in the Lakeshore subwatershed; non-compliant issues included excess sediment depth and vegetative management issues.

Figure 9 summarize notable inspection and maintenance evaluation activities in the Salmon Creek (RM 00.60) subwatershed, including general facility location, compliant facilities, and referrals of noncompliant facilities.

As listed in Table 11, 22 public stormwater facilities were inspected in the Salmon Creek (RM 00.60) subwatershed. Fifteen facilities were found to be out of compliance and seven facilities were found to be in compliance. These facilities included a total of 169 facility objects, of which 137 (81 percent) were in compliance.

The inspection process in the Salmon Creek (RM 00.60) subwatershed generated 15 referrals: one referral to the CWP Stormwater engineer, and 14 referrals to Public Works Maintenance and Operations for needed maintenance activities.

One major defect and hazardous condition was discovered in the Salmon Creek (RM 00.60) subwatershed; a failing of a bioswale created severe erosion issues. This facility was referred to a CWP engineer to evaluate erosion severity and hillside stability.

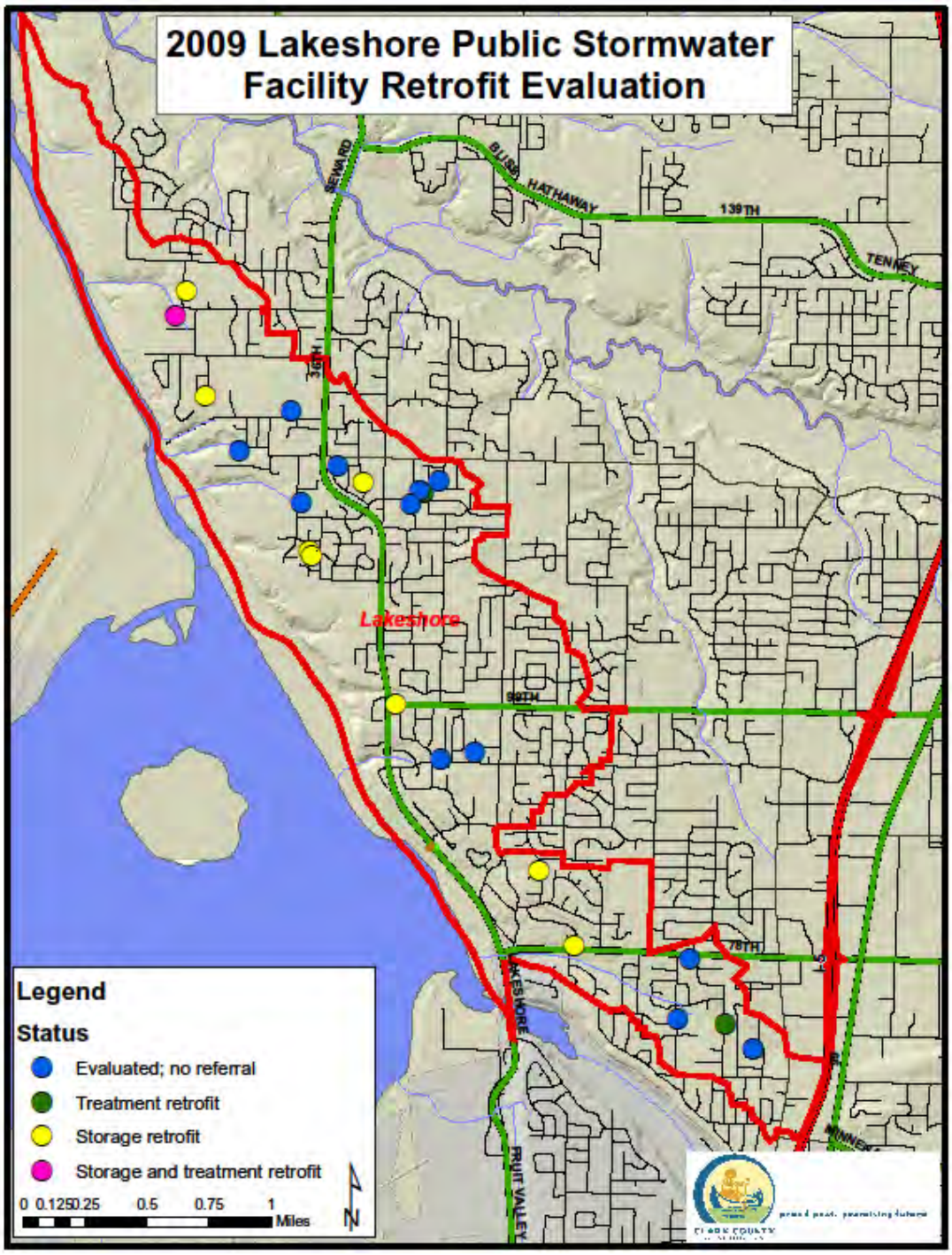
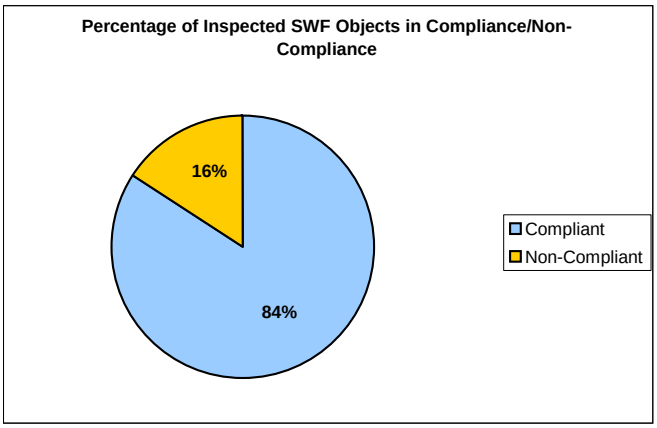


Figure 8: Summary of 2009 Public Stormwater Facility Inspection and Maintenance Evaluation Activities in the Lakeshore subwatershed

Table 10: 2009 Public Stormwater Facility Inspection and Maintenance Evaluation Activity in the Lakeshore subwatershed

SNAP Public Stormwater Facility Maintenance and Inspection Evaluation	
Subwatershed: Lakeshore	
Public SWF Inspected	23
Stormwater Facility Objects Inspected	138
% Compliant SWF Objects	84
% Non-Compliant SWF Objects	16



Facility Objects Inspected	Initial Inspections: Compliant	Initial Inspections: Non-Compliant	Most Common Defect	Maintenance Trigger
Access Road or Easement	22	1	access restricted	access restricted by private gate or lock
Catch Basin	2	0	n/a	n/a
Control Structure / Flow Restrictor	5	0	n/a	n/a
Conveyance Stormwater Pipe	16	2	sediment & debris	sediment depth is greater than 20% of pipe diameter
Detention Pond	8	0	n/a	n/a
Drywell	1	0	n/a	n/a
Energy Dissipater	12	1	sediment & debris	accumulated sediment that exceeds 20% of the design depth.
Facility Discharge Point	6	0	n/a	n/a
Fence, Gate or Water Quality Sign	13	1	sign unreadable	water quality sign is missing or 20% of the surface is unreadable
Field Inlet	13	0	n/a	n/a
Sediment Trap	3	7	Sediment	sediment that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin
Treatment Wetland	1	0	n/a	n/a
Typical Biofiltration Swale	11	10	sediment accumulation on grass	sediment depth exceeds 2 inches on grass
Wetpond	3	0	n/a	n/a
Total	**116**	**22**		

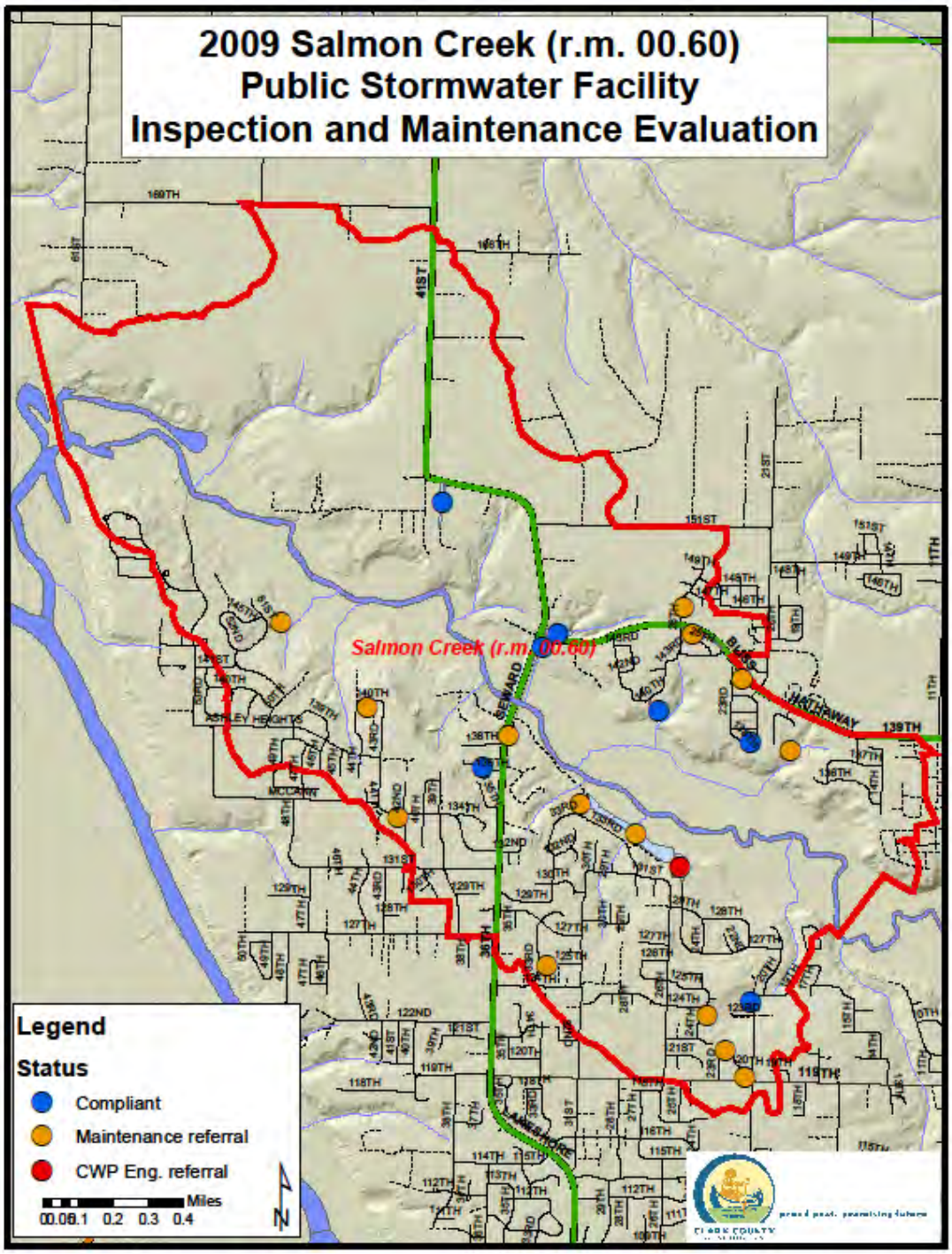
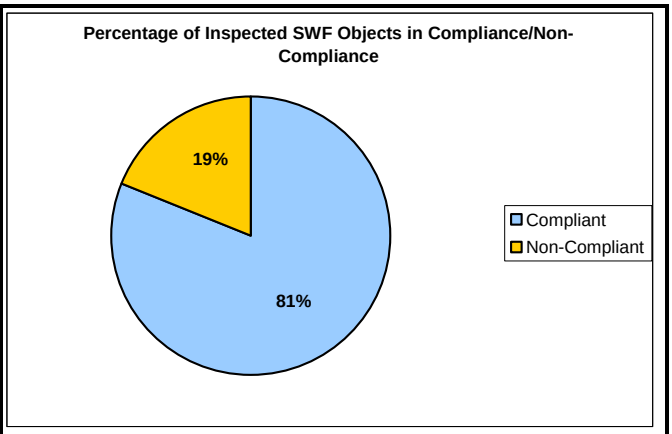


Figure 9: Summary of 2009 Public Stormwater Facility Inspection and Maintenance Evaluation Activities in the Salmon Creek (RM 00.60) subwatershed

Table 11: 2009 Public Stormwater Facility Inspection and Maintenance Evaluation Activity in the Salmon Creek (RM 0060) subwatershed

SNAP Public Stormwater Facility Maintenance and Inspection Evaluation	
Subwatershed: Salmon Creek (r.m. 00.60)	
Public SWF Inspected	22
Stormwater Facility Objects Inspected	169
% Compliant SWF Objects	81
% Non-Compliant SWF Objects	19



Facility Objects Inspected	Initial Inspections: Compliant	Initial Inspections: Non-Compliant	Most Common Defect	Maintenance Trigger
Access Road or Easement	22	0	n/a	n/a
Catch Basin	11	0	n/a	n/a
Control Structure / Flow Restrictor	7	2	cleanout gate damaged or missing	chain/rod leading to gate is missing or damaged
Conveyance Stormwater Pipe	28	0	n/a	n/a
Debris Barrier & Access Barrier	1	0	n/a	n/a
Detention Pond	16	2	sediment & debris	accumulated sediment exceeds 10% of the designed pond depth or affects inletting or outletting condition of the facility
Drywell	1	0	n/a	n/a
Energy Dissipater	10	2	erosion	soil erosion in or adjacent to rock pad.
Facility Discharge Point	3	0	n/a	n/a
Fence, Gate or Water Quality Sign	8	6	sign unreadable	water quality sign is missing or 20% of the surface is unreadable
Field Inlet	15	2	Sediment	sediment exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin
Infiltration Trench	1	0	n/a	n/a
Open Channel	1	0	n/a	n/a
Sediment Trap	3	3	Debris barrier clogged	trash and debris that is blocking more than 20% of grate surface inletting capacity
Treatment Wetland	1	0	n/a	n/a
Typical Biofiltration Swale	7	15	vegetation	grass is taller than 10 inches; nuisance weeds and other vegetation start to take over
Wetpond	2	0	n/a	n/a
Total	**137**	**32**		

Component 3: Offsite Assessment

Purpose

Discharges from stormwater outfalls can cause moderate to severe erosion as stormwater moves through the riparian zone and to the receiving water. Erosion creates a source of sediment to the stream due to incision and slope failures. It can also increase slope instability problems.

The Offsite Assessment looks for offsite or downstream problems associated with the county's storm sewer system, particularly from facility outfalls that discharge to critical areas.

Methods

County-owned and operated stormwater outfalls meeting one or more of the following criteria are included in the offsite assessment:

- Within 200 feet of a critical area (e.g. riparian, wellhead protection, landslide hazard, etc)
- Within 300 feet of a headwater stream
- Located on public land
- Originates from a public-dedicated facility currently under the two-year maintenance warranty bond

Stormwater outfalls are prioritized into three categories:

- Priority 1 outfalls are stormwater outfalls that discharge to landslide hazard areas outside of county road rights-of-way.
- Priority 2 outfalls are stormwater outfalls that discharge to all other critical areas outside of county road rights-of-way
- Priority 3 outfalls are stormwater outfalls that discharge to critical areas within county road rights-of-way

At a minimum, all Priority 1 outfalls are inspected. As resources allow, Priority 2 and Priority 3 outfalls may be inspected. If an outfall fails to meet the general outfall design criteria or is contributing to a downstream erosion problem, the outfall is not in compliance. Non-compliant outfalls are referred to the appropriate Public Works program for maintenance or repair, or in some cases referred as potential Capital Projects.

Results

Based on the county's StormwaterClk database, as of June 2009 there were 48 mapped outfalls in the Lakeshore subwatershed; 20 Priority 1 outfalls, no Priority 2 outfalls, and 28 Priority 3 outfalls.
In the Salmon Creek (RM 00.60) subwatershed there were 48 mapped outfalls; 20 Priority 1 outfalls, no Priority 2 outfalls, and 30 Priority 3 outfalls.

Figure 10and Figure 11 summarize notable outfall assessment activities including general outfall locations in each subwatershed.

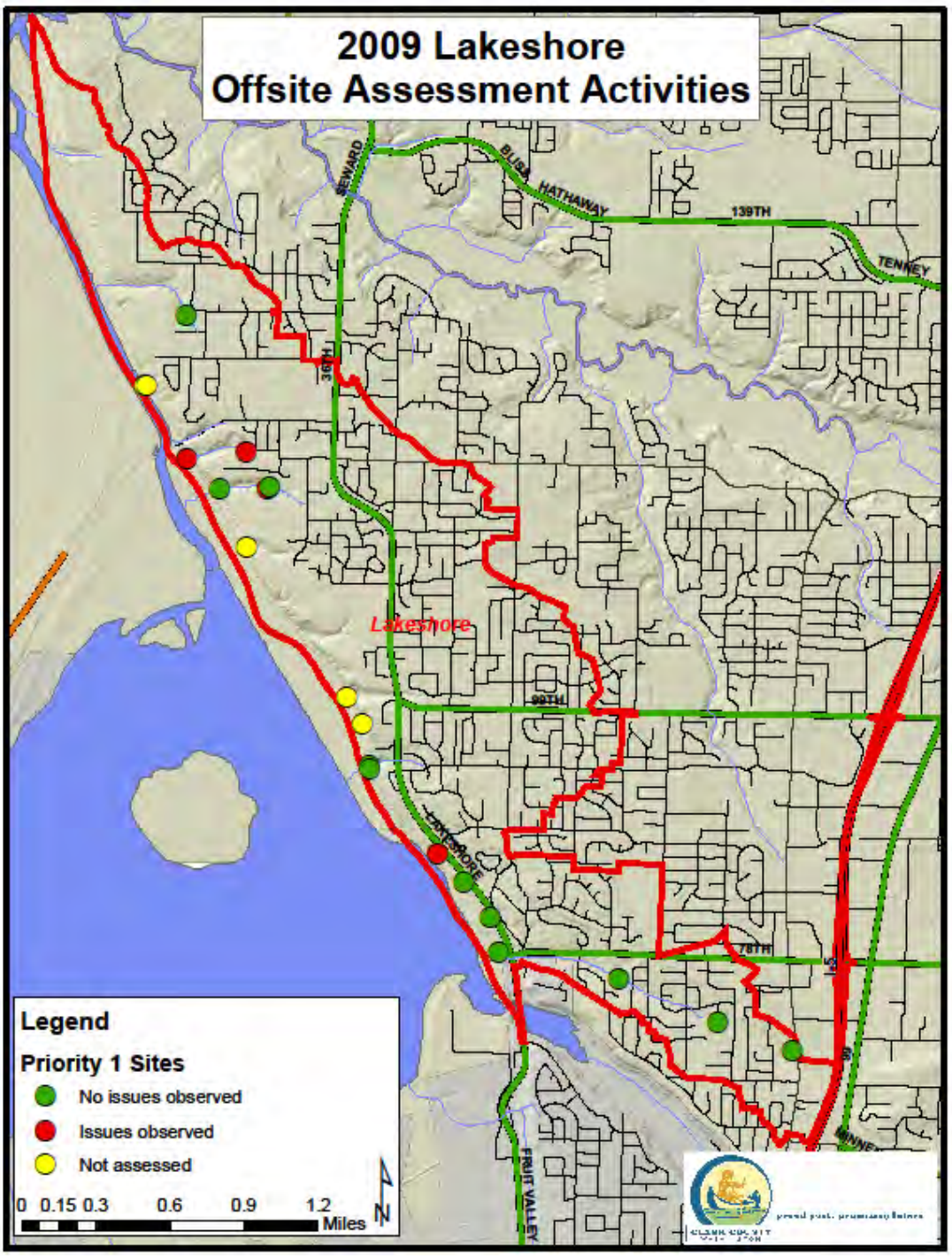


Figure 10: Summary of 2009 Off-site Assessment Activities in the Lakeshore subwatershed

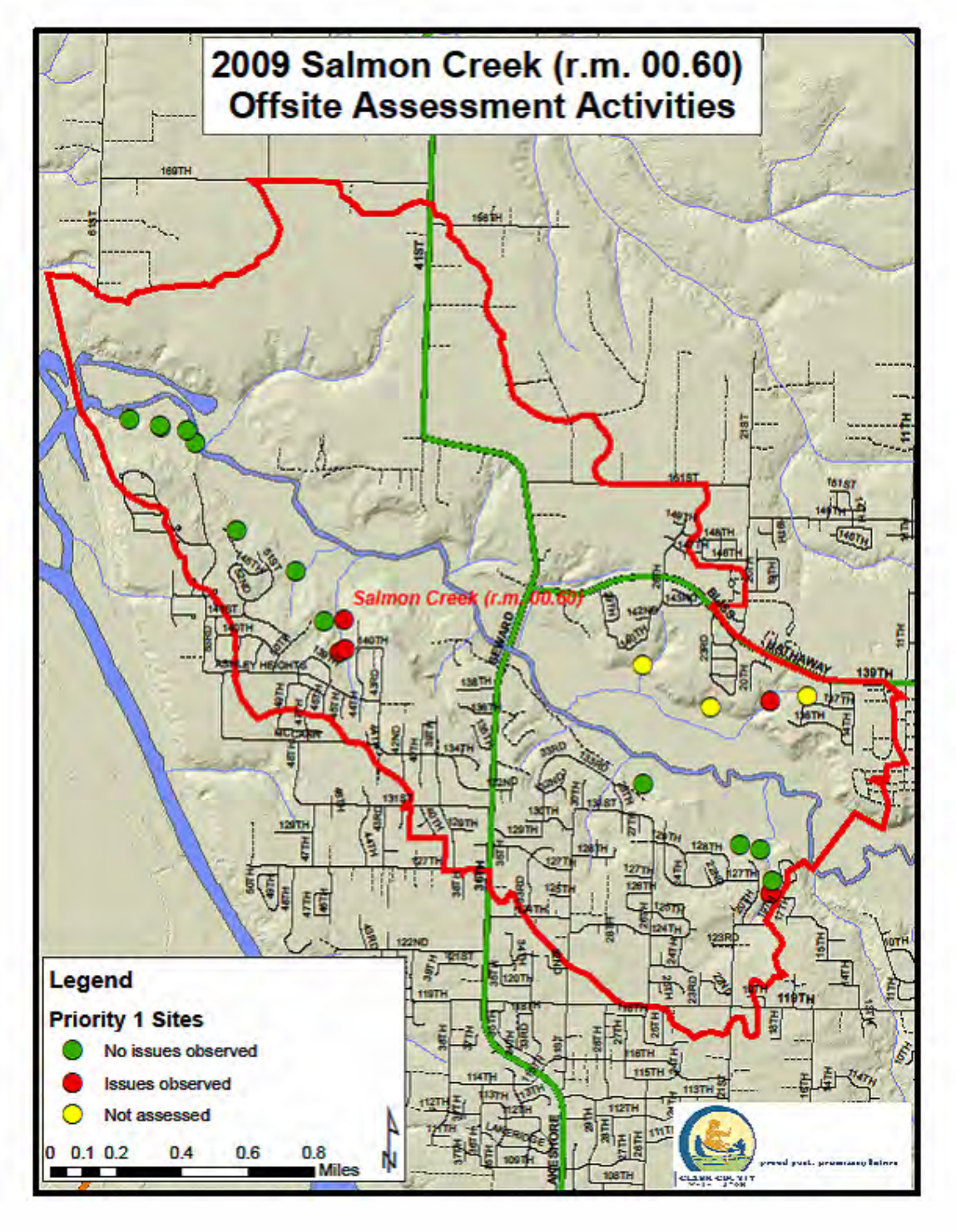


Figure 11: Summary of 2009 Off-site Assessment Activities in the Salmon Creek (RM 00.60) subwatershed

Table 12 summarizes offsite assessment results from the Lakeshore subwatershed. There were 20 mapped outfalls discharging to critical areas. Five of the 20 Priority 1 outfalls were inaccessible and not assessed. Fifteen Priority 1 outfalls were assessed, of which eleven were found to be in compliance. No Priority 3 outfalls were assessed.

Table 12: 2009 Off-site Assessment Project Activity Summary for Lakeshore subwatershed

Metric	Number of Outfalls		
	Priority 1	Priority 2	Priority 3
Total number of mapped outfalls	20	0	28
# of outfalls assessed	15	n/a	0
# of outfalls compliant	11	n/a	n/a
# of noncompliant outfalls	4	n/a	n/a
# of referrals initiated	4	n/a	n/a
# of referrals ongoing	4	n/a	n/a
# of outfalls fixed	0	n/a	n/a

Table 13 summarizes offsite assessment results from the Salmon Creek (RM 00.60) subwatershed. There were 20 mapped outfalls discharging to critical areas. Three of the 20 Priority 1 outfalls were inaccessible and not assessed. Seventeen Priority 1 outfalls were assessed, of which eleven were found to be in compliance. No Priority 3 outfalls were assessed.

Table 13: 2009 Off-site Assessment Project Activity Summary for Salmon Creek (RM 00.60) subwatershed

Metric	Number of Outfalls		
	Priority 1	Priority 2	Priority 3
Total number of mapped outfalls	20	0	31
# of outfalls assessed	17	n/a	0
# of outfalls compliant	12	n/a	n/a
# of noncompliant outfalls	5	n/a	n/a
# of referrals initiated	4	n/a	n/a
# of referrals ongoing	4	n/a	n/a
# of outfalls fixed	0	n/a	n/a

Potential Projects

The offsite assessment project yielded eight potential project opportunities; four in the Lakeshore subwatershed and four in the Salmon Creek (RM 00.60) subwatershed. These opportunities include stabilizing banks, installation of energy dissipaters, and flow reduction enhancement (Table 14).

Table 14: Description of Potential Project Opportunities

Identifier	Outfall ID	Basis for Project	Project Description	Subwatershed
OS-	245	Undercutting/ scouring	Stabilize bank and add riprap; drainage issues associated with facility (unique ID 1210)	Lakeshore
OS-	783	Moderate erosion issues downstream outfall	Monitor/investigate headcut more thoroughly to determine rate of migration and assess risk. If required, stabilize channel with grade control to prevent headcut migration and further erosion issues.	Lakeshore
OS-	1523	Moderate erosion issues downstream outfall	Monitor/investigate headcut more thoroughly to determine rate of migration and assess risk. If required, stabilize channel with grade control to prevent headcut migration and further erosion issues.	Lakeshore
OS-	9576	Moderate erosion issues at outfall	Monitor/investigate headcut more thoroughly to determine rate of migration and assess risk. If required, stabilize channel with grade control to prevent headcut migration and further erosion issues.	Lakeshore
OS-	267	Severe erosion issues at outfall; undercutting/ scouring	Monitor/investigate headcut more thoroughly to determine rate of migration and assess risk. If required, stabilize channel with grade control to prevent headcut migration and further erosion issues.	Salmon Creek (RM 0060)
OS-	268	Moderate erosion issues downstream of outfall	Monitor/investigate headcut more thoroughly to determine rate of migration and assess risk. If required, stabilize channel with grade control to prevent headcut migration and further erosion issues.	Salmon Creek (RM 0060)

Identifier	Outfall ID	Basis for Project	Project Description	Subwatershed
OS-	270	Severe erosion issues at outfall; undercutting/scouring; possible infiltration trench failure	Monitor/investigate headcut more thoroughly to determine rate of migration and assess risk. If required, stabilize channel with grade control to prevent headcut migration and further erosion issues.	Salmon Creek (RM 0060)
OS-	833	Moderate erosion issues downstream outfall	Monitor/investigate headcut more thoroughly to determine rate of migration and assess risk. If required, stabilize channel with grade control to prevent headcut migration and further erosion issues.	Salmon Creek (RM 0060)

Management Recommendations

Retrofit evaluations conducted at 43 public stormwater facilities generated 19 referrals for further evaluation as Capital Improvement Projects. The most common treatment BMP across facilities referred was a typical bioswale. The majority of the facilities referred had large lots with minimum stormwater infrastructure and included an increase for potential storage as part of the project description. The average age of the facility referred in the Lakeshore subwatershed was 13.1 years old. The average age of the facility referred in the Salmon Creek (RM 00.60) subwatershed was 14.2 years old. Further evaluations of other stormwater facilities with similar age and stormwater infrastructure may identify additional referrals for further evaluation as Capital Improvement Projects.

The inspection and maintenance evaluation is conducted at public stormwater facilities in conjunction with retrofit evaluations. The most common facility objects found out of compliance during the public stormwater facility inspection process were sediment traps, bioswales, and lack of stormwater facility signage. Excessive sedimentation was the most common noncompliant defect across facility objects. Sedimentation defects were the common noncompliant issue for detention ponds, conveyance stormwater pipes, sediment traps, and field inlets. Vegetative management issues were the most common noncompliant defects regarding bioswales. These defects included overgrown bioswales where grasses exceeded 10 inches in height with nuisance weeds and other vegetation starting to take over. Approximately 45 percent of public stormwater facilities were missing signage. Correcting facility sedimentation issues and maintenance of bioswales, and adding appropriate signage will bring most facilities into compliance.

Outfall assessments generated eight potential project opportunities. The most common offsite or downstream problem included moderate erosion issues downstream of the outfall. Bank and channel stabilization efforts would prevent further erosion issues. Also, an increase in the frequency of offsite assessment activities may reduce downstream erosion problems by discovering potential issues before they become a more serious erosion problem. Also, more effective energy dissipaters and an increase in bank stabilization efforts at outfalls where higher flow is expected may also reduce potential erosion problems.

Source Control

Purpose

Source control visits to Clark County businesses provide both an educational and technical assistance purpose. An initial site visit allows staff to educate owners and employees by providing basic information about nearby water resources and Clark County's Water Quality Ordinance (13.26A). The initial site visit also provides information on how Clark County's storm sewer system works, how the site is connected to this storm system, and how the activities performed by the business may impact their subwatershed.

Most importantly, the purpose of the source control visit is to find, then eliminate or change, business activities that are negatively impacting stormwater runoff.

Methods

Under the County's 2007 NPDES municipal stormwater permit, each year staff is required to visit 20% of businesses that perform one of many potential pollution-generating activities listed in the permit. Additionally, the permit requires visits to any business with a paved parking area. To simplify project planning and tracking, the CWP plans to visit 20% of all county businesses each year.

To determine which specific businesses will be inspected each year, the Stormwater Needs Assessment Program (SNAP) prioritizes a list of subwatersheds where source control visits will be performed. Once those subwatersheds are determined, GIS maps are developed to highlight all parcels paying the Type 4 (commercial and industrial property) and Type 3 (Multi-Family property) Clean Water Fee. Each highlighted parcel is labeled with the parcel number (Property Account Number).

At each site, staff asks the business manager or owner to lead a tour of the business, inside and out. By closely observing business activities and asking questions, staff gains information about site-specific conditions and current stormwater best management practices (BMPs).

If any business related activities allow contaminants to enter stormwater runoff, specific BMPs are suggested to the business manager or owner. Following the tour, BMP sheets explaining the issue and required fixes are left with the manager or owner. If the BMP will take some time to implement, a follow up visit date is agreed upon. Letters are sent to businesses when multiple activities require BMPs and/or when a specific BMP may take some time to implement. Letters usually give a deadline for completion of BMP implementation.

Following the deadline date, a follow up visit is made to the business to confirm BMP implementation. As long as some corrective effort has been made the source control staff will continue working with the business until they are in compliance. However, if the business fails to take any corrective action, despite repeated visits, a referral to Clark County Code Enforcement and possibly the Washington Department of Ecology is made to assist with compliance through enforcement.

During or immediately after each site visit, a Business Site Visit Report Form is completed for entry into the Tidemark database.

Results

In 2009, staff visited 100% of the businesses required under the NPDES permit in the Lakeshore subwatershed. Table 15 summarizes source control activities.

Table 15: Source Control Project Summary, Lakeshore subwatershed

Metric	Number
Number of sites visited	10
Number of sites with source control issues	2
Number of repeat visits	2
Number of sites with issues successfully resolved	2
Number of sites referred to other agencies	0

Overview

The Lakeshore subwatershed lies just east of Vancouver Lake. This subwatershed is predominately single family residential. The Type 4 parcels requiring source control visits were almost all churches along with a couple of public schools.

Church custodial staffs were the main point of contact for educating on source control BMPs. Issues centered on wash water disposal, stormwater facility maintenance, and parking lot leaks and spills.

Overall, Lakeshore subwatershed is an area of low priority for future source control site visits. There are few parcels requiring source control site visits, and those parcels are used for activities with minimal impact on stormwater.

Success stories:

The following case highlights a parcel in the Lakeshore subwatershed where an interesting situation was discovered.

Case 1:

- While inspecting the stormwater facility on one large commercial parcel, source control staff found the business was discharging pool water into their stormwater facility. At one end of the stormwater facility, an overflow pipe was discharging to an unknown location.
- Clark Regional Wastewater District (CRWWD) was notified since it appeared the overflow was discharging to their sanitary lines. CRWWD had no record of such a connection.

- A dye test was performed which determined the overflow was not going to the nearby sanitary manhole nor the sanitary system at all. The overflow pipe was perforated allowing any overflow to infiltrate into the soils. This is the same treatment provided by the stormwater facility which the Clean Water Program determined was in compliance with our Water Quality Ordinance.
- This determination was significant because had a connection to sanitary service been required there would have been a substantial capital expense for the business.

Illicit Discharge Detection and Elimination Screening

Illicit Discharge Detection and Elimination Screening assessment was not conducted.

Stream Reconnaissance and Feature Inventory

Purpose

The Feature Inventory records the type and location of significant stream impairments, potential environmental and safety hazards, and project opportunities in selected stream reaches.

Feature Inventory results are used primarily to document conditions and identify potential improvement projects or management actions for implementation by the CWP or other agencies. They also provide an extensive GIS database of sites that can be evaluated for project mitigation needs and as a county-wide planning tool for riparian and habitat enhancement projects.

Methods/Limitations

Geographic scope of the Feature Inventory was established by the CWP taking into consideration projected TIA, DNR water types, stream gradient, zoning, Clark County development permitting authority, and land ownership.

The Feature Inventory recorded significant conditions in the stream corridor relevant to SNAP components. Feature types are listed in Table 16.

The in-stream assessment approach allowed investigators to observe stream corridor features that are not always identifiable through desk methods, such as analysis of existing aerial photographs and GIS data.

A GPS position, one or more digital photos, and relevant attribute information were collected for each logged feature. All data and linked photos are stored in the Feature Inventory Geodatabase located on the Clark County server at: W:\PROJECT\011403, Needs Assessment Planning and Reports\GIS\Data\ CWP Project Planning Database. Feature data includes field observations, estimated measurements, and notes describing important feature characteristics or potential projects.

The Feature Inventory project is not intended to be an exhaustive inventory of all human alterations to the stream corridor. Rather, the project seeks to identify the most significant features pertaining to stormwater management and potential stormwater mitigation projects.

Feature dimensions and other attribute data are estimates, and should not be utilized for quantitative calculations.

Study Area

The extent of the completed Feature Inventory in the Lakeshore and Salmon Creek (RM 00.60) subwatersheds is shown in Figure 12. Approximately 2.6 miles of stream corridor was assessed overall. In Lakeshore, the assessment included the entire length of Chicken Creek (the only named stream in the Lakeshore subwatershed). In Salmon Creek (RM 00.60), the assessment was limited to portions of several small tributary streams. Mainstem Salmon Creek was not assessed. Of the proposed survey extents, one parcel was not accessible due to private property concerns.

Results/Findings

72 features were identified in the assessed area, and geomorphic data was collected at 13 locations. A breakdown of recorded features by type is presented in Table 16. Stream crossings (primarily culverts) were the most prevalent feature type identified. A significant number of stormwater outfalls, impacted stream buffers, and areas with severe bank erosion were also identified.

Table 16: Summary of Features Recorded in Lakeshore and Salmon Creek (RM 00.60) subwatersheds

Feature Type	Number Recorded
AGR - Aggradation	0
AP – Access point	1
CM – Channel modification	4
ER – Severe bank erosion	11
IB – Impacted stream buffer	9
IW – Impacted wetland	0
MB – Miscellaneous barrier	2
MI – Miscellaneous point	7
OT – Stormwater outfall	12
SCB – Stream crossing, bridge	1
SCC – Stream crossing, culvert	20
SCF – Stream crossing, ford	0
TR – Trash and debris	3
UT – Utility impact	0
WQ – Water quality impact	2
GG- Geomorphology point	13
Total	85

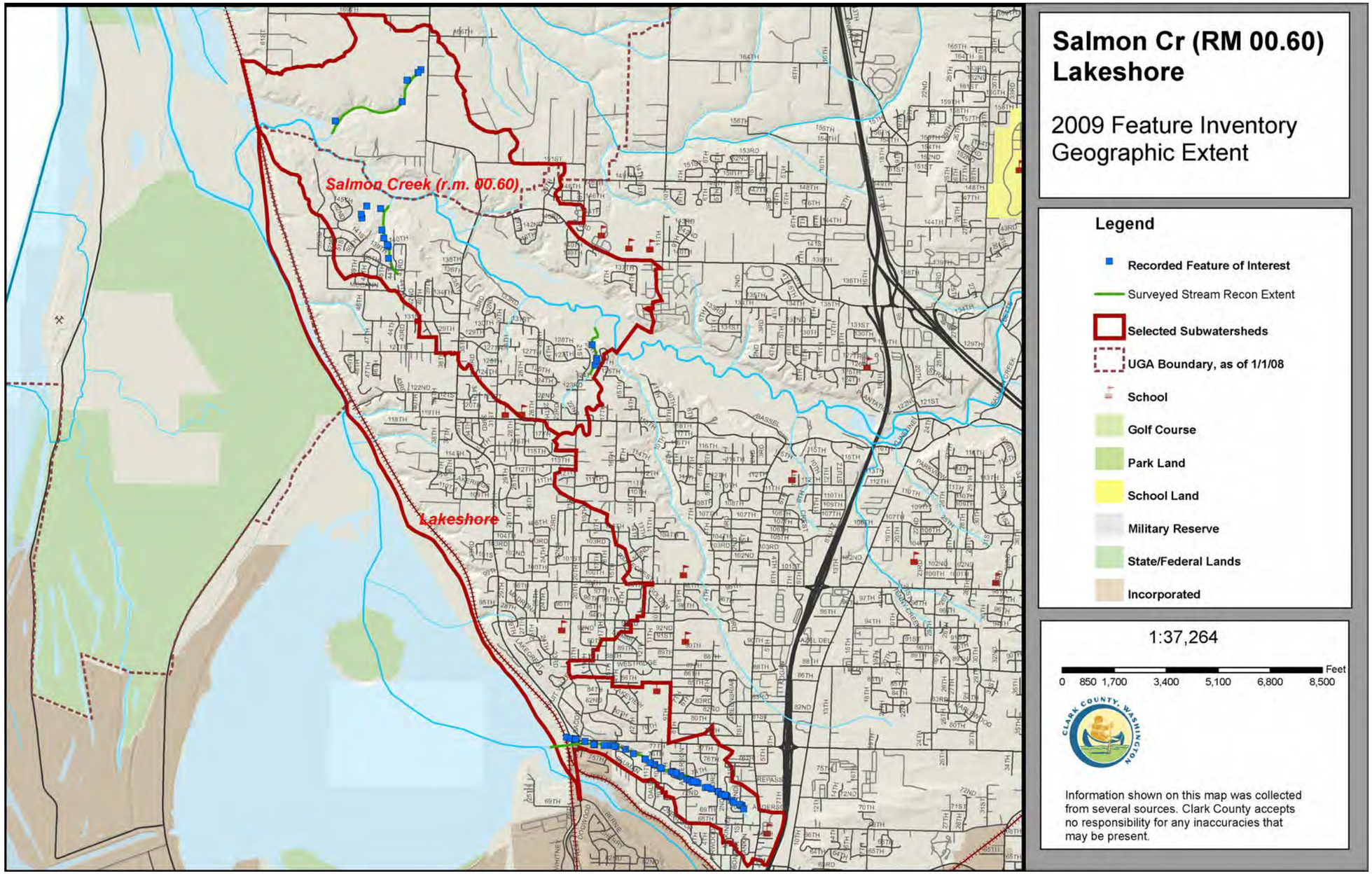


Figure 12: Lakeshore and Salmon Creek (RM 00.60) Geographic Extent of 2009 Feature Inventory

General Observations

The geographic scope of the Feature Inventory was limited to Chicken Creek and several small tributary streams along Salmon Creek. The discovery of numerous features of interest on small tributary channels indicates that significant stream impairments, potential environmental and safety hazards, and potential project opportunities may exist outside of the geographic scope of this Feature Inventory.

Stormwater conveyance in the surveyed reaches is piped infrastructure or direct runoff. The predominant source of stormwater is runoff from residential developments and roadways.

In the Chicken Creek drainage, stormwater detention and storage is very limited; a large number of 4-6" diameter pipes were also observed carrying roof drain runoff directly to the creek channel.

Chicken Creek has been landscaped and channelized in many sections; several reaches consist of concrete flumes or rock-walled channel. Where the channel exits these modifications, erosion and downcutting was invariably observed. Erosion also significantly increased moving downstream, the result of cumulative effects from upstream channelization. Numerous homes are within a few feet of the stream channel; flooding has been observed by one homeowner who spoke with field staff.

Riparian vegetation has been impacted through virtually the entirety of Chicken Creek. Although invasive species are present, primarily blackberry and ivy, the majority of the channel runs through manicured lawns or other landscaping with little to no native vegetation.

In the assessed Salmon Creek tributaries, stormwater facilities tend to be perched at the top of steep, narrow channels; in some cases outfalls from such facilities are causing significant channel erosion. Riparian zones are much more intact compared to Chicken Creek, due to the steepness of the canyons.

Potential Project Opportunities

Listed opportunities represent potential projects or project areas. They are not fully developed projects, and therefore require additional evaluation and development by Clark County or consultant staff. Identifying them as potential projects in this document is the first step in the process of developing SCIP projects.

Potential project opportunities were identified based on the results of the Feature Inventory conducted in the Lakeshore and Salmon Creek (RM 00.60) subwatersheds. The CWP will evaluate the potential projects for further development or referral to the appropriate organization. Each potential project is listed in tables, including the basis for the project and a description of the potential project. The location of each potential project is shown in Figure 13 and Figure 14. Potential project opportunities were categorized into six groups based on the nature of the potential work. A total of 18 opportunities were identified. A summary of identified project opportunities by potential project category is shown in Table 17.

Table 17: Breakdown of Potential Project Opportunities by Category

Potential Project Category	Potential Projects Identified
Emergency/Immediate Actions	0
Stormwater Facility Capital Improvement Projects	10
Stormwater Infrastructure Maintenance Projects	0
Habitat Restoration/Enhancement Projects	0
Property Acquisition for Habitat Preservation	0
Referral Projects for other Agencies	8

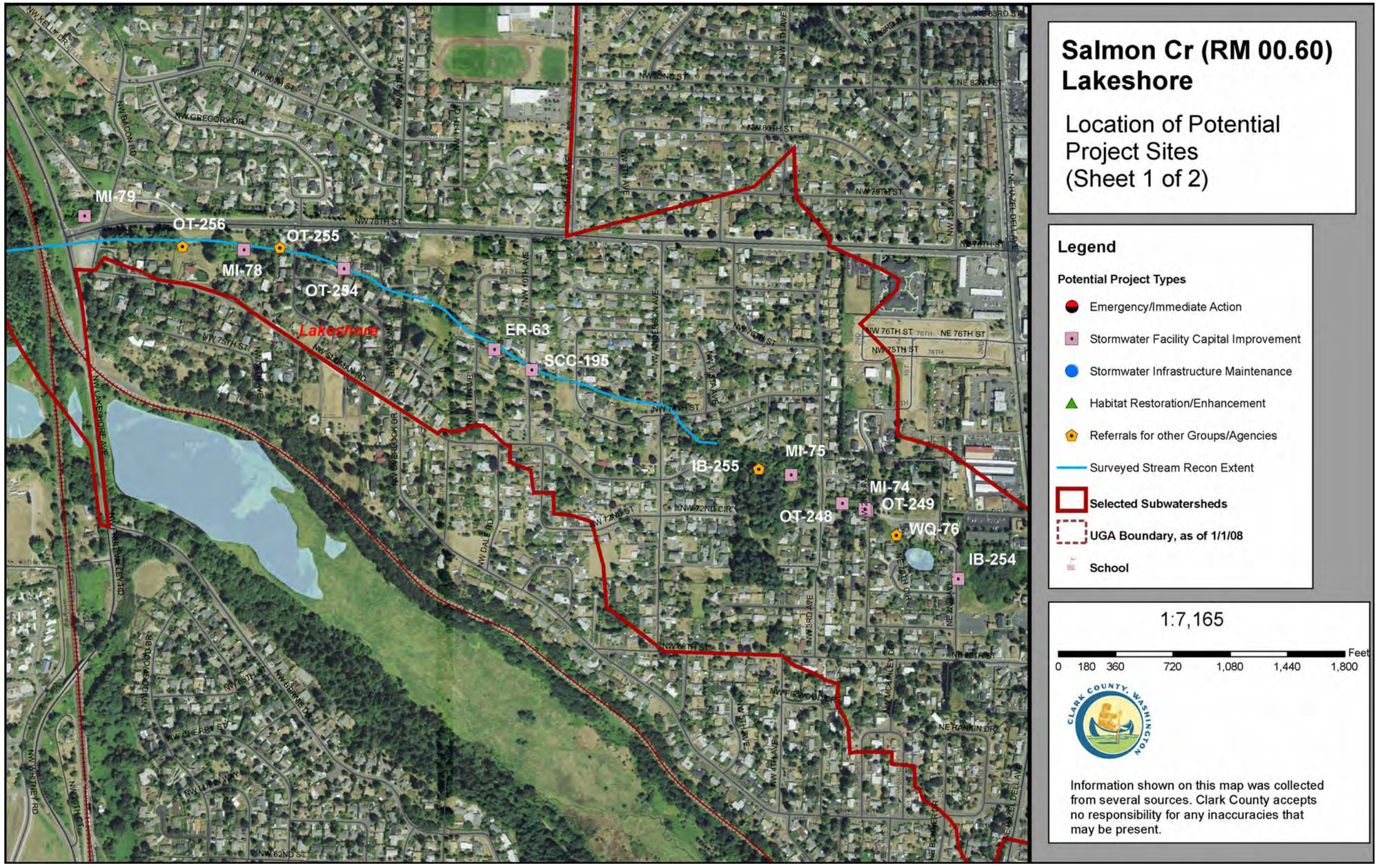


Figure 13: Lakeshore and Salmon Creek (RM 00.60) Location of Potential Project Sites

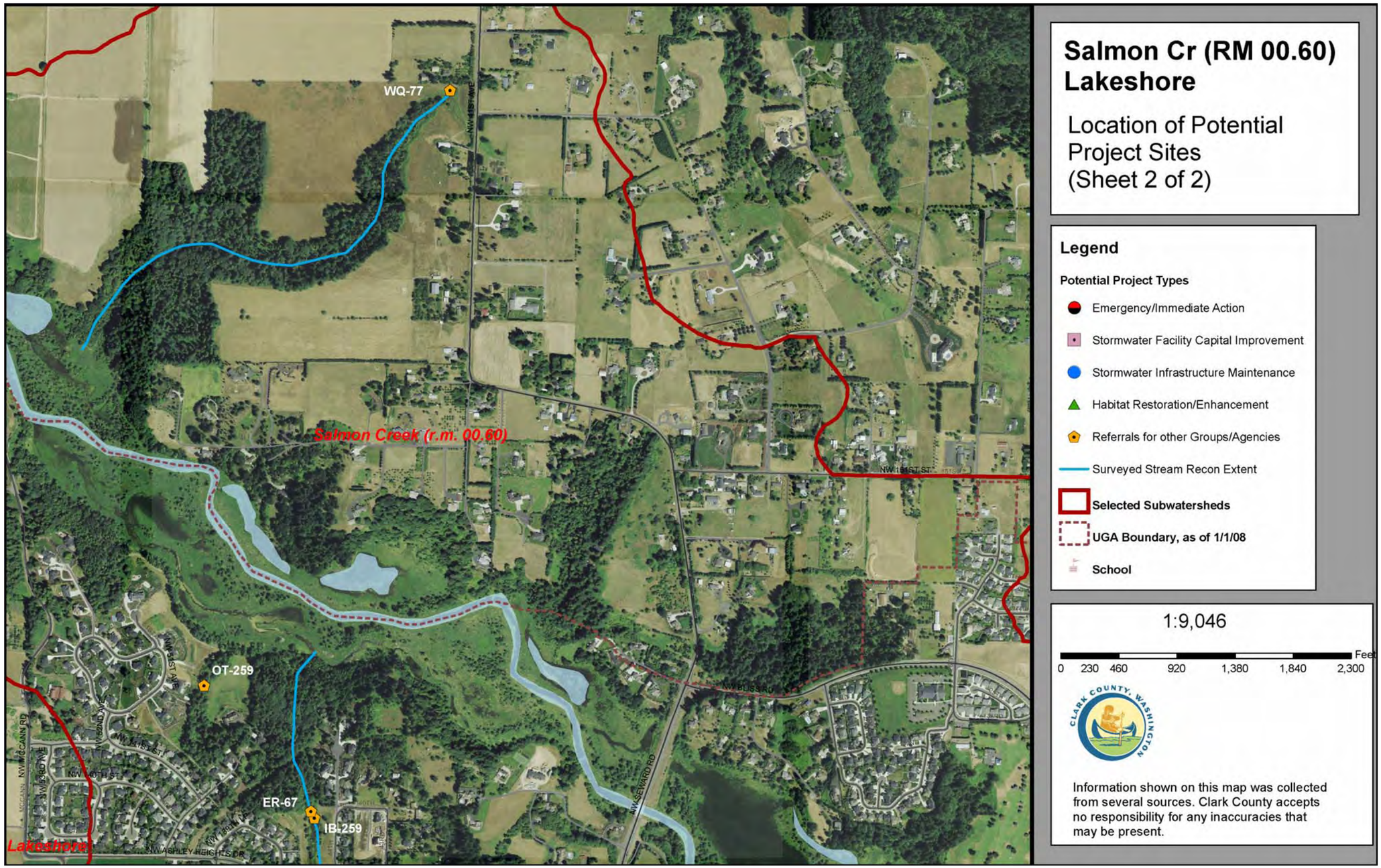


Figure 14: Lakeshore and Salmon Creek (RM 00.60) Location of Potential Project Sites

Emergency/Immediate Actions
Emergency/Immediate Actions require an immediate site response project to address a potential or imminent threat to public heath, safety, or the environment.

No opportunities were identified in this category.

Stormwater Facility Capital Improvement Projects
Stormwater Facility Capital Improvement Projects are projects that create new or retrofit existing stormwater flow control or treatment facilities. Facility retrofits include projects that will increase an existing facility's ability to control or treat stormwater in excess of the original facility's design goals.

Table 18: Description of Potential Stormwater Facility Capital Improvement Project Opportunities

ID	Basis for Project	Project Description
ER-63	Stream (Chicken Creek) is channelized and eroding, flows through 0.25 acres unused platted land. Flow control and treatment virtually nonexistent in this vicinity	Purchase parcel; construct detention/treatment facility or floodplain bench
IB-254	1.5 acres at headwater of Chicken Creek Note: same location as CIP-75	Purchase parcel; construct detention/treatment facility
MI-74	Creek flows through 0.5 acres unused platted land near headwater of Chicken Creek. See also features MI-73 (existing in-line pond on property) and ER-61.	Purchase parcel; construct detention/treatment facility or floodplain bench
MI-75	Potential retrofit of existing facility in Jorgenson Park for expanded flow control and/or treatment	Potential retrofit
MI-78	Potential for stormwater treatment facility near outlet of Chicken Creek to Vancouver Lake	Purchase parcel; construct treatment facility for nutrient, sediment, and/or fecal coliform removal
MI-79	Potential for stormwater treatment facility near outlet of Chicken Creek to Vancouver Lake	Purchase parcel; construct treatment facility for nutrient, sediment, and/or fecal coliform removal
OT-248	Untreated and un-detained runoff from public streets	Construct facility in ROW to detain and treat street runoff
OT-249	Untreated and un-detained runoff from public streets	Construct facility in ROW to detain and treat street runoff
OT-254	Untreated and un-detained runoff from public streets	Remove existing pipe and create swale or rain garden
SCC-195	House immediately upstream of undersized culvert experiences flooding; There is a parcel with open space for potential storage upstream, near SCC-194.	Purchase; construct detention facility

Stormwater Infrastructure Maintenance Projects
Stormwater Infrastructure Maintenance Projects include potential projects which address and repair maintenance defects affecting existing stormwater infrastructure. Infrastructure maintenance projects are required by the County NPDES municipal stormwater permit. Projects in this category with estimated costs exceeding $10,000 are considered under the SCIP process. Projects addressing simpler maintenance defects are referred directly to the County Public Works Operations and Maintenance staff.

No opportunities were identified in this category.

Habitat Restoration/Enhancement Projects
Habitat Restoration/Enhancement Projects include potential projects which result in the restoration or enhancement of wetlands, upland forest, or riparian habitat. In-stream channel habitat and bank protection projects do not fall within the scope of Clark County's CWP, and are placed under the category of Referral Projects for other Groups/Agencies.

No opportunities were identified in this category.

Property Acquisition for Habitat Preservation
Property Acquisition for Stormwater Mitigation Projects includes potential acquisitions of properties for any purpose that meets permit requirements to mitigate for stormwater impacts. This includes preservation or restoration of upland forest and riparian habitat zones.

No opportunities were identified in this category.

Referral Projects for Other Groups/Agencies
Referral Projects for other Groups/Agencies includes potential projects that do not fall within the defined scope of Clark County's CWP. This includes, but is not limited to, in-channel restoration, agricultural BMPs, fish-passage barrier removals, and invasive plant management. It also includes referrals for projects such as trash removal, stream culvert repairs/maintenance, and drainage projects.

Table 19: Description of Potential Referrals to Other Groups/Agencies

ID	Basis for Project	Project Description
IB-255	Widespread invasive plants within channel and in riparian area. County park land (Jorgensen)	Refer to Parks
IB-259	Blackberries taking over private facility (Ashleigh Heights Ph. 5)	Refer to Public Works private facility inspection
OT-255	Swimming pool drain piped to creek	Refer to DES Source Control for site visit
WQ-76	Livestock access to creek	Refer to Outreach/Tech Assistance--landowner letter

ID	Basis for Project	Project Description
WQ-77	Livestock access to creek	Refer to CCD. Also refer to Outreach/Tech Assistance-- landowner letter
ER-67	Three locations with severe erosion; all appear to result from private stormwater outfalls within the Ashley Heights subdivision	Engineer inspection; referral to Code Enforcement if issues are confirmed
OT-256	Unmapped 18" outfall	Add to IDDE screening list; also refer to CWP Infrastructure Inventory
OT-259	6" metal pipe outfall, unknown origin	Add to IDDE screening list

Stormwater Management Recommendations

A number of general stormwater management measures should be implemented throughout the Lakeshore and Salmon Creek (RM 00.60) subwatersheds:

- Educate private landowners concerning importance of invasive plant removal, and suggest removal techniques
- Encourage or develop incentives for private landowners to disconnect downspouts and infiltrate runoff rather than piping directly to the stream
- Educate private landowners on the importance of native riparian vegetation for shading streams
- Prioritize stormwater treatment in downstream areas of Chicken Creek (Lakeshore subwatershed). Stormwater impacts to Vancouver Lake include fecal coliform bacteria, nutrients, and sediment.
- Prioritize stormwater detention in upstream areas of Chicken Creek and in tributary streams within Salmon Creek (RM 00.60) subwatershed

Physical Habitat Assessment

Purpose

Physical habitat assessments provide direct measurements of stream channel morphology, habitat conditions, and riparian conditions for specific stream reaches. This information can be used for planning projects and interpreting hydrologic, macroinvertebrate, and geomorphologic information at reach and subwatershed scales.

Methods

Physical habitat measurements were made for several reaches of Salmon Creek (EDT reaches Salmon 1-4, RM 0.0 to RM 1.1) by R2 Resource Consultants, Inc. (December 2004) for the Lower Columbia Fish Recovery Board. The project followed modified USFS Level II protocols.

No physical habitat data were collected in the Lakeshore subwatershed.

Results

The R2 Resource Consultants, Inc. (R2) report includes a good narrative summary of the habitat survey results, including figures and tables, some of which are presented here. The full report may be found on the CWP website at:
http://www.clark.wa.gov/water-resources/documents-monitoring.html#strmac

The Salmon 1-4 survey reach is classified as palustrine to wide, large floodplain channel types. The reach has a map gradient of <0.5 percent. Glide habitat represents 100% of the survey reach habitat by length. No pool or riffle habitat was observed.

Embeddedness and substrate composition were not rated because the dominant substrate class was sand and silt throughout the reach. Table 20 summarizes habitat evaluations based on Washington Conservation Commission and NOAA Fisheries Properly Functioning Condition standards.

Table 20: Summary of Habitat Evaluations of Salmon Creek (Salmon 1-4 Survey Reach) Based on Washington Conservation Commission and NOAA Fisheries Properly-Functioning Condition Standards

Parameter	WCC[1]	PFC[2]
% Pool by Surface Area	Poor	
Pool Frequency		Not properly functioning
Pool Quality	NA	NA
LWD	Poor	Not properly functioning
Substrate	NA	NA
Streambank Stability	Good	Properly functioning
Water temperature	Poor	Not properly functioning

[1] Available Ratings: Good; Fair; Poor

[2] Available Ratings: Properly Functioning; At Risk; Not Properly Functioning

Geomorphology Assessment

Purpose

This report is an assessment of physical conditions in Chicken Creek and several unnamed Salmon Creek (RM 00.60) tributaries, based on field reconnaissance and review of remote sensing data. The field reconnaissance included characterizations of the channel, bank, and floodplain conditions at thirteen points in tributaries to Vancouver Lake and Salmon Creek. No reach delineations were made.

The objectives of this geomorphic assessment were to:

- Detail the geomorphic factors and processes influencing hydrology, sediment delivery, channel form, water quality, and habitat.
- Describe the apparent influence of past land use on geomorphic processes.

- Identify reaches that are unstable or moving toward unstable conditions under current channel morphologic and hydrologic conditions.
- Identify reaches that are stable or moving toward stable conditions under current channel morphologic and hydrologic conditions.
- Identify reaches that are most and least sensitive to future changes in hydrologic conditions.

Geomorphic field reconnaissance and remote sensing analysis results are used to make management recommendations and identify project types that might be implemented by Clark County to protect reaches that are currently unstable or sensitive to future disturbance, and to enhance the reaches that are currently stable or are less sensitive to future disturbance.

Methods

The geomorphic assessment is based on a reconnaissance of several points in Chicken Creek and unnamed tributaries to Salmon Creek (RM 00.60). The geomorphic reconnaissance was conducted in parallel with the stream reconnaissance and feature inventory. Channel, bank, and floodplain conditions were documented during the reconnaissance in December 2009. A detailed description of the methods used to document each channel, bank, and floodplain characteristic is provided in the see Stream Reconnaissance and Feature Inventory chapter.

Documented channel conditions included:

- Bankfull channel width and depth (or bank height where bankfull depth was not discernible).
- Channel gradient.
- Substrate material conditions.
- Sinuosity.
- Amount of functioning large woody debris (LWD).
- Channel type.
- Channel stability.

Channel types were based on the Montgomery and Buffington (1997) process-based classification system, which includes the cascade, step pool, plane bed, pool/riffle, dune/ripple, bedrock, and colluvial channel types. Additional channel types identified included glide-cohesive/rectangular, excavated/constructed, wetland, impounded, and other. Channel stability of the surveyed reach was a field determination based on the channel's relative equilibrium within the context of its hydrologic regime, sediment supply, and riparian vegetation. Each reach's channel stability was based on visual determination of whether the channel appeared to be stable (dynamic equilibrium), actively incising, actively widening, actively incising and widening, or actively aggrading. It was also noted when a channel was forced into stability by unnatural processes (e.g., mechanical armoring).

Documented bank conditions included the location and relative percentage of active bank erosion, bank material conditions, and a classification of bank stability. Bank stability classification was based on a protocol that uses bank vegetation, undercutting, erosion and scalloping, exposed tree roots, and downed trees to classify a stream channel as stable, slightly unstable, moderately

unstable, or completely unstable (Scholz and Booth 2001). This classification, combined with other bank assessment methods, provides a way to describe current and potential future bank stability conditions.

Documented floodplain conditions included the floodplain width and a classification describing the relative degree of floodplain connectivity between the active channel and the floodplain. This floodplain connectivity metric was used to describe how frequently the stream channel currently accesses the adjacent floodplain. Floodplain connectivity was assessed using the following qualitative categories:

- **Low connectivity**: The stream rarely exceeds the horizontal and vertical limits of the active/bankfull channel.
- **Medium connectivity**: The stream shows signs of occasionally overflowing the active/bankfull channel.
- **High connectivity**: The stream appears to exceed the limits of the active, bankfull channel, and inundates significant portions of the adjacent floodplain or overbank areas at regular (approximately annual) intervals.

Geomorphic field reconnaissance data were collected and entered in a geodatabase then reviewed using a geographic information system (GIS) and pertinent and available remote sensing data. For this geomorphic assessment, the reviewed GIS layers were Clark County's stormwater and sewer utility alignments, parcel boundaries, and two foot contours based on light detection and ranging (LiDAR) data (Clark County 2009).

The response potential is a qualitative classification that describes the likelihood that a reach will experience future channel degradation resulting from hydrologic changes. The response potential rating is a preliminary estimate and should be field verified as part of project planning. Each geomorphic survey point was classified as having low, moderate, or high response potential. Response potential is a function of the channel, bank, and floodplain conditions including existing channel and bank stability, channel and bank material conditions, channel gradient and level of functional LWD, underlying geologic conditions, and the existing level of development within the drainage areas contributing to the reach. Response potential classifications are as follows:

- **Low response potential**: May have geologic conditions that are resistant to channel change or may be artificially confined, armored, or lined to limit channel response.
- **Moderate response potential**: Has geologic or geomorphic conditions susceptible to alluvial changes caused by historic, ongoing, or future land use and hydrologic change in the watershed.
- **High response potential**: Exhibits alluvial characteristics, and is susceptible to extreme channel or geomorphic change if land use or the watershed's hydrologic patterns change.

Also, response potential generally increases as functional LWD and floodplain connectivity decrease.

Geologic Setting

The geology of the Lakeshore and Salmon Creek (RM 08.96) study area includes widespread cataclysmic flood deposits and recent alluvium in the Salmon Creek and Columbia River flood plains.

Cataclysmic flood deposits are silt to sand-sized sediments are interpreted as slack-water deposits of large floods initiated by the failure of ice dams at Glacial Lake Missoula in western Montana during the late Pleistocene, regionally dated between 17,000 and 13,000 years ago (Everts 2004). Flood deposits are unconsolidated and are susceptible to erosion.

Recent flood plain alluvium along Salmon Creek is sand and grave deposited by Salmon Creek after the end of the Pleistocene Ice Age. Near the Columbia River, flood plain deposits are finer grained material. The cataclysmic flood deposits are overlain by various silt loam soils. These soils are characterized by moderate to poor permeability that may locally inhibit infiltration.

Results

The findings of the geomorphic field reconnaissance indicate that Chicken Creek and observed tributaries to Salmon Creek have been, and continue to be, influenced by both natural geologic characteristics and human development within the subwatershed. The geomorphic characteristics of the channel were also found to be influenced by localized features such as bank hardening, channel crossings, channel modifications, and riparian vegetation loss.

A total of 13 geomorphic points were collected on Chicken Creek and four small streams. Figure 15, Figure 16, and Figure 17 illustrate the locations of each tributary, and the geomorphic data points. The geomorphic data collected for each reach are grouped by tributary and summarized in Table 21

The streams are described upstream from the lowest point, in this order: Chicken Creek, Salmon Creek tributaries 1, 2, 3 and 4. Data points GG-155 through GG-149 cover Chicken Creek from its mouth to its origin near Hazel Dell Avenue. Data points GG-160 and GG-159 cover Salmon Creek tributary 1; GG-157 and GG-158 cover tributary 2; GG-156 is the sole point in tributary 3; and GG-161 is the only point in tributary 4 near Cougar Creek.

The following discussion focuses on the response potential of surveyed geomorphic reaches, and the specific physical characteristics and factors that determine the response potential in the study area. Refer to Table 21, Figure 15, Figure 16, and Figure 17 for the response potential and geographic location of individual reaches.

Table 21: Geomorphic data for Lakeshore and Salmon Creek (RM 00.60)

Tributary	Inventory Site ID #	Channel Conditions									Bank Conditions				Floodplain Conditions		Underlying Geologic Material	Response Potential
		Bankfull Channel Width (ft)	Bankfull Channel Depth (ft)	Channel Gradient (%)	Substrate Material		Sinuosity	Functional LWD	Channel Type	Channel Stability	Eroding Banks (%)	Bank Stability	Bank Material		Floodplain Width (ft)	Floodplain Connectivity		
					Primary	Secondary							Primary	Secondary				
Chicken Cr	GG-155	25	1.5	1-2 %	Fines	Sand	Low (1.0-1.2)	Not prop functioning	Plane bed	Stable	< 5%	Stable	Fines	Sand	45	High	Flood Deposits	Low
Chicken Cr	GG-154	1	2	1-2 %	Fines	Sand	Straight (1.0)	Not prop functioning	Plane bed	Stable	5 - 30%	Moderately Unstable	Fines	Sand	60	Low	Flood Deposits	Low
Chicken Cr	GG-153	4	2	1-2 %	Sand	Gravel	Straight (1.0)	Not prop functioning	Plane bed	Stable	< 5%	Forced stable	Sand	Gravel	30	Low	Flood Deposits	Low
Chicken Cr	GG-152	3	3	1-2 %	Fines	Sand	Straight (1.0)	Not prop functioning	Plane bed	Incising	5 - 30%	Moderately Unstable	Fines	Sand	30	Low	Flood Deposits	High
Chicken Cr	GG-151	6	2	< 1%	Fines	Sand	Low (1.0-1.2)	Not prop functioning	Plane bed	Stable	< 5%	Stable	Fines	Sand	20	Medium	Flood Deposits	Low
Chicken Cr	GG-150	20	1	< 1%	Fines	Sand	Low (1.0-1.2)	Prop functioning	Plane bed	Stable		Stable	Fines	Sand	60	High	Flood Deposits	High
Chicken Cr	GG-149	2	2	1-2 %	Fines	Sand	Straight (1.0)	Not prop functioning	Plane bed	Stable	< 5%	Stable	Fines	Sand	200	Medium	Flood Deposits	Low
SC 1	GG-160	30	1	< 1%	Fines	Sand	High (>1.5)	Prop functioning	Plane bed	Stable	< 5%	Stable	Fines	Sand	100	High	Flood Deposits	Low
SC 1	GG-159	6	5	2-4 %	Fines	Sand	Straight (1.0)	Not prop functioning	Plane bed	Incising and Widening	60 - 100%	Moderately Unstable	Fines	Sand	20	Low	Flood Deposits	High
SC 2	GG-157	10	2	< 1%	Fines	Sand	Straight (1.0)	Prop functioning	Plane bed	Aggrading	No Data	Stable	Fines	Sand	30	Low	Flood Deposits	Low
SC 2	GG-158	1	2	1-2 %	Fines	Sand	Straight (1.0)	At risk	Plane bed	Stable	< 5%	Slightly Unstable	Sand	Sand	20	Medium	Flood Deposits	Moderate
SC 3	GG-156	10	1	< 1 %	Fines	Sand	Straight (1.0)	Prop functioning	Plane bed	Aggrading	< 5%	Stable	Fines	Sand	200	High	Alluvium	Low
SC 4	GG-161	1	0.5	2-4 %	Fines	Sand	Straight (1.0)	Not prop functioning	Plane bed	Stable	< 5%	Forced stable	Fines	Sand	15	High	Flood Deposits	Moderate to High

LWD = Large woody debris

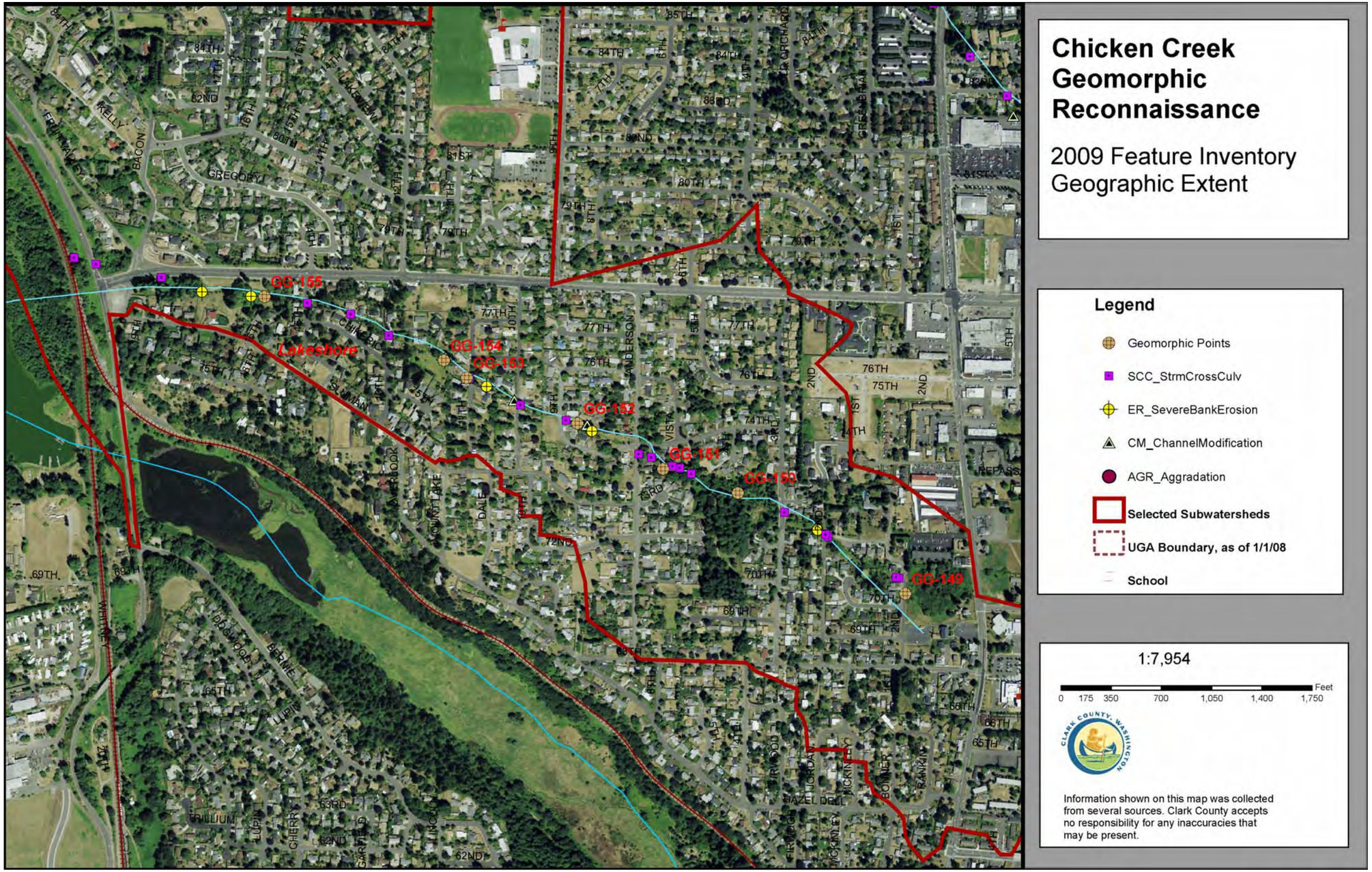


Figure 15: Geomorphic data points, Chicken Creek

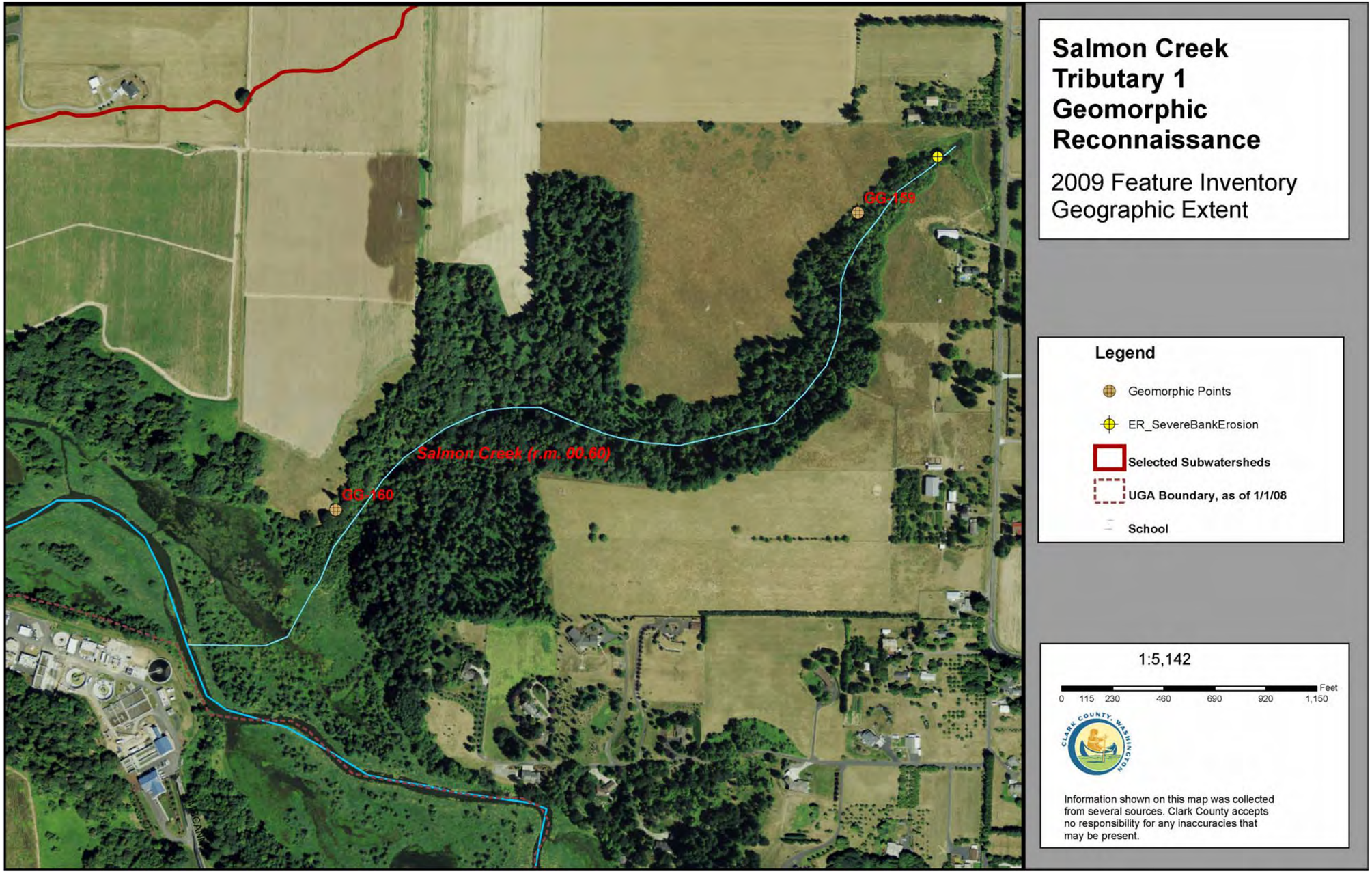


Figure 16: Geomorphic data points, Salmon Creek tributary 1.

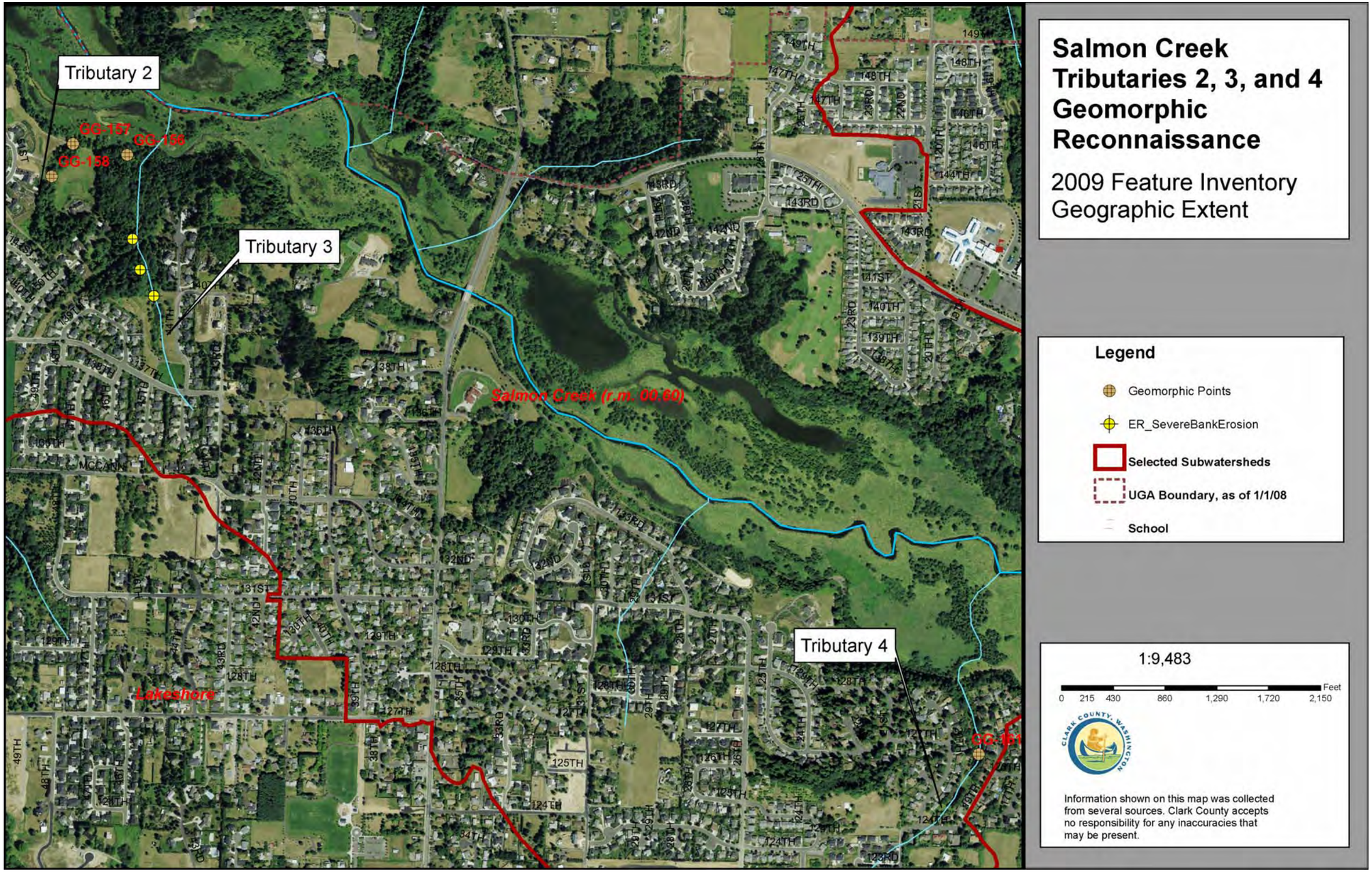


Figure 17: Geomorphic data points, Salmon Creek tributaries 2, 3, and 4.

Response Potential by Tributary

Chicken Creek
Sites GG-155 through GG-149 are points collected from lowermost Chicken Creek to its headwaters. In addition to these points, information was gleaned from erosion points, channel modification points, and aggradation points. Chicken Creek drains a mid to late 20th Century residential area with some commercial development in the upper reaches. Stormwater is either piped or conveyed down streets to Chicken Creek making it a very flashy urban stream. While there are several flow control facilities in the basin, most areas lack them.

Chicken Creek flows over fine-grained Cataclysmic Flood deposits that are somewhat cohesive and form steep banks where incision occurs. Because of this, the small size of the creek and its path through residences' yards, much of the creek has been modified to stop erosion, drain more effectively, or create landscape water features. Channel characteristics range from stable wide channels where natural conditions allowed the stream to adjust to its hydrology (20 feet wide and 1 foot deep) to deep cohesive gully-like channel (3 feet wide and 3 feet deep) to completely hardened channel. The many road crossings and channel hardening points likely help limit deep incision and bank collapse. Riparian and floodplain conditions are generally very poor due to residential encroachment.

Generally, the non-hardened channel has a fairly stable, cohesive mud bank with little sediment. Where erosion collapses banks, it provides sediment to the creek. Portions of the creek lacking bank hardening or a natural channel connected to its flood plain probably have moderate to high response potential. Sites directly above grade controls such as culverts had a low response potential.

Salmon Creek Tributary 1
The tributary draining past site GG-160 and GG-159 has land cover that is a mix of small pastures, fields and rural residential, while the stream channel is in a forested canyon. Site GG-160 is in the lowermost part of the tributary where it discharges to Salmon Creek flood plain and GG-159 is in the upper part of the tributary. The channel is in Cataclysmic Flood deposits, which are easily eroded. The canyon appears to have good riparian cover. The tributary is likely to respond to development by widening and incision due to erosion into fine-grained banks. Field observations and stream gradient suggest the tributary has a high response potential.

Salmon Creek Tributary 2
The tributary includes sites GG-157 and GG-158. GG-157 is located where the tributary discharges to the Salmon Creek flood plain and GG-158 is where the tributary flows in a canyon. This tributary is notable in that the residential subdivisions in its natural drainage area have piped stormwater away from the drainage to either discharge to the mouth of the creek or another drainage. The canyon is wooded but not in good condition. The substrate is Cataclysmic Flood deposits subject to erosion. Under normal conditions SC 2 would have a high response potential but the rerouting of stormwater runoff away from the stream makes it likely to be relatively stable.

Salmon Creek Tributary 3
The stream location represented by GG-156 is a small high-gradient tributary that is largely built out with recent residential subdivisions. Site GG-156 is at the point where the stream discharges to the Salmon Creek flood plain. Photos show a significant amount of sediment deposit at that point. The stream above includes three severe erosion points. Tributary 3 probably has a fairly high response potential due to its gradient and substrate.

Salmon Creek Tributary 4
Site GG-161 is midway up the stream canyon. The drainage area was largely converted to residential subdivisions during the late 1990's and early 2000's. The channel at GG-161 is described as forced stable, reported to be small cobble. Lower down, the channel is in Cataclysmic Flood deposits. Riparian conditions are not properly functioning. No erosion points were logged on this stream, suggesting that flow controls in place for more recent development may be protecting the channel. Based on substrate and gradient, tributary 4 should have a moderate to high response potential.

Management Recommendations
Based on geomorphic assessment results and information from other relevant inventories (e.g., stream features inventory), management recommendations have been developed that emphasize the following objectives:

- Protecting reaches that are currently marginally unstable or sensitive to future disturbance.
- Enhancing reaches that are currently stable or are less sensitive to future disturbance.

Recommendations to protect reaches include the implementation of projects that will prevent further channel degradation from changes in the watershed land use and hydrology. Enhancement recommendations include projects that will improve and help rehabilitate the geomorphic functions of existing reaches. For example, enhancement is recommended in reaches that exhibit self-forming alluvial channel characteristics.

In general, the management recommendations have been grouped according to broadly defined watershed management strategies for each geomorphic reach group, and specific rehabilitation project categories: channel, bank, and floodplain. The watershed management strategies and channel, bank, and floodplain rehabilitation projects are described in the following subsections.

Watershed Management Strategies
The geomorphic processes of Chicken Creek and Salmon Creek (RM 00.60) subwatershed tributaries are inextricably linked with hydrologic processes and land use management in its watershed. Therefore, geomorphic-based management recommendations cannot succeed without addressing development trends and processes in the watershed. Practically speaking, the existing hydrologic regime is unlikely to significantly change, assuming the use of stormwater best management practices (BMPs) to address additional runoff from future development. Stormwater management should direct protection and restoration efforts where they have the greatest opportunity for success.

The following management strategies and recommendations may be effective at restoring geomorphic process and reducing the effects of altered hydrology when applied in the appropriate areas.

- **Manage runoff**: The area has relatively high levels of urbanization, where hydrologic conditions from existing development has or will continue to form stream channel conditions. Development regulations will manage runoff from future development. In streams where channels are relatively stable, it may be reasonable to include retrofit projects to protect them from further disturbance. New development and retrofit projects should focus on infiltration practices to protect and restore hydrologic processes.
- **Support channel function and encourage natural features:** Management strategies should continue to preserve riparian areas. In addition, promoting the establishment of native vegetation, particularly conifers, would promote the success of channel rehabilitation projects as well as the natural ability of the channel to sustain physical channel complexity.
- **Conserve and protect areas with established LWD**: Other than Chicken Creek, tributaries in the study area are generally in wooded ravines. Over the long term LWD conditions should improve in these areas protected by critical areas code, including habitat, wetland and geologic hazard regulations.
- **Restore and preserve wetlands and established hydrologic processes**: Historically, the upper reaches of tributaries in the study area had limited depressional wetlands. Most of them are now converted to fields and pastures or residential developments. Increasing stormwater infiltration using LID features will improve hydrologic processes.

Channel, Bank, and Floodplain Rehabilitation Projects

This section describes and categorizes potential projects that could be implemented to improve or maintain channel, bank, and/or floodplain conditions in the study area tributaries. Table 22 summarizes (by reach) where project categories are most appropriate.

Channel Rehabilitation

Potential actions that could promote in-channel stabilization in some of the study area tributaries include the following.

Grade Control. Grade control features are intended to limit channel incision, increase the base channel elevation, and improve overbank and floodplain connectivity. Placement of grade control structures is recommended in reaches where reducing channel incision would improve stream stability and function.

Grade control would be most appropriate in reaches where incision is common and ongoing, and where the channel exhibits self-forming alluvial characteristics and the potential for rehabilitating floodplain connectivity. Also, grade control structures could be especially beneficial if added in strategic locations where nickpoint migration threatens to cause increasing channel incision and channel degradation, or where further incision or associated bank erosion could threaten infrastructure, such as road crossings and utility alignments.

Table 22: Potential channel, bank, and floodplain rehabilitation projects, Lakeshore and Salmon Creek (RM 00.60)

		Channel Rehabilitation Project Categories																
		Channels									Banks							Floodplain
Tributary	Site	Grade Control		LWD Placement		Channel Realignment		Stabilization		Revegetation		Structure Removal		Revegetation
Chicken Creek	ER-66 ER-65	X								X				X
Chicken Creek	GG-155									X				X
Chicken Creek	GG-154	X								X				X
Chicken Creek	GG-153									X				
Chicken Creek	GG-152	X								X				
Chicken Creek	GG-151									X				X
Chicken Creek	GG-150													
Chicken Creek	GG-149									X				X
SC 1	GG-160													X
SC 1	GG-159	X						X		X				X
SC 2	GG-157	X						X						X
SC 2	GG-158							X		X				X
SC 3	GG-156													X
SC 4	GG-161									X				X

Large Wood Debris Placement. In-channel LWD creates hydraulic and habitat complexity. Placement of LWD is recommended where it can improve stream function by increasing channel complexity and stability and enhance floodplain connectivity. LWD can also be placed to function as grade control. Due to the elevated risk of failure in the urban environment, LWD placement should be carefully engineered.

Channel Realignment. Channel realignment is recommended when erosion threatens infrastructure or to enhance habitat. No channel realignments are recommended in the study area. Some problems are present in Chicken Creek but they do not threaten public infrastructure or pose a significant risk. Channel realignments to restore habitat in Chicken are not recommended because of the low potential for improvement.

Bank Rehabilitation

Bank Stabilization. Bank stabilization structures are intended to stabilize a failing or eroding bank. Bank stabilization structures could incorporate LWD placement as well as revegetation with native species. Placement of bank stabilization features is recommended where these structures would improve overall bank conditions, prevent further degradation at locations of severe erosion, and/or protect infrastructure.

Several bank stabilization sites are noted in the study area; however, the small size of the streams, private ownership and difficult access make them unlikely candidates.

Bank Revegetation. Bank revegetation is intended to restore vegetation quality and quantity. Revegetation with native species can help control the spread of invasive species. Bank revegetation can improve bank stability, stream cover, and eventually supply large wood debris for restoring and preserving channel habitat. These goals are applicable in almost any stream reach. They can be leveraged on county open space improvements such as trail construction. Revegetation efforts would need to be coupled with the removal of invasive species and regular maintenance to ensure the survival of native plant species.

Bank re-vegetation is recommended wherever invasive plants are present and forest is not properly functioning. Most of this work would be on private land.

Bank Structure (Hydromodification) Removal (e.g. Riprap Removal). Previous treatments may no longer function as originally intended, or may be failing altogether. Removal of these structures is recommended where removal can improve stream function and habitat. Generally, hydromodifications are rare in the Salmon Creek tributaries and ubiquitous in Chicken Creek. Considering Chicken Creek's hydrology and residential land use encroachment to the stream bank, hydromodifications should be left in place for the foreseeable future.

Floodplain Revegetation

Floodplain revegetation is intended to restore vegetation quality and quantity that influence flood plain habitat, woody debris delivery, shade, and flood control functions. Reestablishment of native species can help control invasive weeds throughout the creek's floodplain areas. Floodplain revegetation should be considered in conjunction with other riparian planting

strategies such as bank revegetation. Revegetation of flood plain is recommended where there are significant flood plain areas lacking forest.

Riparian Assessment

Purpose

The riparian assessment characterizes existing conditions based on available data, to identify general riparian needs, and potential areas for rehabilitation projects. Riparian enhancement projects, such as installation or protection of native plantings within riparian areas, can provide for increased future shading and woody debris recruitment which can further provide an opportunity for stormwater-related watershed improvement.

The need for riparian rehabilitation tends to be widespread and exceeds the scope and resources of the CWP mission of stormwater management. Therefore, potential riparian projects are usually referred to agencies such as the LCFRB, Lower Columbia Fish Enhancement Group (LCFEG), Clark Public Utilities, Fish First, the Washington State University (WSU) Watershed Stewards Program, and the Clark Conservation District for possible implementation.

This section focuses on opportunities likely to be considered by the CWP SCIP, which are primarily on publicly owned lands within high priority salmon-bearing stream reaches as defined by LCFRB salmon recovery priorities.

Method

Where possible, the assessment is based on GIS data from existing reports, primarily the Habitat Assessment reports prepared for the Lower Columbia Fish Recovery Board (R2 Resource Consultants, Inc., 2004), but also with analysis of the Salmon Creek Limiting Factors Analysis Report (HDR Engineering, Inc., 2002). These reports apply primarily to salmon-bearing stream reaches and therefore do not provide information for many smaller streams. Results are based on aerial photo interpretation using Washington Forest Practices Board methods for LWD delivery and channel shade estimates.

In watersheds such as Lakeshore where no data exists from the LCFRB characterization, an examination of current orthophotographs is used to make a general assessment of riparian condition and identify areas where restoration or preservation projects may be appropriate.

Many riparian project opportunities are discovered through other SNAP activities, including Rapid Stream Reconnaissance feature inventories and geomorphological assessments. Potential projects discovered through these activities are discussed in their respective sections, and most are included on a final list for referral to outside agencies.

The 2002 Salmon Creek Limiting Factors Analysis and the 2004 LCFRB Habitat Assessment report were also reviewed for specific project opportunities within each subwatershed. Potential project sites have been reviewed and verified through field reconnaissance and are detailed in the results.

Results

Results are based primarily on the 2004 LCFRB Habitat Assessment for the Salmon Creek (RM 00.60) subwatershed. The full characterization report is available on the Clark County website at: http://www.clark.wa.gov/water-resources/documents.html#mon

Because the Lakeshore subwatershed was not included in the 2004 LCFRB habitat assessment, LWD recruitment potential and shade rating analyses were based on a qualitative review of 2007 orthophotographs.

Riparian (Large Woody Debris (LWD) Delivery)

Figure 18 shows the Salmon Creek (RM 00.60) subwatershed's LWD delivery potential (Note: Lakeshore was not included within the 2004 LCFRB assessment). Within the Salmon Creek (RM 00.60) subwatershed, the survey includes the mainstem of Salmon Creek and a portion of an unnamed tributary. The mainstem of Salmon Creek is shown as having primarily low LWD recruitment along the approximately three mile distance surveyed. The surveyed tributary is also shown as having low LWD recruitment along the approximately ¼ mile distance surveyed. Review of aerial photographs of the non surveyed areas indicates a mixture of forested, herbaceous, and urban land cover types and are thus likely to have "High," to "Low" LWD recruitment levels accordingly.

Review of the Lakeshore subwatershed, including several relatively small streams discharging into Vancouver Lake or Lake River, indicated Moderate to High LWD recruitment potential for most tributaries. Tributaries located to the north of (approx) 93rd Street have riparian vegetation that is partially or completely forested. Another tributary discharges into Vancouver Lake at (approx) 78th Street, and flows through urban areas for the majority of its length. That tributary is likely to have Low LWD recruitment levels.

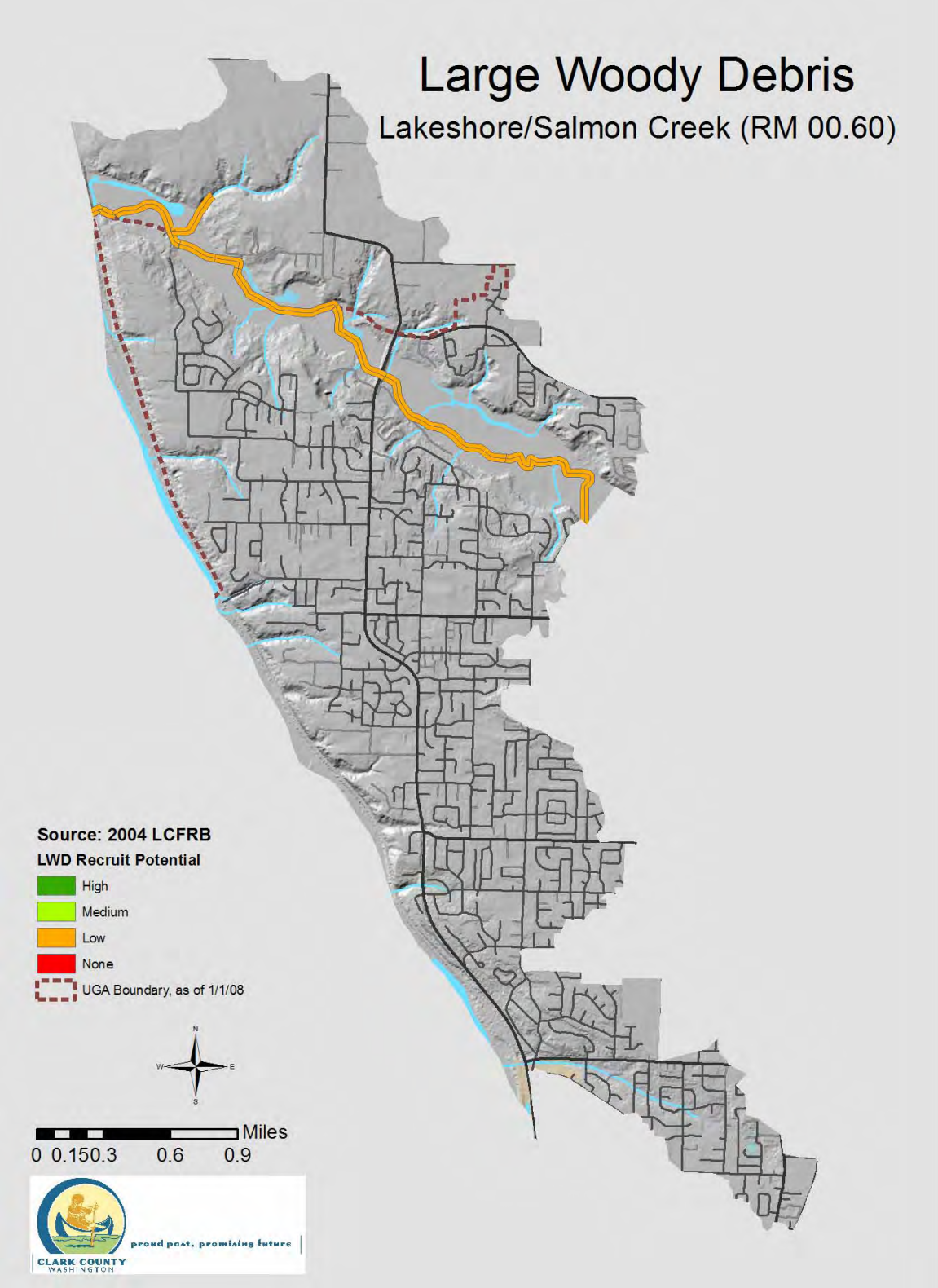


Figure 18: Lakeshore and Salmon Creek LWD Recruitment Potential (adapted from R2 Resource Consultants, Inc., 2004)

Shade

The Salmon Creek (RM 00.60) subwatershed's shade ratings from the 2004 LCFRB Habitat Assessment are illustrated on Figure 19 (Note: Lakeshore was not included within the 2004 LCFRB assessment). Within the Salmon Creek (RM 00.60) subwatershed, the survey covered the mainstem of Salmon Creek and a portion of an unnamed tributary. The majority of the mainstem of Salmon Creek within the Salmon Creek (RM 00.60) subwatershed had shade values ranging from 0-20%, with the exception of one reach (Salmon6) which had a shade value of 30%.

Low levels of shade within the lower reached of Salmon Creek may be a natural function of its width. Even assuming full mature forest vegetation adjacent to the channel banks, the projected reference surface water temperatures in lower reaches of Salmon Creek are not expected to be "conducive to core anadromous salmon spawning and rearing temperatures (LCFRB 2004, P.5-15)."

Orthophotography review of non-surveyed tributaries within the Salmon Creek (RM 00.60) subwatershed indicates a mixture of forested, herbaceous, and urban land cover types and are thus likely to have Low to Moderate shade levels accordingly.

The Lakeshore subwatershed's shade ratings were not included in the 2004 LCFRB Habitat Assessment. Review of this subwatershed, including several relatively small streams discharging into Vancouver Lake or Lake River, indicated Low to Moderate shade levels for most tributaries. Tributaries located to the north of (approx) 93rd Street have riparian vegetation that is partially or completely forested. Another tributary discharges into Vancouver Lake at (approx) 78th Street, and flows through urban areas for the majority of its length. That tributary is likely to have Low shade levels.

The LCFRB habitat assessment for the Salmon Creek (RM 00.60) subwatersheds indicated that the surveyed reaches are currently off-target with respect to the State Forest Practices shade/elevation screen standards.

Management Recommendations

Overall recommended management activities for the Salmon Creek (RM 00.60) and Lakeshore subwatersheds include riparian forest restoration in areas dominated by exotic vegetation, acquisition of existing forest land for future protection of streams and watersheds, and invasive species removal.

Potential Projects

Potential riparian restoration projects for the Salmon Creek (RM 00.60) and Lakeshore subwatersheds were identified from review of the 2004 LCFRB Habitat Assessment report, along with the 2002 Salmon Creek Limiting Factors Analysis with orthophotography analysis in areas not formally surveyed.

Potential riparian restoration projects in the Lakeshore subwatershed may be limited by a seeming lack of publicly owned land adjacent to streams. One exception is Jorgensen Park (Parcel # 147979-000 and 148346-000), however this park is the site of an existing Clark County Public

Works mitigation project involving reforestation. Another exception may be parcel # 098824-189, which is owned by Clark County, mapped as Urban Natural Open Space, and is vegetated with trees and shrubs. All 3 parcels mentioned in this paragraph are located on Chicken Creek.

Within the Salmon Creek (RM 00.60) subwatershed, several mostly forested, unnamed tributaries to Salmon Creek flow through privately owned land and likely represent low priorities for project action. On the other hand, the majority of length of the mainstem of Salmon Creek within this subwatershed flows through land that is publicly owned (Salmon Creek Greenway). The stream banks within the Salmon Creek Greenway are largely vegetated only by herbaceous species. Enhancing the banks by installing native trees would increase the capacity of the riparian zone to provide LWD recruitment and shade (although note that, as per the discussion above, low shade levels in these reaches may represent the natural condition). See Table 23 for identification of these potential project areas.

Several areas within the Salmon Creek Greenway area of the Salmon Creek (RM 00.60) subwatershed are currently being used as mitigation sites by Clark County Public Works, including two relatively minor reforestation projects close but not adjacent to the south bank (Parcels #'s 184831-000 and 183508-000).

Table 23: Tax Exempt Parcels Overlapping Potential Riparian Restoration Areas

ASSR_SN	ASSR_AC	OWNER	PT1DESC	Description
187394-000	40.58 acres	Clark County Parks and Recreation	Unused or vacant land	Areas of potential reforestation on the mainstem of Salmon Creek within the Salmon Creek Greenway
187376-000 187360-000 187410-000 187565-000 187564-000 187557-000 187927-000 187917-000 187847-000 184718-000 184835-000 184755-000 184836-000 184840-000 184839-000 183706-000	12.94 acres 7.25 acres 41.02 acres 20.31 acres 13.04 acres 41.5 acres 2.31 acres 2.82 acres 13.22 acres 2.05 acres 5.64 acres 14.66 acres 3.55 acres 45.12 acres 5.34 acres 23.24 acres	Clark County	Unused or vacant land	Areas of potential reforestation on the mainstem of Salmon Creek within the Salmon Creek Greenway
183508-000	20.11 acres	Clark County	Sewage Related Bldg or Structure	Areas of potential reforestation on the mainstem of Salmon Creek at wastewater treatment plant

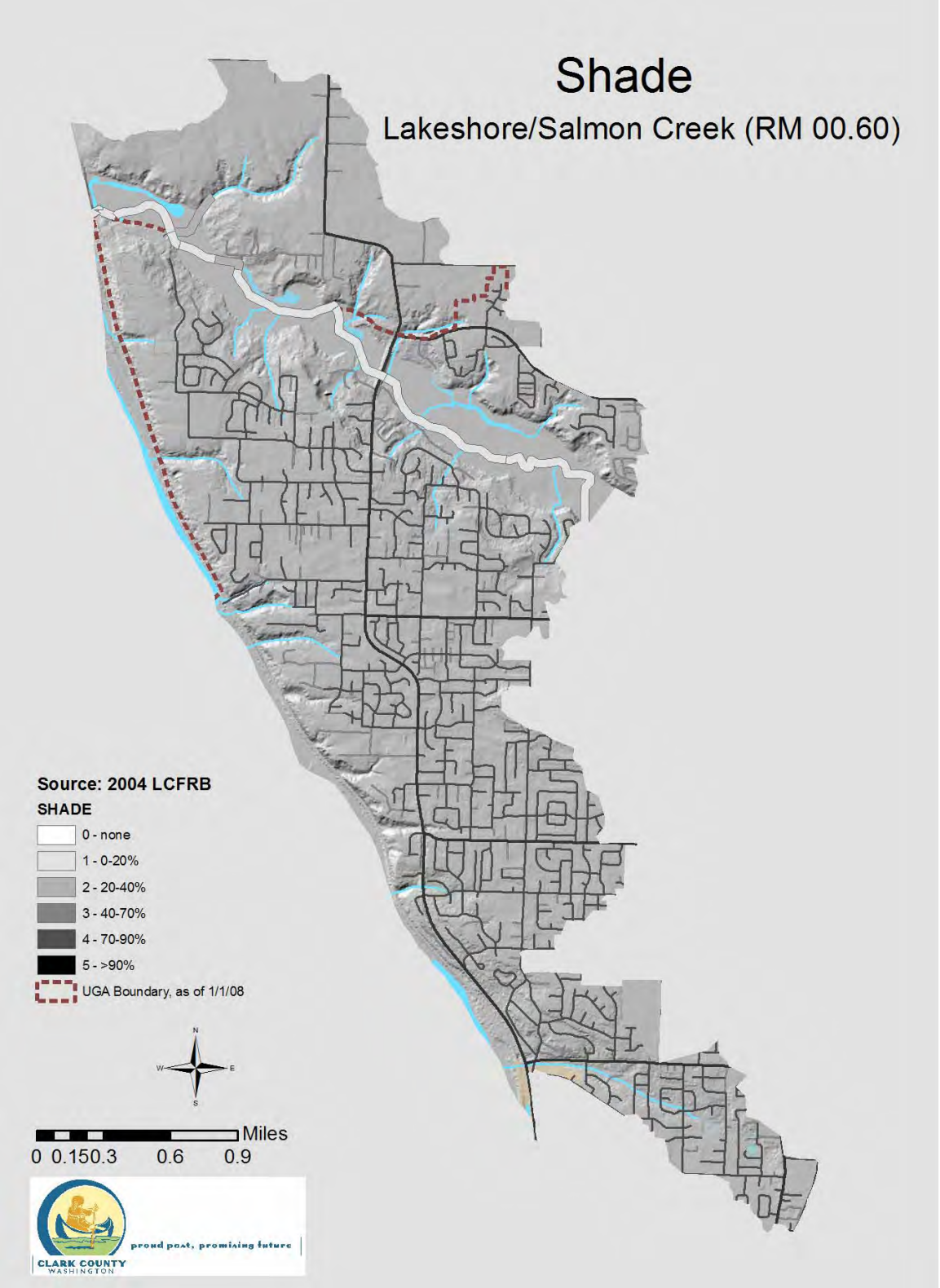


Figure 19: Lakeshore and Salmon Creek Shade Values (adapted from R2 Resource Consultants, Inc, 2004)

Floodplain Assessment

A floodplain assessment was not conducted.

Wetland Assessment

Purpose

Wetlands perform important hydrologic, water quality, and habitat functions. The primary reasons for the wetlands assessments are to:

- Describe wetland conditions related to how they influence hydrology, water quality, and habitat
- Identify priority potential wetland projects to mitigate for stormwater impacts
- Make management recommendations for wetlands related to stormwater management

A primary objective of the wetland assessment is to identify sites containing modestly sized, degraded or ditched wetlands where minor construction projects can be used to improve wetland hydrology. Improved wetland function can reduce peak storm discharges, increase groundwater recharge, and improve habitat through increasing biodiversity, species population health, and organic input.

Methods

The assessment includes review of existing GIS data for wetlands. Primary information sources are the county wetlands atlas, Draft Watershed Characterization of Clark County Version 3 (Ecology, 2007), and personal communication with other county programs.

Potential project sites have been reviewed and verified through field reconnaissance and are detailed in the results section below.

Tax-exempt parcels often indicate the presence of publicly owned land, schools, or churches where large parcel sizes and opportunities for leveraging may exist. Potential wetlands were overlaid with tax-exempt parcels and with county vacant buildable lands model (VBLM) information to identify possible wetland enhancement opportunities.

Results

Figure 20 shows potential wetland areas within the Lakeshore/Salmon Creek (RM 00.60) subwatersheds based on data from the county wetlands atlas, including the Clark County wetland model, National Wetlands Inventory, and high-quality wetlands layer.

Lakeshore/Salmon Creek (RM 00.60) subwatershed has large expanses of potential wetland areas associated with the lower Salmon Creek riparian corridor and floodplain areas. The majority of the wide floodplain associated with Salmon Creek is designated as wetlands, as the vast majority of Salmon Creek's floodplain lies adjacent to its mainstem. There is a narrow fringe of wetland along the east banks of Lake River, some additional wetlands along minor tributaries of Salmon Creek and Lake River, and isolated wetland pockets scattered throughout the subwatersheds.

Table 24 shows the total area and proportion of wetland classes estimated to be present in the subwatershed.

Table 24: Distribution of Wetlands by Hydrogeomorphic Class

HGM Class	Area (ac.)	% of Sub-basin*	% of total wetland
Slope Wetlands	2	<0.01%	<0.01%
Depressional Wetlands	107	3%	22%
Riverine Wetlands	388	9%	78%
All Wetlands	499	12%	

*Subwatershed area 4139 Ac.

Most of the riverine wetland area is associated with the Salmon Creek floodplain while the depressional wetlands are either associated with headwaters of minor tributaries and small drainage ways or isolated, locally closed basins.

Review of the wetland inventories and studies identified one large area with several project opportunities within publicly held land. Within the Lakeshore/Salmon Creek (RM 00.60) watershed, there are potential wetlands throughout the Salmon Creek Greenway owned by Clark County that could be enhanced or restored with native vegetation.

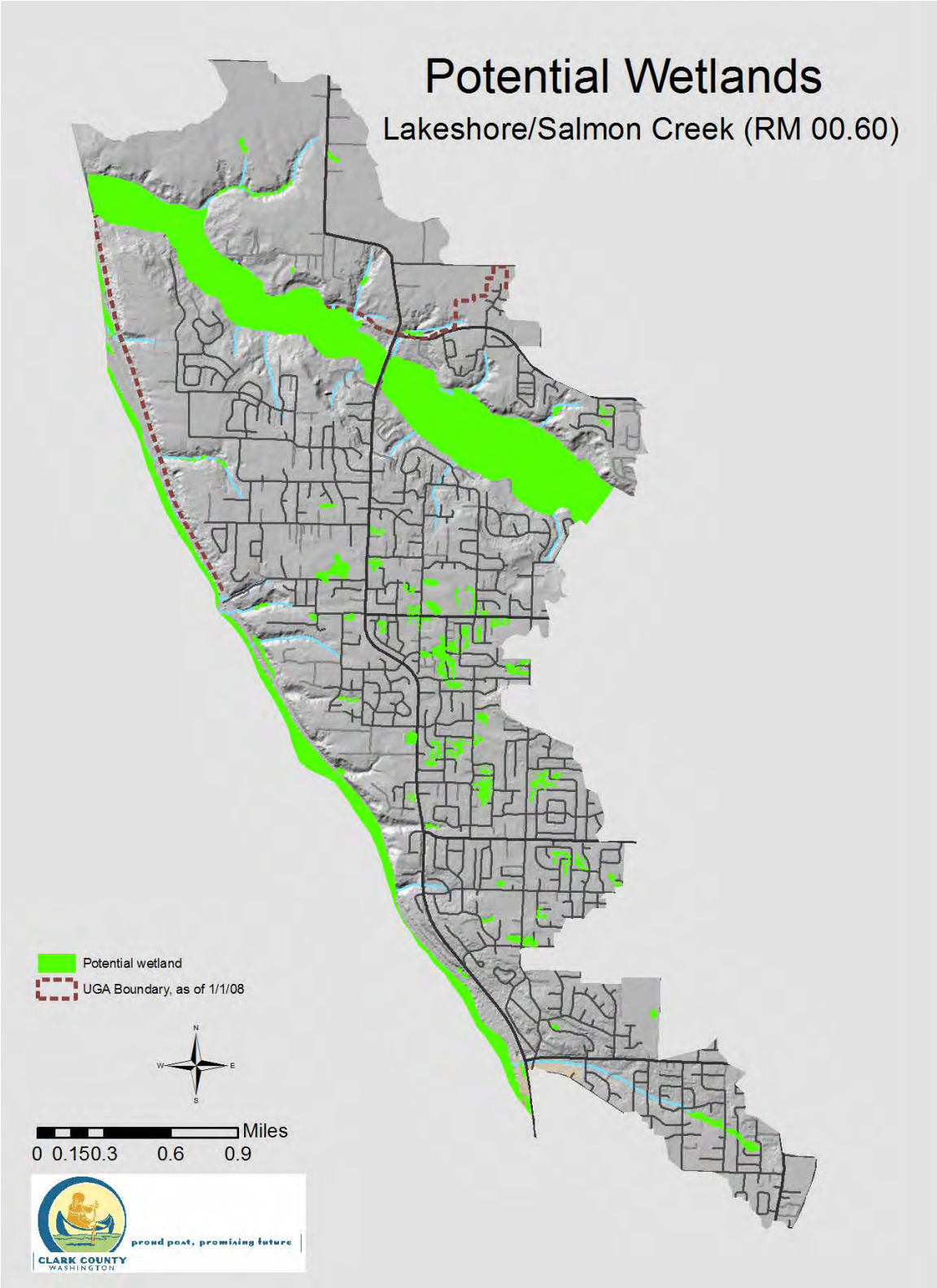


Figure 20: Lakeshore/Salmon Creek (RM 00.60) Potential Wetlands

Draft Watershed Characterization
The Washington Department of Ecology completed a prototype watershed assessment to assist in planning wetland and riparian habitat restoration and preservation projects. The Watershed Characterization and Analysis of Clark County (Washington Department of Ecology, 2009) may be found on the Ecology website at:
http://www.ecy.wa.gov/mitigation/docs/09-06-019_small.pdf

Results pertaining to the Lakeshore/Salmon Creek (RM 00.60) subwatersheds are summarized below.

The Lakeshore/Salmon Creek (RM 00.60) subwatersheds are part of the Terrace hydrogeologic unit. This unit is dominated by rain; has a westward to southwestern trending groundwater flow pattern; a large delta (now a terrace) formed by glacial floods consisting of gravels, sand, silts and clay; and a relatively level to moderately steep topography in the foothills and slopes above the Columbia River (Ecology, 2009).

Figure 21 depicts priority areas for protection and restoration of hydrologic processes county-wide based on an analysis of the relative importance and level of alteration in each subwatershed.

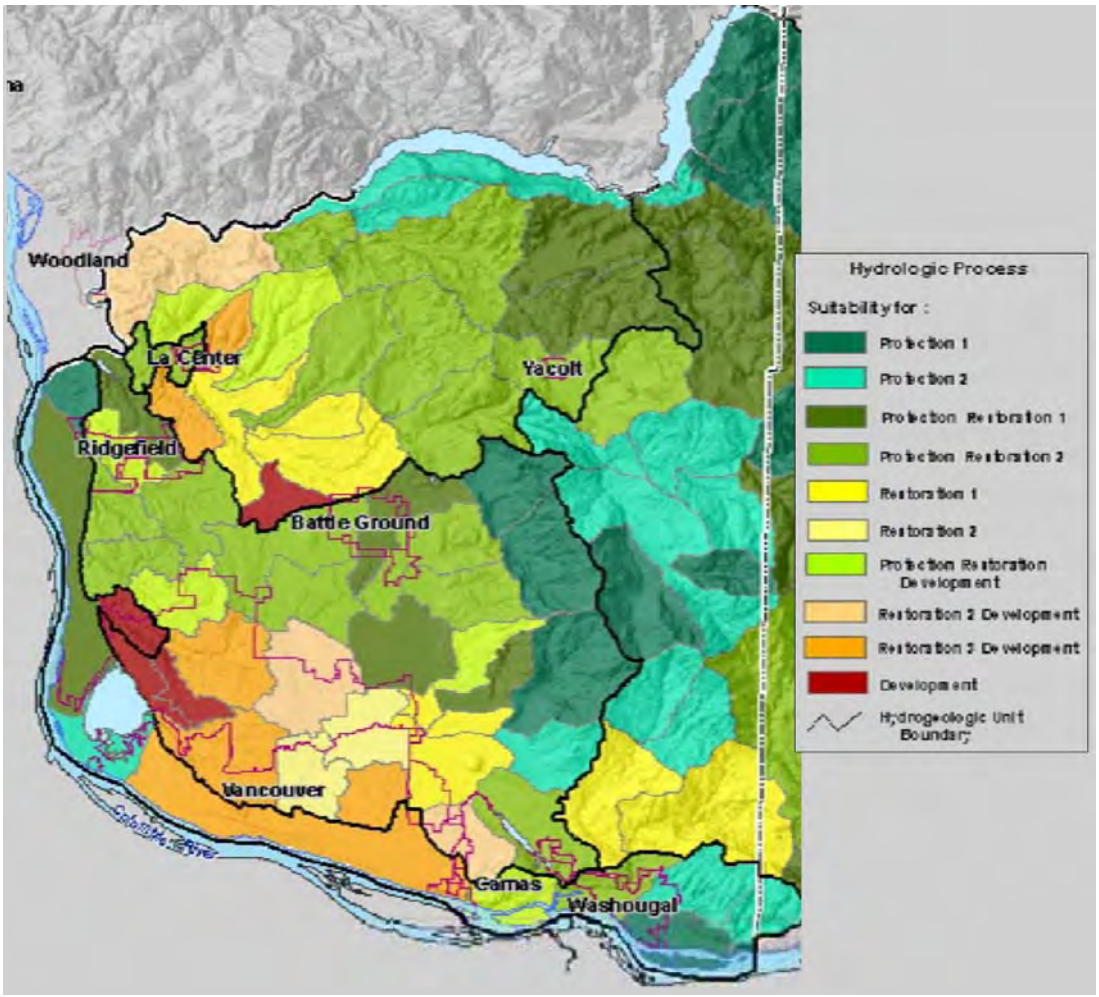


Figure 21: Priority areas for protection and restoration of hydrologic processes (from Watershed Characterization and Analysis of Clark County (Ecology, 2009))

In general, blue and green areas have higher levels of importance for watershed hydrologic processes and limited alteration and should be considered for protection. Yellow areas have a higher level of importance for watershed processes and a higher level of alteration and should be considered for restoration unless watershed processes are permanently altered by urban development. Orange to red areas have lower levels of importance for watershed processes and higher levels of alteration and should be considered as more suitable for development. Because orange areas represent a transition from restoration areas, planning measures employing both restoration and appropriately sited development should be considered (Ecology, 2009).

Development (red) is the hydrologic process priority for the Lakeshore/Salmon Creek (RM 00.60) subwatersheds.

Potential Projects

Potential project locations for further exploration based on this wetland assessment include those listed in Table 25.

Table 25: Public Lands containing large areas of Potential Wetlands

ASSR_SN	Size	OWNER	Land Uses	Description
Multiple	360.0 acres	Clark County	Undeveloped Park Land, Greenway Trail	Salmon Creek Greenway. Wetlands associated with the lower reach of Salmon Creek

This is large greenway corridor with multiple wetland enhancement and restoration project opportunities.

Table 26: Description of Potential Project Opportunities

ID	Basis for Project	Project Description
OS-207	Lack of native wetland vegetation and widespread invasive plant species within wetland area. Invasive species is predominantly reed canary grass.	Re-establish native undergrowth and canopy vegetation within wetland area to shade out invasive plants and enhance wetland habitat. Eradicate reed canary grass.

Macroinvertebrate Assessment

Purpose

The Benthic Macroinvertebrate Index of Biological Integrity or B-IBI (Karr, 1998) is a widely used measurement of stream biological integrity or health based on macroinvertebrate populations. Macroinvertebrates spend most of their lives in the stream substrate before emerging as adults. While in the stream, they are subject to impacts from continuous and intermittent pollutant sources, hydrology and habitat changes, and high summer water temperatures.

The B-IBI score is an index of ten metrics describing characteristics of stream biology, including: tolerance and intolerance to pollution, taxonomic richness, feeding ecology, reproductive strategy, and population structure. Each metric was selected because it has a predictable response to stream degradation. For example, stonefly species are often the most sensitive and the first to disappear as human-caused disturbances increase, resulting in lower values for the metric "Number of Stonefly taxa".

In addition to the overall B-IBI scores, examining individual metric scores gives insight into stream conditions and better explains differences in the overall score.

Methods

All field and laboratory work followed CWP protocols for macroinvertebrate sampling and analyses (June 2003). Samples are collected during late summer, preserved, and delivered to a contracted lab for organism identification, enumeration, and calculation of B-IBI metrics.

Raw data values for each metric are converted to a score of one, three, or five, and the ten individual metrics are added to produce an overall B-IBI score ranging from 10 to 50. Scores from 10 to 24 indicate low biological integrity, from 25 to 39 indicate moderate integrity, and greater than 39 indicate high biological integrity.

Results are influenced by both cumulative impacts of upstream land use and reach-specific conditions at or upstream of sampling sites. Thus, samples from a reach integrate local and upstream influences. Many of the B-IBI metrics are also influenced by naturally occurring factors in a watershed; for example, the absence of gravel substrate can lower scores.

In 2008, the only macroinvertebrate data for this study area was collected by the CWP at Chicken Creek station CHK010 near the intersection of NW 78th Street and NW Lakeshore Avenue. No samples were collected in the Salmon Creek (RM 00.60) subwatershed.

Results

Station CHK010's 2008 B-IBI score of 24 places it in the low biological integrity category.

Table 27 shows four low, five moderate, and one high score among the average results for individual metrics at station CHK010. The wide range of low scoring metrics suggest the presence of chemicals such as heavy metals or pesticides, human disturbance impacts affecting water temperature, sediment levels, and food sources, exposure to chronic or recurring water quality or habitat impacts, and impacts to the most sensitive species (Fore, 1999).

Table 27: Station CHK010 Annual Macroinvertebrate Community Metrics and Total Scores from 2008

B-IBI Metrics	CHK010 2008		
	Value	Score	Category
Total number of taxa	40	3	moderate
Number of Mayfly taxa	4	1	low
Number of Stonefly taxa	2	1	low
Number of Caddisfly taxa	5	3	moderate
Number of long-lived taxa	2	1	low
Number of intolerant taxa	1	1	low
Percent tolerant taxa	32.0	3	moderate
Percent predator taxa	16.0	3	moderate
Number of clinger taxa	20	3	moderate
Percent dominance (3 taxa)	47.2	5	high
Summary of avg. metric scores		24	low

Booth et al. (2004) found that there is a wide but well defined range of B-IBI scores for most levels of development, but observed overall that B-IBI scores decline consistently with increasing watershed total impervious area (TIA).

By comparing Chicken Creek to the likely range of conditions for watersheds with similar amounts of development, measured as total impervious area, it is possible to make some general statements about the potential benefits from improving stream habitat.

Figure 22 shows the 2008 CHK010 B-IBI score is at the upper limit of the range of expected scores (estimated 2000 Total Impervious Area from Wierenga, 2005).

Given Chicken Creek's B-IBI score falls at the upper limit of those typically found for subwatersheds with impervious areas of about 45 percent, it is unlikely that habitat rehabilitation would result in significant improvement in biological integrity. Management strategies that limit further degradation and promote stewardship are important to at least maintain its biological integrity at near-moderate levels.

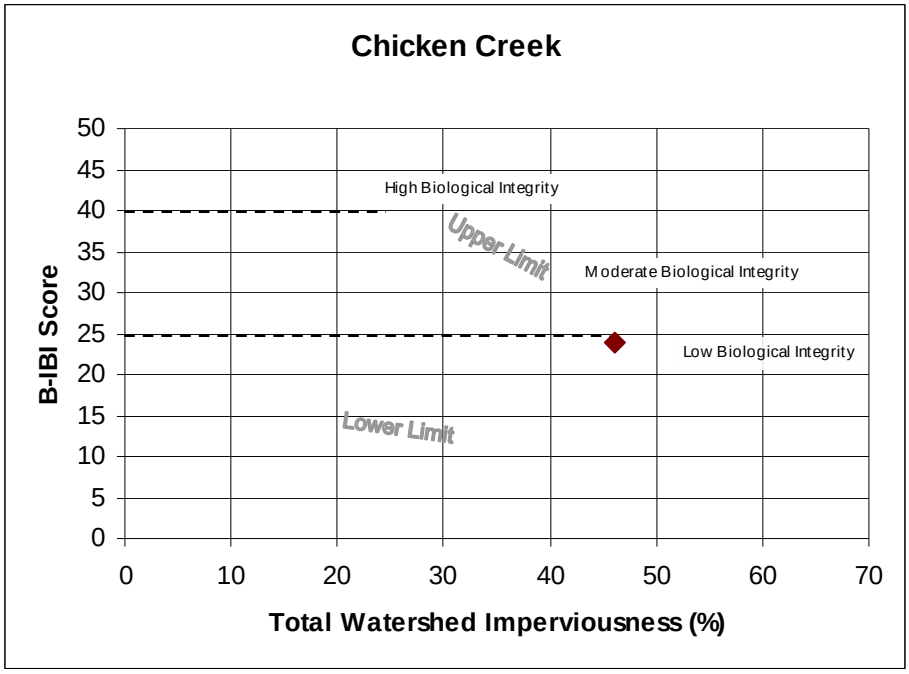


Figure 22: Approximate range of B-IBI in Puget Lowland watersheds, showing progressive decline with increasing imperviousness in the upstream watershed. Adapted from Booth et. al., 2004. Markers indicate Total B-IBI scores at Station CHK010 for particular years, versus estimated 2000 subwatersheds TIA.

Management Recommendations

The general character of its subwatershed suggests management strategies should focus on limiting further degradation and promoting stewardship. These strategies might include

protecting remaining forested riparian areas, improved stormwater control and treatment, and minimizing sediment loading.

Fish Use and Distribution

Purpose

Fish distribution refers to salmon and steelhead use. This information helps to identify stream segments where land-use changes may impact fish populations, informs management decisions, and aids in identifying and prioritizing potential habitat improvement and protection projects.

Methods

Fish distribution for the Salmon Creek (RM 00.60) and Lakeshore subwatersheds is mapped from existing GIS information in the WDFW SalmonScape database, and is available at http://wdfw.wa.gov/mapping/salmonscape/

Several sources of barrier assessment data are available and are briefly summarized here, including:

- WDFW passage barrier database.
- SalmonScape
- Clark County 1997 passage barrier data.
- Clark Conservation District/LCFRB passage barrier dataset.

Many stream crossings have not been assessed for passage barrier potential, and the extent of public and private road crossings is a good indicator of the potential for additional barriers. Road crossings were mapped by overlaying the county road layer with LiDAR-derived stream data.

The barrier assessment data was also reviewed for specific project opportunities within each subwatershed. Potential project sites have been reviewed and verified through field reconnaissance and are detailed in the results section below.

Results/Summary

Distribution

The available evidence suggests that anadromous fish use within the Salmon Creek (RM 00.60) and Lakeshore subwatersheds includes Coho salmon, winter steelhead, and fall Chinook salmon (Figure 23). SalmonScape data also show the presumed presence of fall chum salmon within the mainstem of Salmon Creek, to the same spatial extent as the other species. In all cases, SalmonScape shows anadromous fish use confined to the mainstem of Salmon Creek and Lake River only.

Although not reflected in the mapping, much of the Salmon Creek (RM 00.60) subwatershed contains side channels used by anadromous fish as off-channel rearing habitat. Tributary streams may not be used much due to gradient, seasonal flows, or limited escapement opportunities.

The mapping indicates fall chum salmon presence and presumed use does not continue up Lake River beyond the confluence with Salmon Creek. This is probably due to poor upstream water quality and lack of spawning habitat.

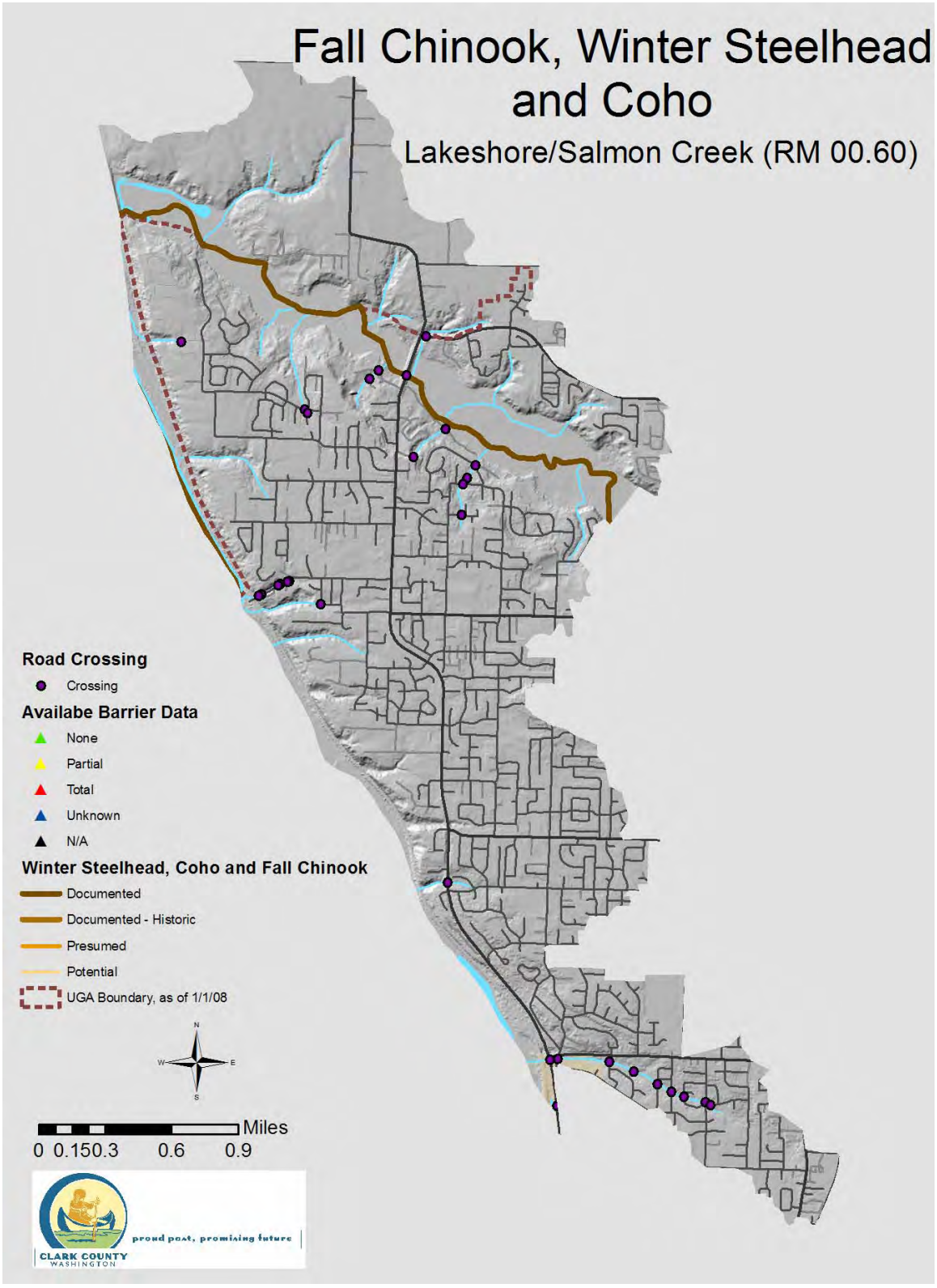


Figure 23: Salmon Creek (RM 00.60) and Lakeshore subwatersheds Fish Distribution and Barriers

Barriers

The WDFW barrier database provides the most complete assessment of barriers in the Salmon Creek (RM 00.60) and Lakeshore subwatersheds (Figure 23).

There are no mapped fish passage barriers within the Lakeshore/Salmon Creek (RM 00.60) subwatersheds at this time. However, the LCFRB reports some Salmon Creek side channels within this subwatershed have been isolated due to channel incision (LCFRB, 2009).

Recommendations

Since no mapped fish passage barriers exist within the Lakeshore/Salmon Creek (RM 00.60) subwatersheds, no infrastructure retrofits are recommended at this time. However, as mentioned by the LCFRB, reconnecting some off-channel habitats to the mainstem of Salmon Creek would have significant, positive benefits, especially for chum spawning and Coho overwintering (LCFRB, 2009).

Hydrologic and Hydraulic Models

Hydrologic and hydraulic modeling was not conducted.

Analysis of Potential Projects

The analysis of potential projects:

- Briefly summarizes stormwater conditions, problems and opportunities.
- Notes recently completed or current projects within the study area that may be relevant to SNAP project selection.
- Describes the analytical approach.
- Lists recommended projects and activities for further evaluation.

Projects or activities are placed in one of several categories.

Project descriptions summarize more detailed descriptions found in report sections. Project planners are encouraged to reference the longer descriptions and also to utilize the information found for each potential project in the SNAP GIS database available from the Clean Water Program. Reference IDs for the database are included in the tables for each project.

Summary of Conditions, Problems, and Opportunities

Conditions and Problems

This section briefly summarizes important results from the assessment chapters and identifies overall stormwater-related problems.

Coordination with Other Programs

The subwatersheds in this assessment area lie primarily within the Unincorporated Vancouver Urban Growth Area.

Vancouver-Clark Parks and Recreation, Clark County Legacy Lands, and Clark Public Utilities are actively involved in the lower Salmon Creek watershed (Salmon Creek RM 00.60). The Salmon Creek Watershed Council provides a forum for citizens and organizations to participate in on the ground restoration, water quality and advocacy. The Washington Department of Ecology coordinates local agency actions as part of ongoing TMDL implementation and adaptive management in Salmon Creek.

Vancouver-Clark Parks and Recreation is also active in the Lakeshore subwatershed and owns several currently vacant parcels for future parks development. The Vancouver Lake Watershed Partnership has taken an active role in coordinating local interest and supporting the development of long-term management and improvement plans for Vancouver Lake. The Lakeshore subwatershed drains directly into Vancouver Lake.

The Clean Water Program regularly communicates and coordinates with all of these entities.

Broad-Scale Characterization

The study area is generally urban residential with some agricultural and rural residential areas. The topography is typical of the relatively level floor of the Willamette valley with low rolling

hills cut by streams tributary to Salmon Creek, Lake River and Vancouver Lake. The Salmon Creek floodplain is approximately 10 to 20 feet above sea level and essentially part of the Columbia River flood plain. All of the tributary streams that flow into canyons lack floodplains.

Geology consists of sedimentary gravel and sandstone deposited by the ancestral Columbia River, overlain with more recent, sandy alluvium deposits. All tributary streams in the study area drain urbanized or urbanizing areas. Consequently, stream hydrology is altered considerably from a natural forested condition.

Overall, standard subwatershed scale metrics such as percent forest, percent total impervious area, road density, and effective impervious area, when compared to NOAA fisheries standards, suggest stream habitat is not properly functioning. Stream crossing density in Salmon (RM 00.60) has stream crossing densities within the functioning category and Lakeshore is between functioning and non-functioning. Forest cover tends to be limited to steeper slopes and in stream valleys, with flatter areas historically cleared for agriculture and home sites. Based on the latest Clark County Comprehensive Plan, the estimated future subwatershed EIA for both subwatersheds is expected to change little in the near term.

Water Quality Assessment

Salmon Creek within this assessment area has multiple listings on the 2008 303(d) Ecology list of impaired water bodies and is included in ongoing TMDL implementation for turbidity and fecal coliform, as well as TMDL development for temperature. There are no specific listings within the Lakeshore subwatershed; however, these small streams drain to Lake River and/or Vancouver Lake, both of which are listed for multiple parameters in both water quality and fish tissue categories.

A relatively lengthy dataset (2002-2009) is available for mainstem Salmon Creek in this assessment area, as Clark County maintains a long-term station on Salmon Creek (Station SMN010) at NW 36th Avenue. A more limited, one-year dataset (2008 through 2009) exists for the only named tributary (Chicken Creek) and six other unnamed tributaries in the Lakeshore subwatershed.

General water quality in lower in Salmon Creek mainstem (SMN010) is poor. However, Ecology (Collyard, 2009), found decreasing trends in fecal coliform (wet season only), nitrate-nitrite, and total phosphorus concentration.

Based on monthly data from 2005 - 2007, geometric mean fecal coliform concentrations at Station SMN010 declined sharply during both the wet and dry seasons when compared to values from the 1995 TMDL. 90th percentile values also decreased substantially during the wet season, and decreased slightly during the dry season. However, station SMN010 still failed the criterion during both wet and dry seasons.

Preliminary analysis indicates all but one of the stations in the Lakeshore characterization study failed both parts of the state fecal coliform criteria in both the wet and dry seasons, and nutrient levels typically exceeded EPA suggested criteria for streams entering lakes.

Continuous stream temperature monitoring (2003) in Salmon Creek indicated that station SMN010 failed to meet the current state criterion (7-day moving average of daily maximum temperatures) of 60.8 degrees F. Results of this study showed that SMN010 had the highest temperatures recorded during the study, and spent very lengthy time periods with elevated temperatures. On at least 75 days, temperatures at SMN010 exceeded 64 degrees F for an average of 19 hours per day.

Drainage System Inventory and Condition

The drainage system inventory is complete in this assessment area. Significant stormwater infrastructure inventory updates took place in 2008 and 2009; 2266 new features were added. There are 8674 total stormwater infrastructure features mapped in this assessment area.

Retrofit evaluations of public stormwater facilities in this assessment area generated 15 potential projects - 11 in the Lakeshore subwatershed and four in the Salmon Creek (RM 00.60) subwatershed. Most identified retrofit opportunities involved increased detention.

Inspection and maintenance evaluations in the Lakeshore subwatershed found that the majority of facility objects (84 percent) were in compliance with Clark County maintenance standards. No major defects or hazardous conditions were discovered; non-compliant issues included excess sediment depth and vegetative management issues.

Inspection and maintenance evaluations in the Salmon Creek (rm 00.60) subwatershed found that the majority of facility objects (81 percent) were in compliance with Clark County maintenance standards. One major defect and hazardous condition was discovered; a failing bioswale created severe erosion issues. This facility was referred to a CWP engineer to evaluate erosion severity and hillside stability. Non-compliant issues included missing signage, clogged debris barriers, and vegetative management issues.

Off-site assessments were conducted at 32 priority outfalls discharging to critical areas; 15 in the Lakeshore subwatershed and 17 in the Salmon Creek (rm 00.60) subwatershed. The offsite assessment project yielded eight potential project opportunities; four in the Lakeshore subwatershed and four in the Salmon Creek (RM 00.60) subwatershed. These opportunities include stabilizing banks, installation of energy dissipaters, and flow reduction enhancement.

Source Control

Source control inspections were conducted at 10 businesses in this assessment area. Two sites had source control problems; both were successfully resolved through technical assistance re-visits.

This area should be a low priority for source control inspections; there are few parcels in these subwatersheds which engage in activities likely to have stormwater contamination issues.

Illicit Discharge Screening

Illicit Discharge Detection and Elimination Screening was not conducted.

Stream Reconnaissance Feature Inventory
A feature inventory was conducted for nearly 2.6 miles of stream corridor within the assessment area. Seventy-two features of interest were recorded; primarily stormwater culverts, outfalls, severe bank erosion, and impacted stream buffers. Eighteen potential opportunities for capital projects or other stream improvements were identified in two categories.

Physical Habitat
Physical habitat measurements in the upper portion of Salmon Creek (RM 00.60) were made in 2004 (R2 Resource Consultants, Inc., 2004) on the mainstem of Salmon Creek (EDT reaches Salmon 1-4, RM 0.0 to RM 1.1). The survey reach has a gradient of <0.5 percent and is classified as palustrine to wide, large floodplain channel types. Glide habitat represents 100% of the survey reach habitat by length. No pool or riffle habitat was observed. Embeddedness and substrate composition were not rated because the dominant substrate class was sand and silt throughout the reach. Pool frequency, LWD, and water temperature were rated not properly functioning in the survey reach. Streambank stability was rated as properly functioning.

Geomorphology and Hydrology
Geomorphology was evaluated for Chicken Creek in the Lakeshore subwatershed, and in four small tributary streams in the Salmon Creek (RM 00.60) subwatershed. Among these, all but one appear to have moderate to high channel response potential to increases in flow. Only the stream labeled Salmon Creek tributary 2, and artificially hardened portions of Chicken Creek, had low response potential.

Field reconnaissance indicates the study area has been, and continues to be, influenced by natural geologic characteristics and human development. Hydrology is significantly altered from pre-development forested conditions.

Hydromodifications are rare in the Salmon Creek tributaries assessed, and ubiquitous within Chicken Creek.

Among potential project categories that could be pursued in this study area, streambank and floodplain revegetation projects are likely to be the most beneficial. Channel re-alignment projects and hydromodification removal are not recommended in this area, while bank stabilization opportunities are unlikely candidates due to private property, difficult access, and small stream size.

Riparian Assessment
In the 2004 LCFRB Habitat Assessment, overall riparian conditions in lower Salmon Creek were rated impaired. Large woody debris recruitment potential was primarily low to medium in the Salmon Creek (RM 00.60) area. Shade levels were below state targets; however, this may be a natural function of the stream width in this area of the watershed. Significant opportunities for riparian restoration exist on County-owned lands within the Salmon Creek (RM 00.60) subwatershed.

Based on visual review of aerial photos, most tributaries in the Lakeshore subwatershed have moderate to high large woody debris recruitment potential, with low to moderate levels of shade.

Wetland Assessment
The Salmon Creek (RM 00.60) subwatershed has large expanses of potential wetland areas associated with the Salmon Creek riparian corridor and floodplain. Most opportunities for wetland enhancement are on County-owned land within the Salmon Creek Greenway. In Lakeshore, there is a narrow fringe of wetland along the east banks of Lake River.

Ecology's watershed characterization of Clark County places the assessment area in a category suitable for development due to a lower level of regional importance and higher level of current alteration from historical conditions.

Macroinvertebrate Assessment
Based on a single sample collected from Chicken Creek (Lakeshore subwatershed) in 2008, biological integrity is low. The B-IBI score for this sample is at the upper limit of the range of expected scores for areas with similarly high levels of total impervious area (~45%). Given this, it is unlikely that habitat rehabilitation would result in significant improvement in biological integrity.

No data are available from the Salmon Creek (RM 00.60) subwatershed.

Fish Use and Distribution
The available information suggests that anadromous fish use in the study subwatersheds includes Coho salmon, winter steelhead, and Chum salmon, but presumed use is confined to the mainstem of Salmon Creek and Lake River. It is likely that side channels in the Salmon Creek (00.60) subwatershed are used by anadromous fish as off-channel rearing habitat.

There are no mapped fish passage barriers within this study area. However, the LCFRB (2009) reports that some side channels in lower Salmon Creek have been isolated due to channel incision. Reconnecting off-channel habitats in this area could have significant benefits for chum spawning and Coho overwintering.

Recently Completed or Current Projects

As of December 2009 there are nine potential stormwater management capital projects listed in this study area in the CWP Capital Planning database; three of these are slated for construction in 2010 (CIP-30, Felida Knolls; OS-95, Lakeshore and NW 99th; CIP-6, Teal Pointe).

There are no road improvement projects listed the 2010-1015 Clark County Transportation Improvement Program.

Clark County Legacy Lands program has recently purchased several parcels along lower Salmon Creek. Several additional parcels are under consideration for future acquisition, some of which are also listed in this report below.

Analysis Approach

Purpose

The Analysis of Potential Projects narrows the initial list of possible opportunities to a manageable subset of higher priority potential projects. Listed opportunities in sections of the SNAP report include sites requiring immediate follow-up, possible stormwater capital improvement projects, referrals to ongoing programs, and potential projects for referral to other county departments or outside agencies.

Stormwater capital improvement project opportunities are recommended for further evaluation by engineering staff, and potential development into projects for consideration through the SCIP process. Referrals to ongoing programs such as illicit discharge screening, operations and maintenance, and source control outreach receive follow-up within the context and schedules of the individual program areas. Referrals to other county departments, such as Public Health, or to outside agencies such as Clark Conservation District and Clark Public Utilities, may lead to additional activities outside the CWP scope.

Methods

An initial review is conducted for all potential projects identified during the stormwater needs assessment. Field notes, descriptions, field photos, and other associated information are reviewed. In some cases, additional field reconnaissance is performed.

In general, potential capital projects are evaluated by CWP staff considering problem severity, estimated cost and benefits, land availability, access, proximity and potential for grouping with other projects, and potential for leveraging resources. Staff considers supporting data and information from throughout the SNAP report to assist in the initial project review.

Based on this review, lower priority opportunities are removed and higher priority projects are recommended for further consideration by the CWP.

Emergency/Immediate Actions

Emergency/Immediate actions may be pursued by Clark County staff or referred to other appropriate agencies. These cases represent a potential or immediate threat to public health, safety, or the environment, and require timely follow-up.

Identifier	Issue	Project	Action
CIP-11	Swale failure (Miller Pond); hole in swale piping down hillside	Engineer referral; fix swale, possible treatment retrofit	Refer to CWP Capital Planning

Potential Stormwater Capital Projects

Stormwater Facility Capital Improvement Projects

Identifier	Issue	Project	Action
CIP-32	Facility (Felida Village) sits on a large parcel with room for potential expansion	Retrofit for increased storage	Refer to CWP Capital Planning
OS-123	Swale is channelized and short-circuited (Millers Edge)	Retrofit for increased treatment and storage	Refer to CWP Capital Planning
OS-124	Facility (Lakeview Estates V) sits on a large parcel with room for potential expansion	Retrofit for increased storage	Refer to CWP Capital Planning
OS-95	Facility (Lakeshore and NW 99th Street) sits on a large parcel with room for potential expansion	Retrofit for increased storage	Refer to CWP Capital Planning
CIP-30	Swale is not functioning properly	Retrofit for increased treatment and storage	Refer to CWP Capital Planning
OS-125	Facility (Gregory Place) sits on a large parcel with room for potential expansion	Retrofit for increased storage	Refer to CWP Capital Planning
OS-126	Facility (Celia Meadows) sits on a large parcel with non-existent swale and little detention.	Retrofit for increased treatment and storage	Refer to CWP Capital Planning
OS-127	Facility (Effinger Subdivision) sits on a large parcel with room for potential expansion	Retrofit for increased storage	Refer to CWP Capital Planning
OS-128	Potential retrofit of bioswale or installation of LID practices	Retrofit for increased treatment	Refer to CWP Capital Planning
OS-129	Facility (West of Westmore) sits on a large parcel with room for potential expansion	Retrofit for increased storage	Refer to CWP Capital Planning
OS-131	Half of swale (Tiare Hills IV) has been converted to yard area. Appears to be draining, but not functioning as designed	Retrofit for increased treatment; engineer referral	Refer to CWP Capital Planning
OS-130	Sedimentation of detention pond; facility (Clomont/Miller	Retrofit for increased treatment and storage	Refer to

Identifier	Issue	Project	Action
	Estates) sits on a large parcel with room for potential expansion		CWP Capital Planning
OS-204	Sedimentation of detention pond; facility (Ridge Creek West) sits on a large parcel with room for potential expansion	Retrofit for increased treatment and storage	Refer to CWP Capital Planning
OS-205	Facility (NW Bliss/NW 36th Avenue) sits on a large parcel with room for potential expansion	Retrofit for increased treatment and storage	Refer to CWP Capital Planning
ER-63	Stream (Chicken Creek) is channelized and eroding, flows through 0.25 acres unused platted land. Flow control and treatment virtually nonexistent in this vicinity	Purchase parcel; construct detention/ treatment facility or floodplain bench	Refer to CWP Capital Planning
IB-254	1.5 acres at headwater of Chicken Creek Note: same location as CIP-75	Purchase parcel; construct detention/ treatment facility	Refer to CWP Capital Planning
MI-74	Chicken Creek flows through 0.5 acres unused platted land near headwater. See also features MI-73 (existing in-line pond on property) and ER-61	Purchase parcel; construct detention/ treatment facility or floodplain bench	Refer to CWP Capital Planning
MI-75	Existing facility (Jorgenson Park) sits on a large parcel with room for potential expansion; also an opportunity for riparian enhancement (IB-255)	Retrofit for increased treatment and storage	Refer to CWP Capital Planning
MI-78	Potential for stormwater treatment facility near outlet of Chicken Creek to Vancouver Lake	Purchase parcel; construct treatment facility for nutrient, sediment, and/or fecal coliform removal	Refer to CWP Capital Planning
MI-79	Potential for stormwater treatment facility near outlet of Chicken Creek to Vancouver Lake	Purchase parcel; construct treatment facility for nutrient, sediment, and/or fecal coliform removal	Refer to CWP Capital Planning
OT-248	Untreated and un-detained runoff from public streets	Construct facility in ROW to detain and treat street runoff	Refer to CWP Capital Planning

Identifier	Issue	Project	Action
OT-249	Untreated and un-detained runoff from public streets	Construct facility in ROW to detain and treat street runoff	Refer to CWP Capital Planning
OT-254	Untreated and un-detained runoff from public streets	Remove existing pipe and create swale or rain garden	Refer to CWP Capital Planning
SCC-195	House immediately upstream of undersized culvert experiences flooding; There is a parcel with open space for potential storage upstream, near SCC-194.	Purchase parcel; construct detention facility	Refer to CWP Capital Planning

Stormwater Infrastructure Maintenance CIPs

Identifier	Issue	Project	Action
OS-206	Undercutting/scouring; drainage issues associated with facility ID 1210	Stabilize bank and add riprap	Refer to CWP Capital Planning

Stormwater Class V Underground Injection Control (UIC) Projects
No projects of this type were identified.

Habitat Rehabilitation/Enhancement Projects

Identifier	Issue	Project	Action
OS-207	Multiple County-owned parcels (approx 360 ac) within lower reach of Salmon Creek Greenway. Lack of native wetland vegetation and widespread invasive plant species within wetland area. Invasive species is predominantly reed canary grass.	Re-establish native undergrowth and canopy vegetation within wetland area to shade out invasive plants and enhance wetland habitat. Eradicate reed canary grass	Refer to CWP Capital Planning
OS-208	Multiple private parcels (Delanoy) surrounding Salmon Creek Treatment Plant; potential for wetland enhancement or reforestation. On Legacy Lands list of potential acquisitions.	Purchase property for restoration; possible joint project with Legacy Lands	Refer to CWP Capital Planning

Property Acquisition for Habitat Preservation
No projects of this type were identified.

Follow-up Activities for Referral within CWP

Private Stormwater Facilities Maintenance

Identifier	Issue	Project
IB-259	Blackberries taking over private facility (Ashleigh Heights Ph 5)	Refer to Public Works private facility inspection

Public Works Stormwater Infrastructure Maintenance
No projects of this type were identified

CWP Outreach/Technical Assistance

Identifier	Issue	Action
OT-255	Swimming pool drain piped to creek	Refer to DES Source Control for site visit
WQ-76	Livestock access to creek	Refer to Outreach/Tech Assistance-- landowner letter
WQ-77	Livestock access to creek	Refer to CCD. Also refer to Outreach/Tech Assistance-- landowner letter

CWP Infrastructure Inventory
No projects of this type were identified

CWP Capital Planning

Identifier	Issue	Action
ER-67	Three locations with severe erosion; all appear to result from private stormwater outfalls within the Ashley Heights subdivision	Engineer inspection; referral to Code Enforcement if issues are confirmed
OS-209	Moderate erosion issues downstream of outfall	Engineer inspection; referral to CWP Capital Planning if appropriate
OS-210	Moderate erosion issues downstream of outfall	Engineer inspection; referral to CWP Capital Planning if appropriate
OS-211	Moderate erosion issues at outfall	Engineer inspection; referral to CWP Capital Planning if appropriate
OS-212	Severe erosion issues at outfall; undercutting/ scouring	Engineer inspection; referral to CWP Capital Planning if appropriate
OS-213	Moderate erosion issues downstream of outfall	Engineer inspection; referral to CWP Capital Planning if appropriate
OS-214	Severe erosion issues at outfall; undercutting/scouring; possible infiltration trench failure	Engineer inspection; referral to CWP Capital Planning if appropriate
OS-215	County-owned parcel 146230000; currently vacant, likely future park. Surrounding area has limited stormwater detention and treatment	Engineer inspection; referral to CWP Capital Planning if appropriate. Possible joint project with Parks
OS-216	County-owned parcel 188992000; currently vacant, likely future park. Surrounding area has limited stormwater detention and treatment	Engineer inspection; referral to CWP Capital Planning if appropriate. Possible joint project with Parks
OS-217	County-owned parcel 188900000; currently vacant, likely future park. Surrounding area has limited stormwater detention and treatment	Engineer inspection; referral to CWP Capital Planning if appropriate. Possible joint project with Parks

OS-218	County-owned parcel 183311000; currently vacant, likely future park. Surrounding area has limited stormwater detention and treatment	Engineer inspection; referral to CWP Capital Planning if appropriate. Possible joint project with Parks

CWP Illicit Discharge Screening

Identifier	Issue	Action
OT-256	Unmapped 18" outfall	Add to IDDE screening list; also refer to CWP Infrastructure Inventory
OT-259	6" metal pipe outfall, unknown origin	Add to IDDE screening list

Projects for Referral to Other County Departments, Agencies, or Groups

Identifier	Issue	Action
IB-255	Widespread invasive plants within channel and in riparian area. County park land (Jorgensen); riparian restoration potential. Also a potential facility retrofit project (MI-75) at this location	Refer to Vancouver-Clark Parks and Recreation

Channel Rehabilitation Projects

Several potential channel rehabilitation opportunities were identified by staff completing the Geomorphology chapter. These opportunities are listed in the Geomorphology Assessment section. From a stormwater perspective, channel rehabilitation projects are typically not a high priority.

Invasive plant removal and re-vegetation projects:

A number of potential re-vegetation and/or invasive plant removal opportunities on publicly owned land within the lower end of the Salmon Creek Greenway were noted by staff completing the riparian assessment. These opportunities are listed in the potential projects section of the Riparian Assessment chapter and overlap significantly with wetland habitat restoration opportunities represented by project OS-207. Also, invasive plant removal and vegetation rehabilitation is typically included to the extent feasible in stormwater capital projects. Agencies and groups interested in vegetation projects are encouraged to refer to the opportunities listed in this report as a starting point for project planning.

Non-Project Management Recommendations

Non-project stormwater management recommendations address areas where county programs or activities could be modified to better address NPDES permit components or promote more effective mitigation of stormwater problems. Information of this type contributes to adaptive management strategies and more effective stormwater management during the permit term.

Management and programmatic recommendations in the study area subwatersheds, by NPDES permit component, include:

Storm Sewer Mapping and Inventory

- None

Coordination of Stormwater Activities

- None

Mechanisms for public involvement

- Publish SNAP reports on CWP web page

Development Regulations for Stormwater and Erosion Control

- None

Stormwater Source Control Program for Existing Development

- Prioritize stormwater treatment in downstream areas of Chicken Creek (Lakeshore subwatershed). Stormwater impacts to Vancouver Lake include fecal coliform bacteria, nutrients, and sediment
- Prioritize stormwater detention and infiltration in upstream areas of Chicken Creek, and in tributary streams within Salmon Creek (RM 00.60) subwatershed.

Operation and Maintenance Actions to Reduce Pollutants

- Focus additional effort on maintenance of bioswales, particularly excessive sediment conditions
- Focus additional effort on repairing and maintaining energy dissipaters at outfalls

Education and Outreach to Reduce Behaviors that Contribute Stormwater Pollution

- Encourage or develop incentives for private landowners to disconnect downspouts and infiltrate runoff rather than piping directly to streams
- Perform targeted technical assistance responding to results of field assessments
- Educate private landowners concerning the importance of invasive plant removal and suggest removal techniques
- Educate private landowners on the importance of native riparian vegetation for shading streams

TMDL Compliance

- Continue collaboration on Salmon Creek TMDL development. Clark County fulfills its TMDL compliance obligations through ongoing implementation of the Stormwater Management Program

Monitoring Stormwater Program Effectiveness

- Clark County is implementing stormwater monitoring to measure program effectiveness under section S8.E of the NPDES permit in the Lakeshore subwatershed beginning in 2010

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