2010 Stormwater Needs Assessment Program

Upper Fifth Plain Creek/Shanghai Creek Subwatershed Needs Assessment Report

Clark County Department of Environmental Services

March 2011

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Acknowledgements

Development of Stormwater Needs Assessment reports is a team effort involving many individuals implementing various tools and tasks as described in Stormwater Needs Assessment Program, Volume I.

Thank you to staff who contributed chapters or support for this report, including: Cary Armstrong, Brent Davis, George Fornes, Holley Gilbert, Chad Hoxeng, Bob Hutton, Forest Shuler, Cindy Stienbarger, and Ian Wigger.

Special thanks to local agency staff and interested parties who provided discussion, coordination, and project suggestions, including:

- Patrick Lee, Clark County Office of Conservation Lands Management
- Joel Rupley, Clark County Endangered Species Act
- Jeroen Kok, Clark Parks and Recreation

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 Upper Fifth Plain Creek and Shanghai Creek subwatersheds in the Lacamas 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

The DES coordinates with the Washington Department of Ecology, Lower Columbia Fish Recovery Board, Clark County Legacy Lands and Vancouver-Clark Parks and Recreation in efforts to improve stream health.

Ecology is collecting field data for a multi-parameter TMDL during 2010-2011. Clark County participates in the TMDL process. There are no planned road improvement projects included in the 2010-2015 Clark County Transportation Improvement Program, and no planned projects in the 2011-2012 stormwater capital program.

Category	Status
Water Quality	
Overall	• Overall water quality is poor to fair • TMDL under development for fecal coliform bacteria, dissolved oxygen, temperature, and pH
Temperature	• Routinely exceeded the state criterion
Biological	
Benthic macroinvertebrates	• Moderate (Shanghai Creek) to poor (Upper Fifth Plain Creek) biological integrity
Anadramous fish	• No anadramous fish presence; natural barrier below Lacamas Lake • Resident cutthroat trout are presumed present; no mapped passage barriers
Habitat	
NOAA Fisheries criteria	• Forest cover and road density fall into the Non-Functioning category • Stream crossing density and estimated effective impervious area fall into the Properly Functioning category
Riparian	• Forest cover is about 44 percent and is mainly found in stream valleys and some upland areas • Large woody debris recruitment potential is moderate to good in the upper basin and poor in the lower stream reaches • Shade is moderate to good in the upper basin and poor in the lower stream reaches
Wetland	• Predominately slope wetlands; mainly near the confluence of Upper Fifth Plain Creek and Shanghai Creek
Hydrology and Geomorphology	
Overall hydrology	• No hydrologic data are available but likely typical for a partly forested rural watershed
Future condition	• Projected impervious area should remain at levels that do not alter hydrology if forest cover is retained or expanded
Stormwater (unincorporated areas)	
System description	• Primarily road-side ditches; 25 stormwater facilities
Inventory status	• Complete; 1,721 unmapped objects were added to the StormwaterClk database during 2007 - 2009
System adequacy	• Adequate treatment is probably provided by vegetation in ditches • Minimal flow control other than infiltration in ditches
System condition	• No IDDE screening was performed • Eight priority outfalls assessed; all in compliance • Largely undocumented but presumed functional

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 four potential wetland and/or riparian enhancement projects
- Technical assistance visits to landowners and businesses with potential source control problems and water quality ordinance issues
- Numerous small and large-scale invasive plant removal and riparian restoration projects
- Education and Outreach opportunities for numerous potential channel rehabilitation projects
- Technical assistance visits to landowners and businesses for potential pond removal or limitation to reduce thermal inputs
- Education and outreach to landowners and businesses to promote proper septic system maintenance practices

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 Upper Fifth Plain Creek and Shanghai Creek TMDL adaptive management (fecal coliform, temperature, dissolved oxygen and pH)
- Post stream identification signs where roads cross streams; repair or replace deteriorated signs
- Continue to encourage and support riparian planting efforts by private landowners to increase shade and LWD delivery
- Continue to expand efforts to design and build runoff reduction strategies in county right-of-way to increase infiltration and retention of stormwater runoff
- Focus additional assessment efforts on Priority 2 and Priority 3 outfalls
- Educate landowners to discourage disposal of trash and yard debris in streams or other receiving waters
- Encourage appropriate agricultural practices that emphasize soil and water conservation and reduction in nutrient load to streams.
- Protect streams from future stormwater impacts by creating stream buffers, establishing conservation easements, and eliminating agricultural runoff inputs.

- Protect remaining forested areas and encourage reforestation
- Conserve agricultural lands and promote healthy practices
- Implement development regulations to minimize impacts, particularly enhanced nutrient control regulations to help protect Lacamas Lake

Introduction

This Stormwater Needs Assessment includes the Upper Fifth Plain Creek and Shanghai Creek 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 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 also is needed by county programs implementing critical areas protection and salmon recovery planning under the state GMA and federal ESA.

Scope

This report summarizes and incorporates new information collected for 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: Public Works CWP, Stormwater Capital Improvement Program (SCIP), and Development Engineering; Community Planning; Public Health; Legacy Lands; ESA. Potential project or leveraging opportunities also are referred to local agencies, groups and municipalities as appropriate.

Assessment Approach

Priorities for Needs Assessment in Upper Fifth Plain Creek and Shanghai Creek

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, Upper Fifth Plain Creek and Shanghai Creek subwatersheds are categorized as Rural Residential with No UGA

Subwatersheds in this category are generally not heavily forested but have limited stormwater management needs due to the lack of urbanization. Assessment efforts for these subwatersheds focus primarily on summarizing existing information to identify potential restoration projects.

Assessment Tools Applied in Upper Fifth Plain Creek and Shanghai Creek

SNAP uses 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.

Table 1: Stormwater Needs Assessment Tools

Outreach And Involvement *	Riparian Assessment *
Coordination with Other Programs *	Floodplain Assessment
Drainage System Inventory and Condition *	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 and Hydraulic Modeling
Physical Habitat Assessment	Source Control *
Geomorphology And Hydrology Assessment	

Assessment Actions

Outreach Activities

Outreach activities were limited and focused primarily on raising awareness about the SNAP effort. The following activities were completed:

- Press release to local media.
- April 2010– article in Clean Water Program E-Newsletter.
- August 2010 – information on SNAP distributed at 10-day Clark County Fair.
- Clean Water Program web pages updated as needed; 135 visitors to SNAP web page since June 2010 (Note: these figures are under-reported as tracking software only records top 20 pages and documents monthly)
- A description of SNAP is 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

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 Work Plan
- LCFRB Washington Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (2010)
- Ecology 303(d) list
- WRIA 27/28 Plan

- Ecology EIM data
- Washington Department of Ecology completed the Watershed Characterization and Analysis of Clark County (2009)
- Clark County 2004 Subwatershed summary
- Clark County 2006 Stormwater Basin Planning
- Clark County 2010 Stream Health Report
- Clark County Volunteer Project data
- 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 describe 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 more than 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; 4) Orthophoto. These maps are printed out for tabletop evaluations.

General Conditions and Subwatershed Metrics

General Geography

The study area comprises two subwatersheds; Upper Fifth Plain Creek and Shanghai Creek. The area rises from the relatively level Willamette Valley floor to the lower foothills of the Cascade Mountains. Upland areas are also called the Troutdale Bench in reference to the underlying Troutdale Formation gravel deposits. Land use is rural residential in lower elevations and forested on steeper hills and higher elevations in the eastern part of the study area. The entire area is rural, outside of the urban growth areas.

Topography
Both Upper Fifth Plain Creek and Shanghai Creek have headwater areas at about 800 to 900 feet in elevation and flowing south through steep canyons. At about 300 through 400 feet in elevation, both creeks start flowing west through relatively flat rural agricultural areas. Upper Fifth Plain Creek and Shanghai Creek come together and become Lower Fifth Plain Creek at about 250 feet in elevation.

Geology and Soils
The oldest rocks in the study area are lava flows that underlie the entire study area at depth and are exposed along the eastern edge above 400 to 500 feet elevation. The rest of the eastern part of the study area is underlain by sedimentary rocks deposited by the ancestral Columbia and local streams. These gravel and sandstone deposits are exposed up to about 500 feet above sea level on the Troutdale Bench where they are weathered to reddish brown clay, and in canyons, where the rocks are unweathered.

Ice age Cataclysmic Flood deposits of unconsolidated sand, silt, and gravel along creeks blanket the area below about 300 feet elevation. The deposits are relatively thin and generally flat lying.

Soils are generally clayey and poorly drained. Hilltop areas tend to be hydrologic soil group C and B soils formed on weathered gravel deposits. Flat-lying Ice age Cataclysmic Flood deposits are C and D soils, where ground water is shallow, and B soils where groundwater is deeper.

Hydrology
Geology and topography play the main role in determining study area hydrologic framework. Both Upper Fifth Plain Creek and Shanghai Creek drainage systems cut into an upland area underlain by the Troutdale Formation. Headwater streams descend into shallow valleys. After exiting its canyon, Upper Fifth Plain Creek and Shanghai Creek pass through flat Ice Age Catastrophic Flood deposits. These relatively flat lying sedimentary deposits are capable of retaining relatively large amounts of rainfall as recharge and slowly discharging it from springs and seeps during the dry season.

Most of the study area is forested or low density rural areas. Parcels cleared for pasture or crops are numerous in the both subwatersheds. Consequently, stream hydrology may not be highly altered from a natural forested condition.

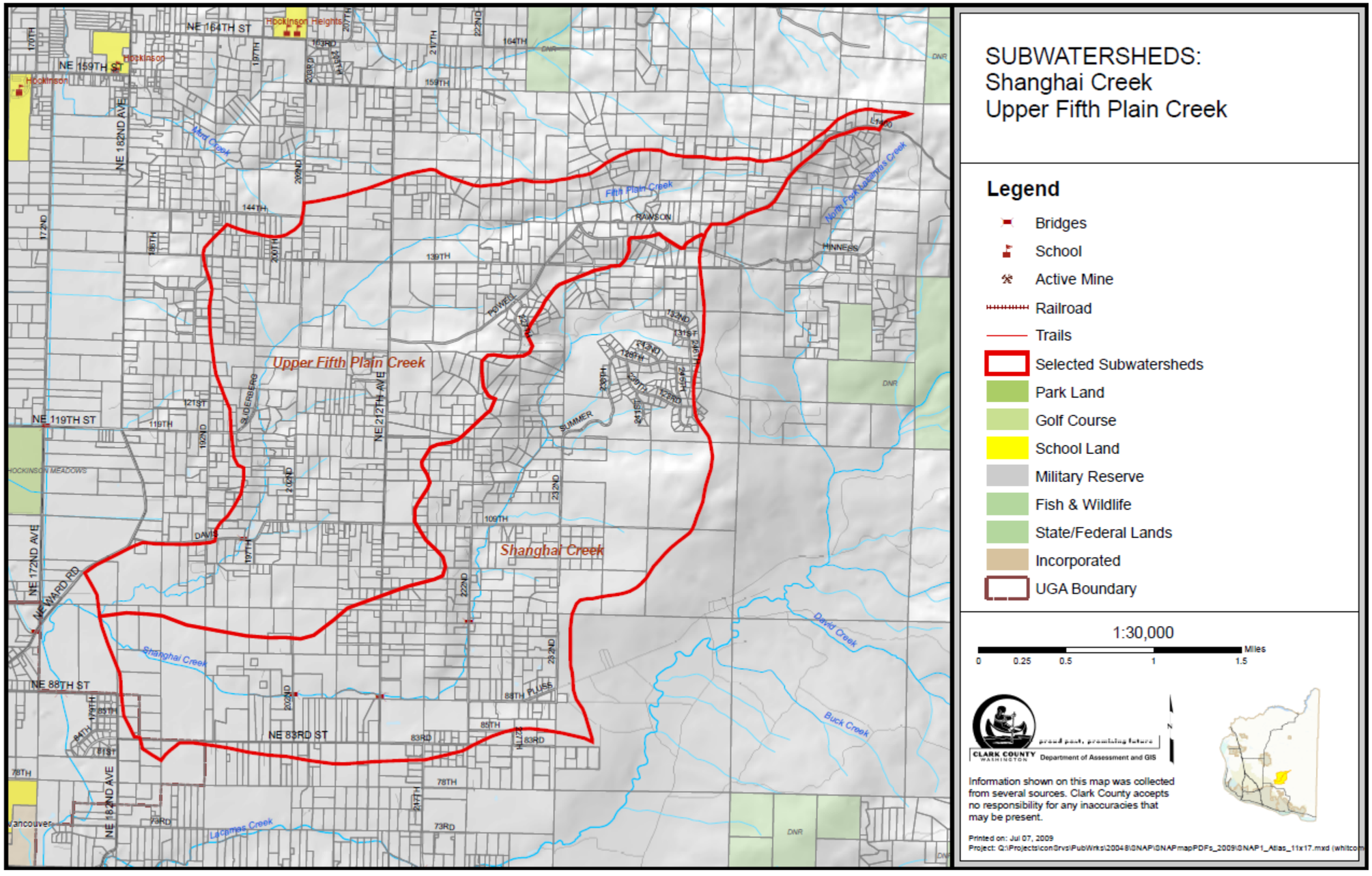

Figure 1: Subwatershed Map: Upper Fifth Plain Creek and Shanghai Creek Subwatersheds

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 does not completely meet standards due to lost forest and the amount of roads present (Table 2). However, the stream crossing density and expected future EIA imply suitability for protection and restoration in both Upper Fifth Plain Creek and Shanghai Creek.

Table 2: Watershed Scale Metrics

Metric	Upper Fifth Plain Creek	Shanghai Creek	Functioning	Non-functioning
Percent Forested (2000 Landsat)	46.5	41.5	> 65 %	< 50 %
Percent TIA (2000 Landsat)	14.5	16.7	< 5 %	> 15 %
Road Density 2007 data (miles/mile2)	7.5	6.7	< 2	> 3
Stream Crossing Density (crossings per stream mile)	2.3	2.6	< 3.2/mile	> 6.4/mile
Percent EIA estimated from the Comprehensive Plan	3.3	3.0	< 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.

Agricultural clearing, rural residential use and pasture are common in both lower Upper Fifth Plain Creek and lower Shanghai Creek subwatersheds. Upper portions of Shanghai Creek subwatershed have significant forested areas in various stages of growth. In Upper Fifth Plain Creek subwatershed, forest remnants remain in a few places, primarily along steeper stream channels in the upper portions of the subwatershed. Consequently, the overall lack of forest cover in these subwatersheds suggests non-functioning habitat.

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 5 percent as fully functional and greater than 15 percent as non-functioning.

The TIA estimate is currently at or just above the threshold for non-functioning habitat in both subwatersheds. However, Landsat data tends to overestimate TIA.

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 in the study area are approximately three times as dense as the threshold for 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 more than 60 feet wide, which would be approximately five- to 10-foot high road fill. The study area subwatersheds both have stream crossing densities within the functioning category (<3.2 crossings/stream mile NOAA Fisheries criteria).

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 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 in the study area is approximately 3 percent, well within the 10 percent EIA NOAA Fisheries standard for functioning salmon habitat.

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, both Upper Fifth Plain Creek and Shanghai Creek subwatersheds fall into the 'zone of uncertain channel stability' category. This indicates that through protection and restoration activities, it may be possible to increase forest cover and reduce the EIA to improve stream habitat. Conversely, increased land clearing could results in less stable channel conditions. Based on subwatershed scale conditions, both Upper Fifth Plain Creek and Shanghai Creek are good candidates for improving forest functions that could have a measurable impact on channel stability.

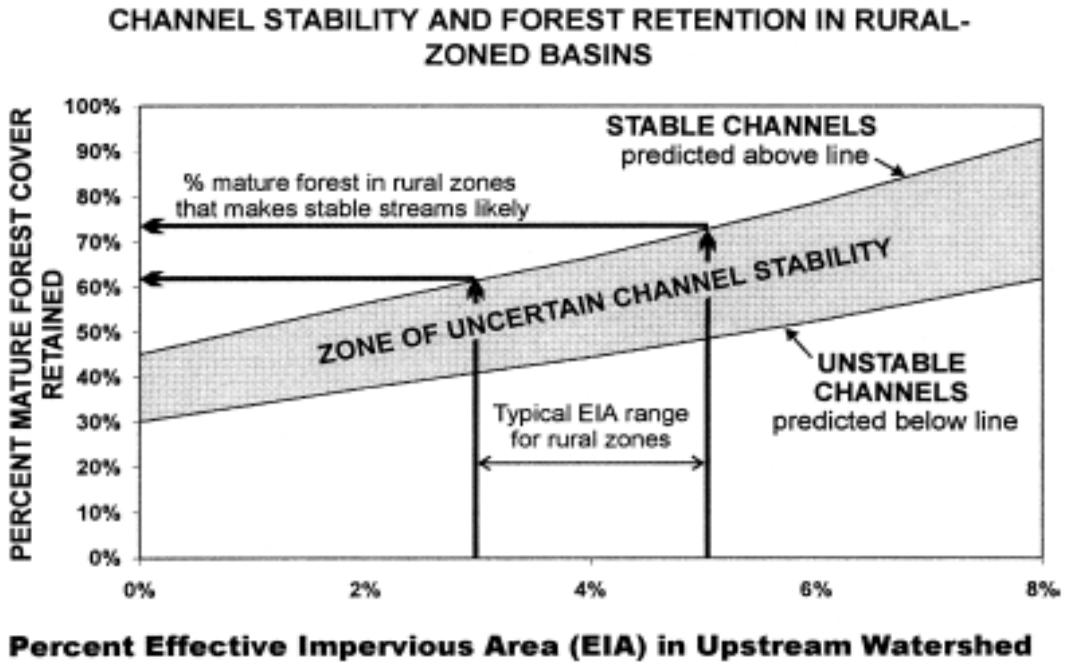

Figure 2: Channel stability in rural areas (Booth, Hartley, and Jackson, June 2002)

Water Quality Assessment

This section briefly summarizes and references available water quality data from the Upper Fifth Plain and Shanghai Creek 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, all lakes and all feeder streams to lakes 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 602).

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

Table 3: Applicable Water Quality Criteria for Upper Fifth Plain and Shanghai Creek Subwatersheds

Characteristic	Ecology criteria
Temperature	≤ 16 °C (60.8 °F)
Dissolved Oxygen	≥ 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	Geometric mean fecal coliform concentration not to exceed 50 colonies/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

Upper Fifth Plain Creek contains segments that are Category 5 listed (polluted waters that require a TMDL) for dissolved oxygen and temperature, and Category 2 listed (waters of concern) for dissolved oxygen, temperature, fecal coliform and pH.

Shanghai Creek contains segments that are Category 5 listed for temperature, dissolved oxygen, and pH, and Category 2 listed for fecal coliform, dissolved oxygen and pH.

Both subwatersheds are included in ongoing TMDL development for fecal coliform, temperature, dissolved oxygen and pH in Lacamas Creek above Lacamas Lake.

Clark County Stream Health Report

In 2010, the CWP compiled available data and produced a countywide assessment of general stream health.

Based on the available dataset, including water quality, biological health and stream flow patterns, overall stream health of the Upper Fifth Plain Creek subwatershed scored in the poor range, while Shanghai Creek scored in the fair range. The 2010 Stream Health Report may be viewed on the county website at: http://www.clark.wa.gov/water-resources/stream.html

Available Data

A very limited dataset is available for this assessment area. Clark County collected quarterly water quality data in Upper Fifth Plain Creek during 2003-2004 under the Volunteer Monitoring Program. No recent water quality data are available in the Shanghai Creek subwatershed.

Ecology began collecting data for TMDL development in late 2010. Available results and reports may be found on the Ecology website at:
http://www.ecy.wa.gov/programs/wq/tmdl/LacamasTMDL.html
As of January 2011, the current Ecology dataset is too limited for inclusion in this report.

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	Volunteer Monitoring Report: Summary for Fifth Plain Creek in the Lacamas Creek Watershed (2005) 2010 Stream Health Report

Water Quality Summary

Station FPL050 (Fifth Plain Creek at NE Davis Road) was monitored by volunteers from October 2002 to October 2004. Nine water samples were collected during this time, and continuous water temperature data were collected during the summers of 2003 and 2004.

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; 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 calculated.

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

Figure 3 shows average water quality index scores by parameter for Fifth Plain Creek from Oct 2002-Oct 2004. FWS and SUM represent the 'Fall/Winter/Spring' and 'Summer' monitoring periods, respectively.

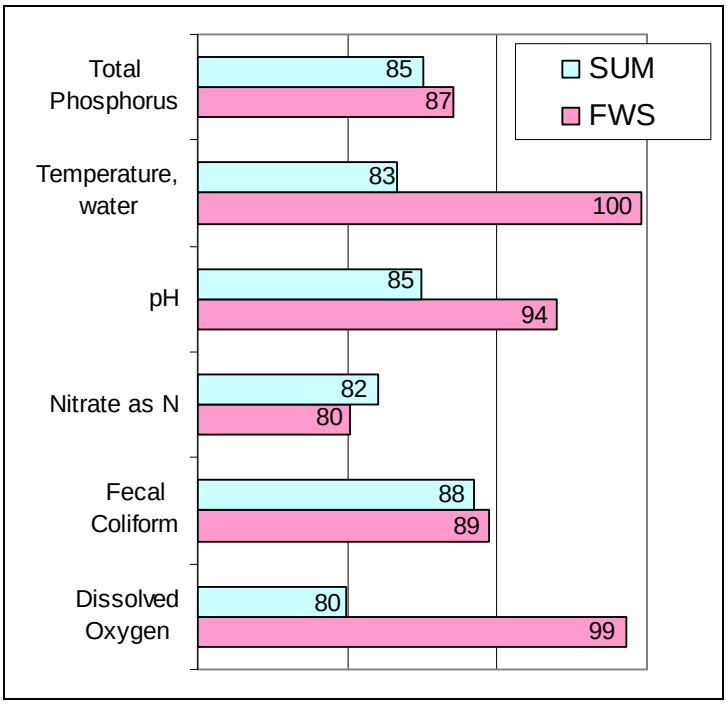

Figure 3: Average Water Quality, Fifth Plain Creek Station FPL050, October 2002 through October 2004, Oregon Water Quality Index (from Volunteer Monitoring Report: Summary for Fifth Plain Creek in the Lacamas Creek Watershed. Clark County, 2005).

Water quality index scores were typically lower during the summer. Nitrate, dissolved oxygen and water temperature were all parameters of concern during the summer. Nitrate levels were also a concern during the winter, with scores approaching the poor category. Fecal coliform was occasionally high in the raw dataset but did not appear to be a chronic problem reflected in the index scores.

The overall score for the site was 84, placing Fifth Plain Creek in the 'Fair Condition' category, a single point away from the good category.

Stream temperature

The 7-DADMax water temperature was 73º F in 2003 and 78º F in 2004. During both years, the water temperature far exceeded the state criterion at the time (64º F) and the current criterion by an even greater margin (60.8º F). Daily maximums exceeded the 64º F criterion for more than 80 days, nearly three months. During both years, water flow was very low in the summer, which contributes to high water temperature and low dissolved oxygen levels.

Impacts to Beneficial Uses and Potential Sources

Based on a limited 2002-2004 dataset, water quality in this assessment area is fair, according to the overall OWQI. Water temperature in 2003 and 2004 greatly exceeded the state criterion. Observed water quality may have negative impacts on the listed beneficial use of core summer salmonid habitat. Table 5 at the conclusion of this section summarizes likely water quality impacts to beneficial uses in Upper Fifth Plain Creek and Shanghai Creek, and probable sources of the observed impact.

Implications for Stormwater Management

Solutions listed in bold (Table 5) 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 contribute to water quality improvement.

Table 5: Known Water Quality Concerns, Sources, and Solutions for Upper Fifth Plain Creek and Shanghai Creek

Characteristic	Beneficial Use Affected	Potential Sources	Mechanism	Solutions (bold indicates direct Clean Water Program involvement)
Water temperature	Core summer salmonid habitat	vegetation removal	direct solar radiation	**Streamside planting/vegetation enhancement/riparian preservation through acquisition** **Education programs** Pond removal or limitation
		low summer flows	decreased resistance to thermal inputs	
		in-line ponds	decreased resistance to thermal inputs	
Dissolved oxygen	Core summer salmonid habitat	Elevated water temperature	Decreased ability to hold oxygen	**See water temperature**
		Low summer flows	Decreased aeration through turbulence	
Nitrate	Aesthetic enjoyment	natural groundwater	groundwater seeps	Erosion control regulations Septic system inspections and maintenance Sanitary sewer leak identification and removal Agricultural Best Management Practices **Education programs (reduced fertilizer use)**
		fertilizers	overland runoff	
		livestock, pets, wildlife	overland runoff direct access	
		failing septic systems	groundwater seeps	
		sanitary sewer leaks	groundwater seeps	

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.

Drainage system inventory is an ongoing CWP work effort focused on updating the StormwaterClk database to include all existing stormwater drainage infrastructure. In 2008-2009, 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 6 indicates the number of features currently inventoried in StormwaterClk. Of the 25 stormwater facilities, 12 are publicly owned and operated.

Table 6: Drainage System Inventory Results, Upper Fifth Plain Creek/Shanghai Creek

Database Feature Category	Inventoried prior to 2007	Added during 2007-2009	Total Features
Inlet	5	11	16
Discharge Point (outfall)	0	186	186
Flow Control	9	12	21
Storage/Treatment	97	52	149
Manhole	2	1	3
Filter System	0	0	0
Channel	159	922	1081
Gravity Main	110	523	633
Facilities	11	14	25

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 detention ponds, treatment wetlands, wet ponds, pre-settling cells, open filters or bioswales and discharge to surface waters or 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 August 2010, there was one mapped public stormwater facility in the Upper Fifth Plain Creek subwatershed and 11 mapped public stormwater facilities in the Shanghai Creek subwatershed.

One mapped public stormwater facility in the Upper Fifth Plain Creek subwatershed was evaluated for retrofit opportunities. No stormwater facilities were evaluated for retrofit opportunities in the Shanghai Creek subwatershed.

No public stormwater facilities were referred for further evaluation as Capital Improvement Projects.

No major defects or hazardous conditions were discovered in the Upper Fifth Plain Creek subwatershed.

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. Evaluations were done on public stormwater facilities containing detention ponds, treatment wetlands, wet ponds, pre-settling cells, open filters or bioswales and discharge to surface waters or 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 typically are not included in this evaluation. They 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, Volume V, of the 2005 Stormwater Management Manual for Western Washington. The standards list the part or component of the facility, condition when repair or

maintenance is needed, and expected results. 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

One inspection and maintenance evaluation was conducted in the Upper Fifth Plain Creek subwatershed. This facility was found to be out of compliance. It had six facility objects, of which five (83 percent) were in compliance. Facility inspection and maintenance evaluations were not conducted in the Shanghai Creek subwatershed.

The inspection process in the Upper Fifth Plain Creek subwatershed generated one referral to Public Works Maintenance and Operations for needed maintenance activities.

No major defects or hazardous conditions were discovered in the Upper Fifth Plain Creek subwatershed.

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 also can 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 August 2010 there were 57 mapped outfalls in the Upper Fifth Plain Creek subwatershed discharging to critical areas: two Priority 1 outfalls; no Priority 2 outfalls; 55 Priority 3 outfalls.

In the Shanghai Creek subwatershed, 68 mapped outfalls discharged to critical areas: four Priority 1 outfalls; no Priority 2 outfalls; 64 Priority 3 outfalls.

Table 7 and summarizes results the Upper Fifth Plain Creek subwatershed. There were 57 mapped outfalls discharging to critical areas. Two Priority 1 outfalls were assessed and found to be in compliance. There were no mapped Priority 2 outfalls. Two Priority 3 outfalls were assessed and both were found to be in compliance. Fifty-three Priority 3 outfalls were not assessed.

Table 7: 2010 Off-site Assessment Project Activity Summary for Upper Fifth Plain Creek subwatershed

Metric	Number of Outfalls		
	Priority 1	Priority 2	Priority 3
Total number of mapped outfalls	2	0	55
# of outfalls assessed	2	n/a	2
# of outfalls compliant	2	n/a	2
# of noncompliant outfalls	n/a	n/a	n/a
# of referrals initiated	n/a	n/a	n/a
# of referrals ongoing	n/a	n/a	n/a
# of outfalls fixed	n/a	n/a	n/a

Table 8 summarizes results the Shanghai Creek subwatershed. There were 68 mapped outfalls discharging to critical areas. Four Priority 1 outfalls were assessed and found to be in compliance. There were no mapped Priority 2 outfalls. Sixty-four Priority 3 outfalls were not assessed.

Table 8: 2010 Off-site Assessment Project Activity Summary for Shanghai Creek subwatershed

Metric	Number of Outfalls		
	Priority 1	Priority 2	Priority 3
Total number of mapped outfalls	4	0	64
# of outfalls assessed	4	n/a	0
# of outfalls compliant	4	n/a	n/a
# of noncompliant outfalls	n/a	n/a	n/a
# of referrals initiated	n/a	n/a	n/a
# of referrals ongoing	n/a	n/a	n/a
# of outfalls fixed	n/a	n/a	n/a

Potential Projects

The offsite assessment project yielded no potential project opportunities.

Management Recommendations

Drainage system inventory is an ongoing CWP work effort focused on updating the StormwaterClk database to include all existing stormwater drainage infrastructure. Prior to 2007, stormwater drainage infrastructure in the Upper Fifth Plain Creek and Shanghai Creek subwatersheds included 393 objects. In 2007-2009, an additional 1,721 previously unmapped objects were added to the StormwaterClk database.

Retrofit and inspection and maintenance evaluations were conducted at one public stormwater facility in the Upper Fifth Plain Creek subwatershed. No referrals were generated for further evaluation as Capital Improvement Projects. Lack of facility signage was the only notable defect. Adding water quality signage will bring this facility into compliance.

Outfall assessments generated no potential project opportunities. Future efforts should be made to assess Priority 2 and Priority 3 outfalls, which make up nearly all of the outfalls discharging to critical areas in the study area. Maintaining the frequency of offsite assessment activities may reduce downstream erosion problems by discovering potential issues before they become more serious erosion problems.

Illicit Discharge Detection and Elimination Screening

Illicit discharge screening was not conducted.

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 source control visit can find, then eliminate or change, business activities that negatively impact stormwater runoff.

Methods

Under the County's 2007 NPDES municipal stormwater permit, each year staff is required to visit 20 percent 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 percent of all county businesses each year.

To determine which specific businesses will be inspected each year, 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 it is 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 2010, no staff visits were needed to meet all the businesses required under the NPDES permit in the Upper Fifth Plain Creek/Shanghai Creek subwatershed. Table 9 summarizes source control activities.

Table 9: Source Control Project Summary, Upper Fifth Plain Creek/Shanghai Creek subwatershed

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

Overview

The Upper Fifth Plain Creek/Shanghai Creek subwatershed lies in south central Clark County. At this time, Upper Fifth Plain Creek is exclusively residential with no Type 4 parcels. Shanghai Creek drains the Summer Hills subdivision and is predominately rural residential.

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 used as a countywide 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 10.

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 Stormwater SQL Geodatabase located on the Clark County server. Feature data include 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 used for quantitative calculations.

Study Area

The extent of the completed Feature Inventory in Upper Fifth Plain Creek and Shanghai Creek subwatersheds is shown in Figure 4. Approximately 1.3 miles of the stream corridor in Upper Fifth Plain Creek and 1.7 miles in Shanghai Creek were assessed. Of the proposed survey extents, only one short reach was not accessible due to private property concerns.

Results/Findings

A total of 81 features were identified in the Upper Fifth Plain Creek and Shanghai Creek subwatersheds. A breakdown of recorded features by type is presented in Table 10. Stream crossings were the most prevalent feature type identified, followed by impacted stream buffers and miscellaneous points of interest. A number of stormwater outfalls, channel modifications and areas of severe bank erosion also were identified.

In addition to stream features, nine geomorphology data points (shown as GG points on Figure 5 through Figure 9) were collected.

Table 10: Summary of Features Recorded in Upper Fifth Plain and Shanghai Creek Subwatersheds

Feature Type	Number Recorded
AGR - Aggradation	0
AP – Access point	1
CM – Channel modification	5
ER – Severe bank erosion	4
IB – Impacted stream buffer	12
IW – Impacted wetland	0
MB – Miscellaneous barrier	1
MI – Miscellaneous point	10
OT – Stormwater outfall	7
RR – Road Reconnaissance feature	0
SCB – Stream crossing, bridge	23
SCC – Stream crossing, culvert	8
SCF – Stream crossing, ford	2
TR – Trash and debris	1

UT – Utility impact	1
WQ – Water quality impact	6
Total	81

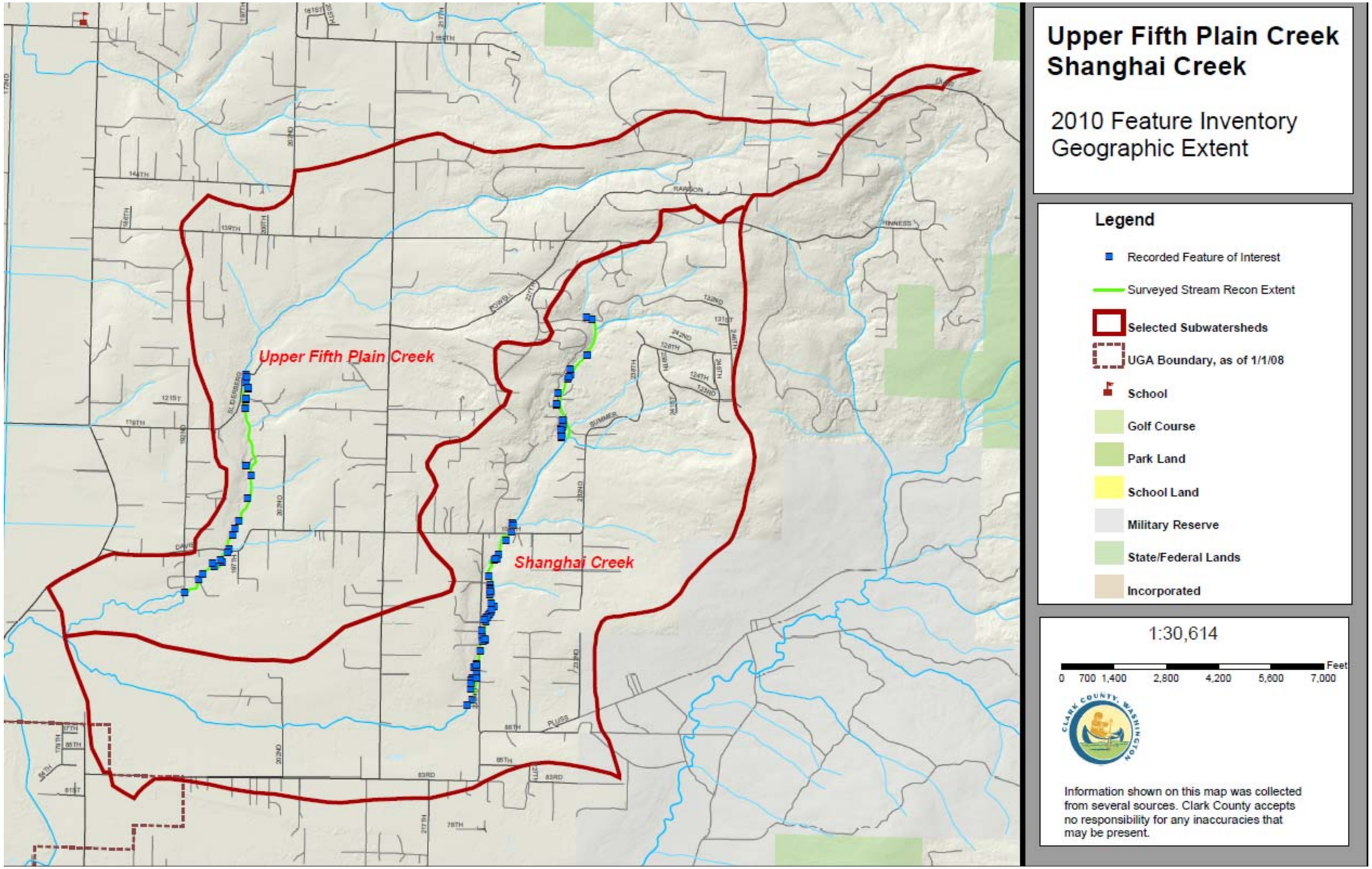

Figure 4: Upper Fifth Plain Creek and Shanghai Creek Geographic Extent of 2010 Feature Inventory

The following subsections contain general descriptions of Upper Fifth Plain and Shanghai Creek subwatershed conditions. The descriptions include observations, trends and issues that were identified either during the field work or subsequent review of collected information.

Stormwater Infrastructure
The stormwater conveyance to Upper Fifth Plain Creek and Shanghai Creek is primarily via roadside ditches. Flow in the subwatershed is predominately northeast to southwest, with numerous small 1st order tributaries entering Shanghai Creek from the east. The predominant source of stormwater in the subwatershed is runoff from agricultural land and rural residential developments draining to streams via small open channels such as field drain ditches, grassy swales, and roadside ditches. There are few facilities that treat consolidated stormwater flow in this subwatershed. The exception is Upper Shanghai Creek, where the large Summer Hills subdivision includes more than 10 stormwater facilities.

Riparian Vegetation
Impacted stream buffers are prevalent in both subwatersheds. A significant portion of surveyed stream reaches has established riparian forest canopy with vegetation communities composed of small to medium sized canopy trees, such as alder and various conifers with woody and herbaceous undergrowth. Undergrowth is typically a mix of native species, invasive reed canary grass and blackberry. In general, blackberry is more common in areas with somewhat dense canopy cover. Reed canary grass is more common in areas with less dense canopy cover and wetter soil conditions. Lack of riparian vegetation due to mowing and landscaping is common in areas where residential development abuts the channel. Agricultural areas in the subwatershed typically have little or no woody riparian vegetation.

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.

Potential project opportunities were identified based on the results of the Feature Inventory conducted in the Upper Fifth Plain and Shanghai Creek subwatersheds. The CWP will evaluate potential projects for further development or referral to the appropriate organization. Each potential project is listed in tables that include the basis for and description of the potential project. The location of each potential project is shown in the figure(s) below. A total of 19 potential projects were identified. A summary of identified project opportunities by category is shown in Table 11.

Table 11: Breakdown of Potential Project Opportunities by Category

Potential Project Category	Potential Projects Identified
Emergency/Immediate Actions	1
Stormwater Capital Projects	3
Referrals for Followup by DES (or County programs supporting DES)	15

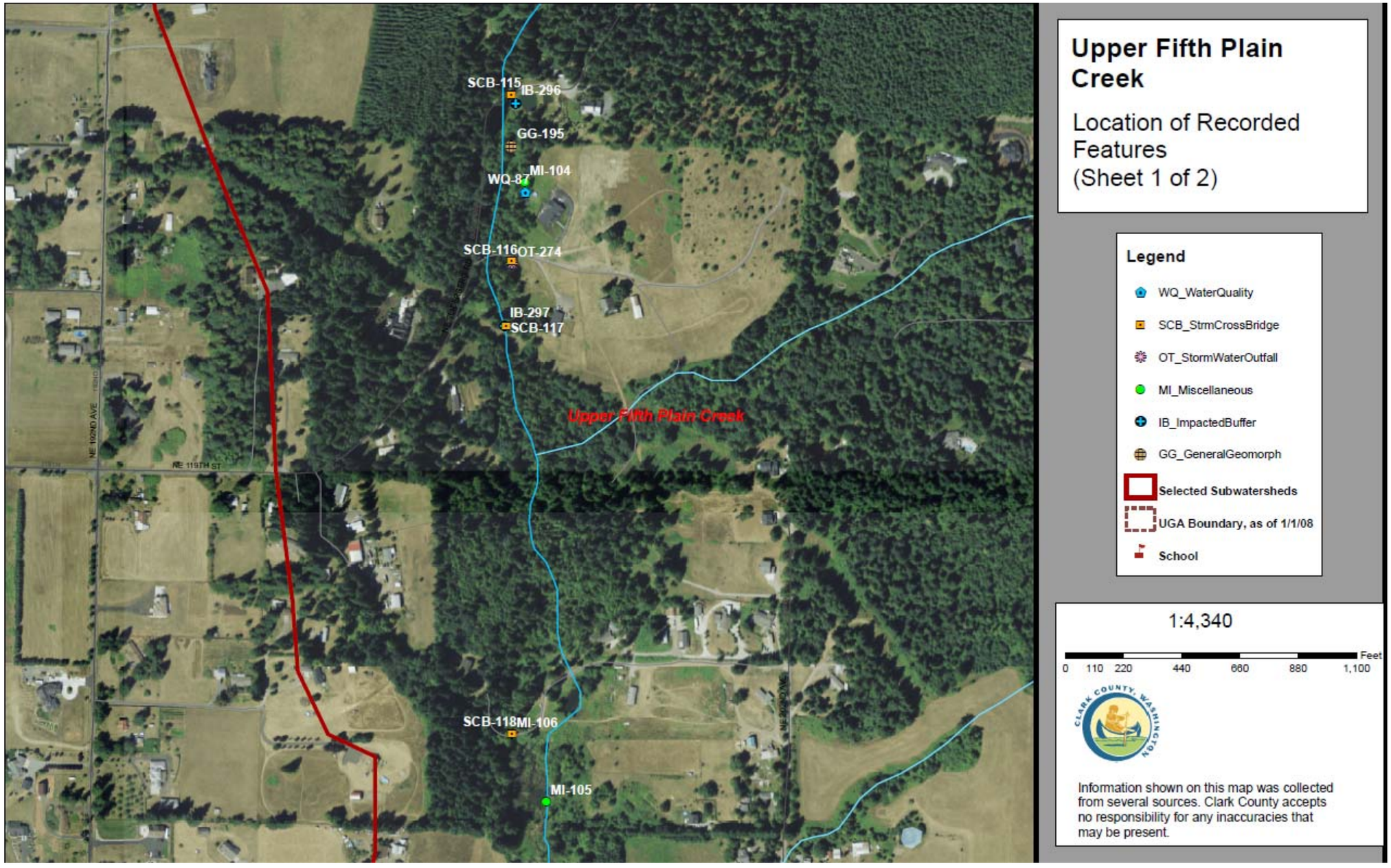

Figure 5: Upper Fifth Plain Creek location of recorded features.

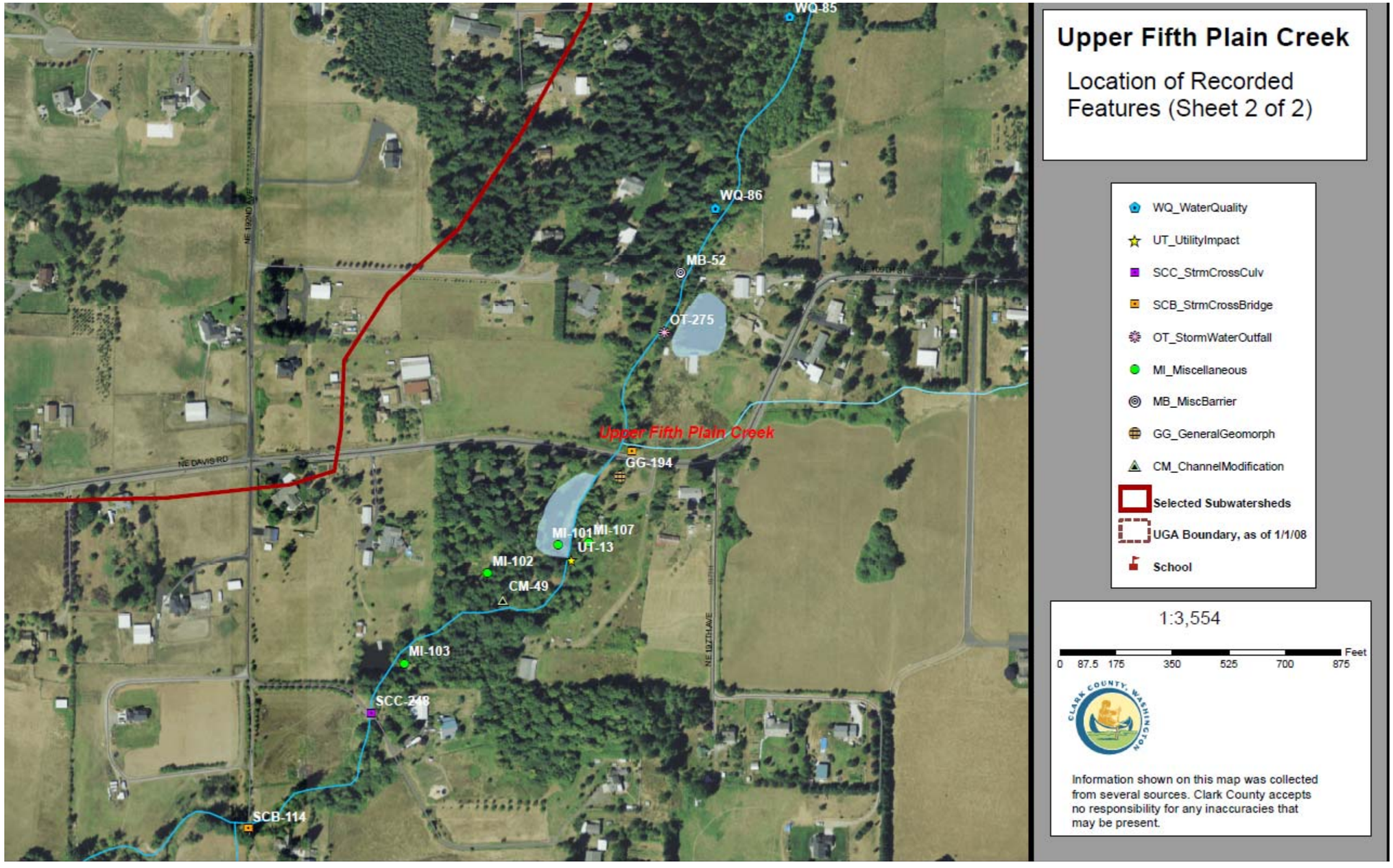

Figure 6: Upper Fifth Plain Creek location of recorded features

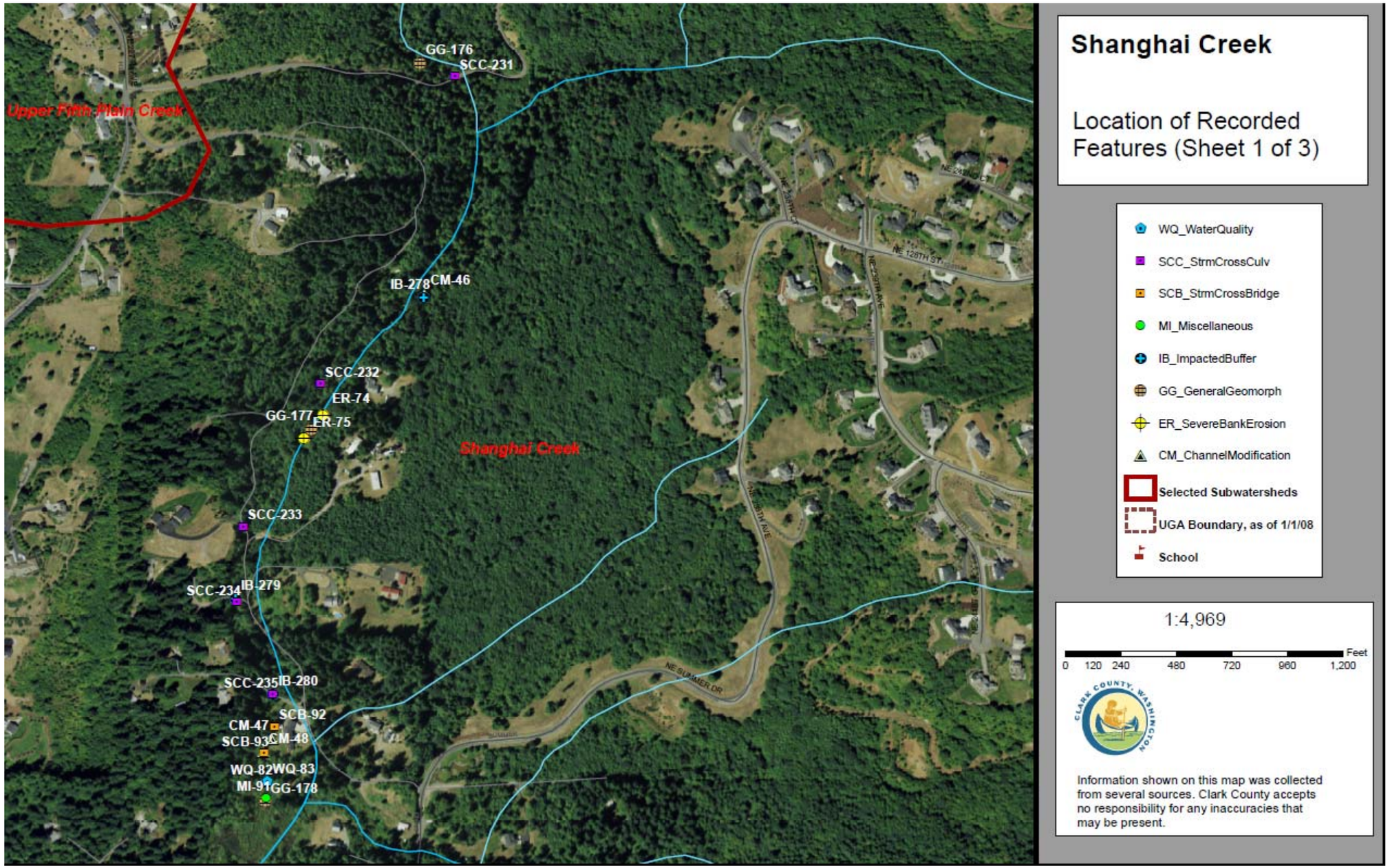

Figure 7: Shanghai Creek location of recorded features

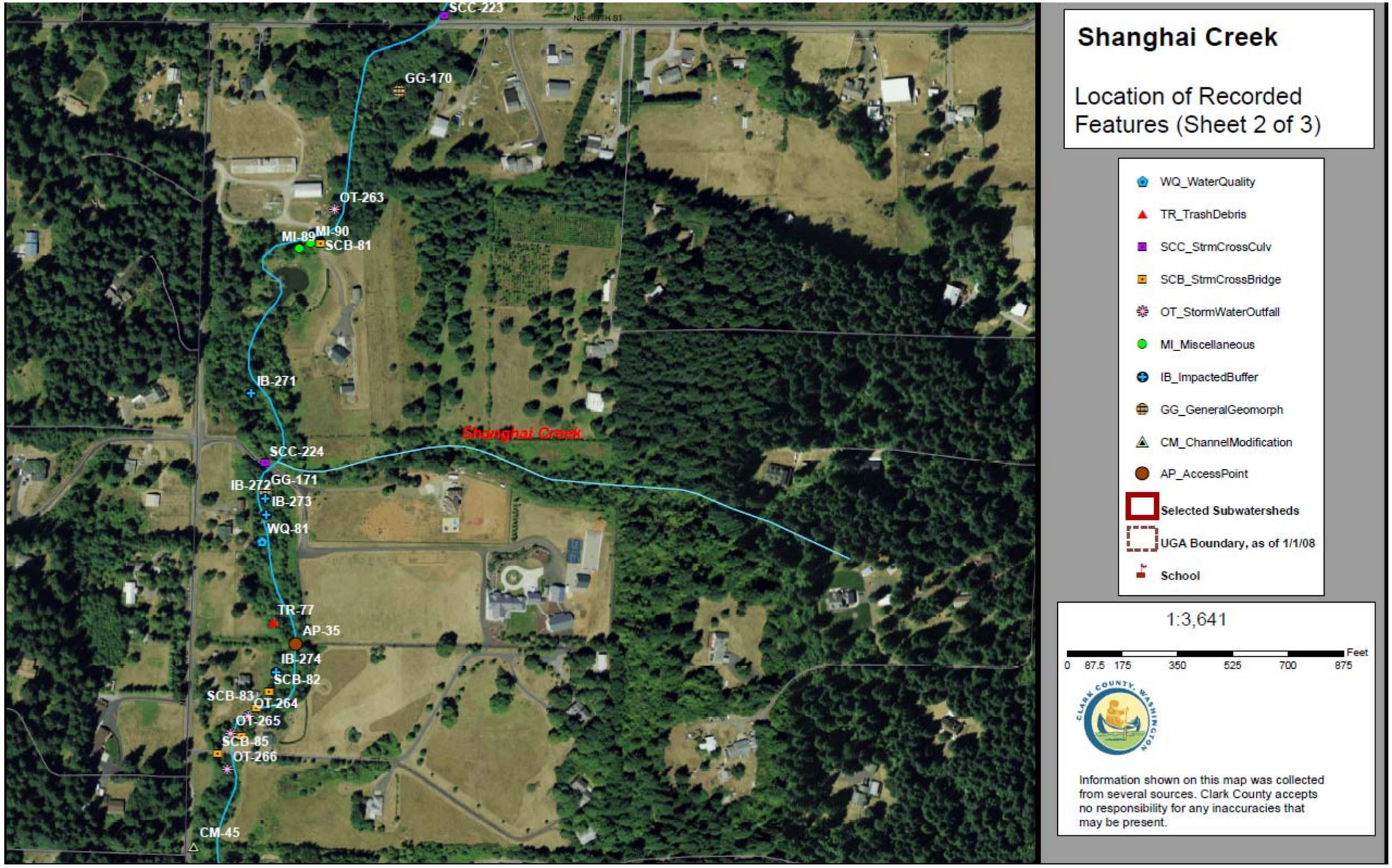

Figure 8: Shanghai Creek location of recorded features

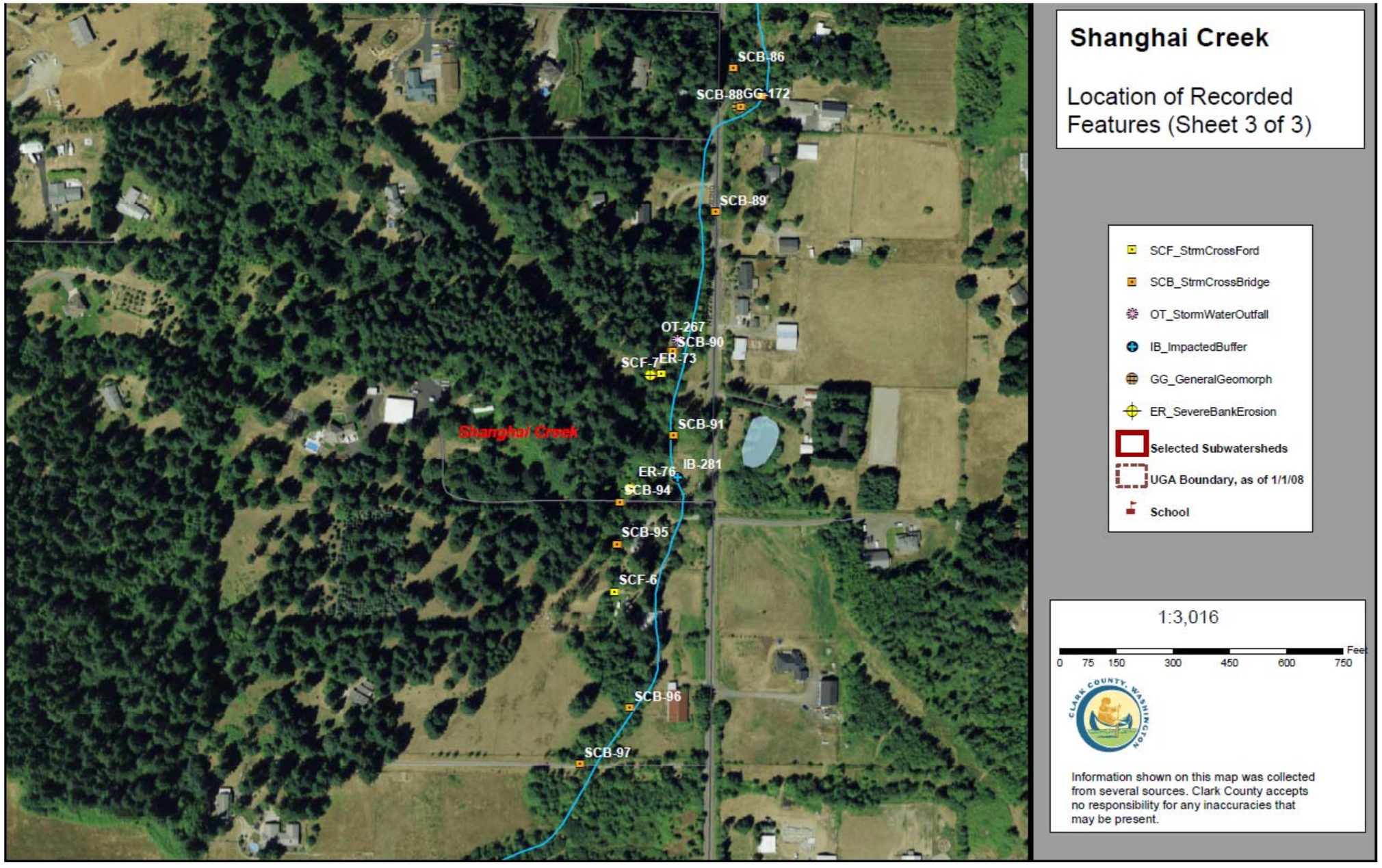

Figure 9: Shanghai Creek location of recorded features

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

Table 12: Description of emergency or immediate actions

ID	Basis for Project	Project Description
ER-73	Slope failure at sharp stream bend; direction of erosion is toward nearby natural gas line. Possibility of further failure reaching line.	Contact NW Natural.

Stormwater Capital Improvement Projects
Stormwater Capital Improvement Projects include projects that create new or retrofit existing stormwater flow control or treatment facilities, substantial infrastructure maintenance projects, habitat enhancement projects, or property acquisition to mitigate for stormwater impacts. Facility retrofits refer to projects that will increase an existing facility's ability to control or treat stormwater in excess of the original facility's design goals.

Table 13: Description of Potential Stormwater Capital Improvement Project Opportunities

ID	Basis for Project	Project Description
CM-49	Concrete barrier wall, 60 feet long x 3 feet tall; old median blocks. Stream channelized away from historical wetland	Remove wall to restore natural channel configuration
MI-107	Two parcels (7 acres total) with abandoned house; pond and degraded wetland; some intact riparian canopy with areas of cleared upland	Potential property acquisition for multi-component project including stormwater mitigation, wetland enhancement, and/or upland planting
MI-91	Substantial area of wetland/degraded wetland in upper watershed. Immediately downstream of Summer Hills subdivision.	Potential property acquisition for protection, stormwater mitigation, and/or wetland enhancement

Referrals for Followup by DES (or County programs under DES oversight)
This category includes opportunities other than capital projects that are dependent upon DES programs or oversight. Examples include referrals to: Public Works Operations for public stormwater infrastructure maintenance or private facility inspection; DES Sustainability and Outreach for landowner letters regarding trash pickup or agricultural BMPS: Illicit Discharge screening project; general reach information forwarded to DES engineers for capital planning purposes. Possible fish barriers or culvert maintenance issues also may be included.

Table 14: Description of Referrals for followup by DES

ID	Basis for Project	Project Description	Action
UT-13	Exposed conduit crossing channel bed, possibly	May need repair or replace if public utility	Refer to Clark Public Utilities

ID	Basis for Project	Project Description	Action
	power; conduit is undercut and bending downstream		
CM-48	Stream armored and channelized with landscaping rock; offline pond and channel; lawn to stream bank		Refer to DES Outreach; contact landowner
SCF-6	Tractor road through creek	Bridge, culvert, or gravel crossing	Refer to DES Outreach; contact landowner
SCF-7	ATV road through creek	Bridge, culvert, or gravel crossing	Refer to DES Outreach; contact landowner
OT-275	Two outfalls from private, offline, half-acre pond; potential water quality impact temperature and bacteria	Increase shading; minimize dry season overflow; discourage waterfowl.	Refer to DES Outreach; contact landowner
WQ-87	Swimming pool drain routed to stream	Re-locate drain to upland	Refer to DES Outreach; contact landowner
OT-266; MI-88	Corrugated pipe outlet likely draining adjacent wetland for historical pasture	Remove/plug drain tile to re-establish wetland	Refer to DES Outreach; contact landowner
OT-263	Downspouts from large equipment shed piped to stream	Disconnect downspouts	Refer to DES Outreach; contact landowner
IB-273; IB-274; IB-281	Lawn or pasture to creek for significant length	Riparian restoration	Refer to DES Outreach; contact landowner
WQ-81	Duck pen on steep, bare dirt slope ending at stream	Install filter strip between pen and stream; erosion/runoff management	Refer to DES Outreach; contact landowner
WQ-85; WQ-86	Livestock access to stream	Install fencing	Refer to DES Outreach; contact landowner

Stormwater Management Recommendations

A number of general stormwater management measures should be implemented throughout the study area:

- Educate private landowners concerning importance of invasive plant removal and suggest removal techniques
- Educate private landowners on importance of native riparian vegetation for shading streams
- Provide landowners a list of suggested plants for stream revegetation and local nurseries that stock them

- In the case of some water impoundments or withdrawals, the State should verify that the owner has water rights
- Protect streams from future stormwater impacts by creating stream buffers, establishing conservation easements, and eliminating agricultural runoff inputs
- Encourage reforestation
- Implement development regulations to minimize impacts, particularly enhanced nutrient control regulations to protect Lacamas Lake.

Physical Habitat Assessment

A physical habitat assessment was not conducted.

Geomorphology Assessment

A geomorphology assessment was not conducted.

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, Washington State University (WSU) Watershed Stewards Program and Clark Conservation District for possible implementation.

This section focuses on opportunities located on publicly owned lands in high priority salmon-bearing stream reaches, as defined by LCFRB salmon recovery priorities.

Method

Where possible, the assessment is based on GIS data from reports prepared for the Lower Columbia Fish Recovery Board. These include the Habitat Assessment reports (R2 Resource Consultants, Inc., 2004) and the 2010 Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan. Both can be found at the LCFRB website at: http://www.lcfrb.gen.wa.us/default1.htm. 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 streams 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 are discussed in their respective sections and most are included on a final list for referral to outside agencies.

Aerial photographs also were reviewed for specific project opportunities in each subwatershed. Potential project sites have been reviewed and verified through field reconnaissance and are detailed in the results.

Results

The 2004 LCFRB Habitat Assessment did not include the Upper Fifth Plain Creek or Shanghai Creek subwatersheds. Therefore, LWD recruitment potential and shade rating analyses were based on a qualitative review of 2010 aerial photographs available through Google Earth.
At the subwatershed scale, LCFRB rated the riparian conditions in the Upper Fifth Plain Creek subwatershed as "Moderately Impaired" and in the Shanghai Creek subwatershed as "Impaired."

Riparian (Large Woody Debris (LWD) Delivery)

Upper Fifth Plain Creek and Shanghai Creek converge near NE Ward Road, at appx (45.69287, -122.48883). Upstream from the point, for about 1.5 mi to appx (45.70555, -122.46992), the forested riparian zone is relatively narrow or sparse. This section of Fifth Plain Creek would be expected to have low to moderate LWD recruitment potential. Upstream from (45.70555, -122.46992), the forested riparian zone is wider and more intact and would be expected to have moderate or high LWD recruitment potential for the remaining length (appx 3 mi).

The lower reaches of Shanghai Creek in the Shanghai Creek subwatershed flow through an open field with no LWD recruitment potential (appx 0.6 mi between (45.69287, -122.48883) and (45.68929, -122.48061). Upstream from that reach, the riparian zone is partially forested and may have low to moderate LWD recruitment potential (appx 3.5 mi between (45.68929, -122.48061) and (45.71184, -122.43752). The headwaters of Shanghai Creek are more heavily forested and may have moderate to high LWD recruitment potential (appx 1 mi between (45.71184, -122.43752) and (45.721671, -122.43216).

Shade

Upper Fifth Plain Creek and Shanghai Creek converge near NE Ward Road, at appx (45.69287, -122.48883). Upstream from the point, for about 1.5 mi to appx (45.70555, -122.46992), the forested riparian zone is relatively narrow or sparse. This section of Fifth Plain Creek would be expected to have low to moderate levels of shade. Upstream from (45.70555, -122.46992), the forested riparian zone is wider and more intact and would be expected to have moderate or high levels of shade for the remaining length (appx 3 mi).

The lower reaches of Shanghai Creek within the Shanghai Creek subwatershed flow through open fields with no shade (appx 0.6 mi between (45.69287, -122.48883) and (45.68929, -122.48061). Upstream from that reach, the riparian zone is partially forested and may have low to moderate levels of shade (appx 3.5 mi between (45.68929, -122.48061) and (45.71184, -122.43752). The headwaters of Shanghai Creek are more heavily forested and may have moderate to high shade levels (appx 1 mi between (45.71184, -122.43752) and (45.721671, -122.43216). Ponds at the headwaters (appx (45.721709, -122.43216) and (45.725521, -122.42533)) may receive sun exposure despite trees on their edges.

Management Recommendations

Overall recommended management activities for the Upper Fifth Plain Creek and Shanghai Creek subwatersheds include riparian forest restoration in areas degraded by residential land use and road improvement/realignment projects, acquisition of existing forest land for future protection of streams and watersheds, and invasive species removal.

Potential Projects

Several reaches of Upper Fifth Plain Creek and Shanghai Creek would benefit from reforestation projects, especially the lower reaches (see descriptions under ***Riparian (Large Woody Debris (LWD) Delivery)*** and ***Shade***. However, the parcels bordering Upper Fifth Plain Creek and Shanghai Creek are all privately owned.

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, Watershed Characterization and Analysis of Clark County (Ecology Publication # 09-06-019, 2009) 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 10 shows potential wetland areas within the Upper Fifth Plain Creek and Shanghai Creek subwatersheds based on data from the county wetlands atlas, including the Clark County wetland model, National Wetlands Inventory and high-quality wetlands layer.

The Upper Fifth Plain Creek and Shanghai Creek subwatersheds have predominately slope wetlands on the terraces in the vicinity of their confluence. Hydrology in these wetlands is generally dominated by seasonal groundwater discharge and surface run-off. Many of these wetlands have been highly modified for agricultural use.

Table 15: Distribution of Wetlands by Hydrogeomorphic Class

HGM Class	Area (ac.)	% of Sub-basin*	% of total wetland
Slope Wetlands	765	13.2%	96.1%
Depressional Wetlands	17	0.3%	2.2%
Riverine Wetlands	14	0.2%	1.7%
All Wetlands	796	13.7%	

*Subwatershed area 5,791 ac.

The wetlands in these subwatersheds are generally located in landscape positions where there could be significant opportunities to improve water quality or hydrologic functions. However, a review of the wetland inventories and studies identifies no publicly held or tax-exempt land in the subwatershed.

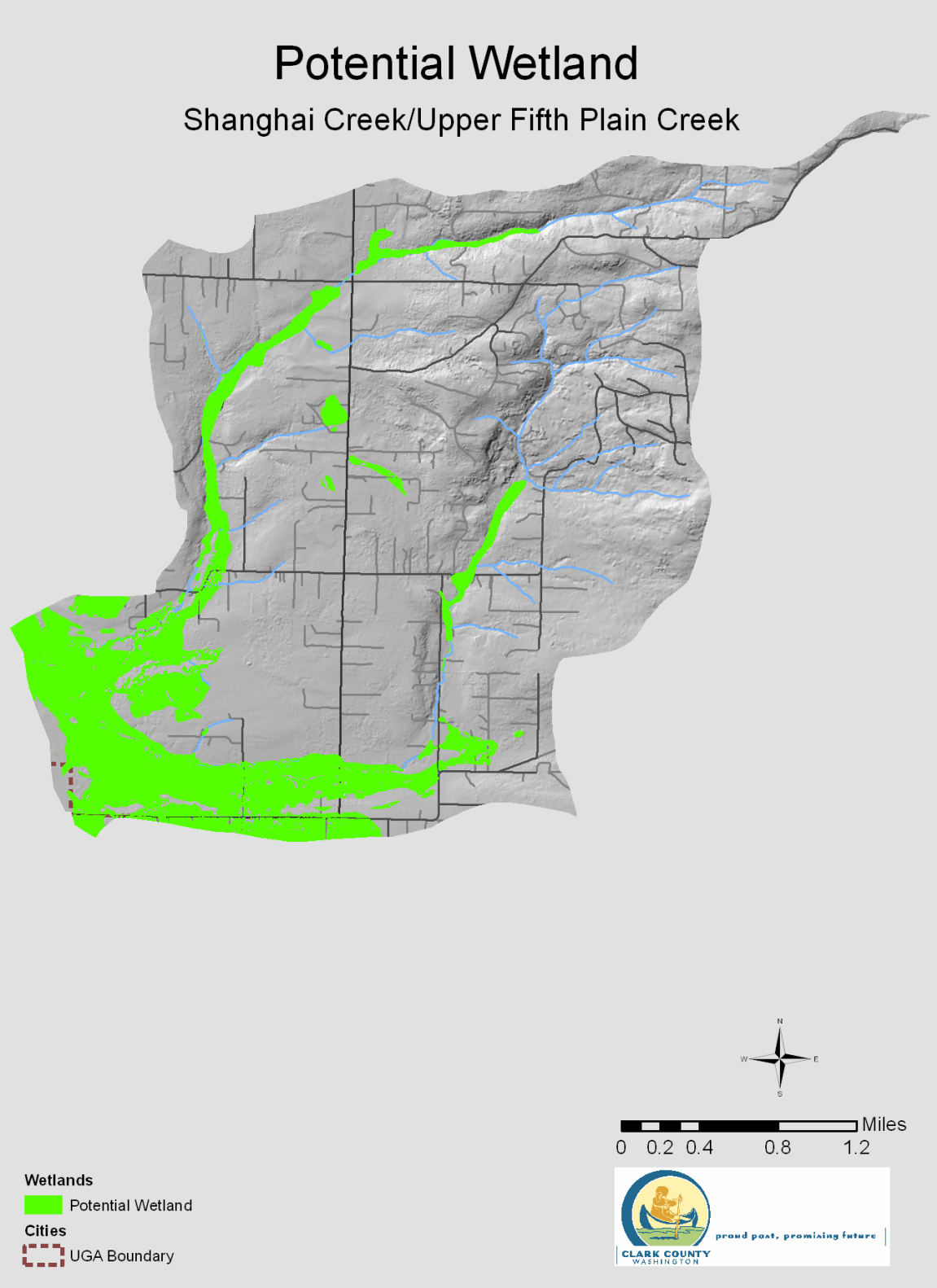

Figure 10: Shanghai Creek and Upper Fifth Plain Creek Potential Wetlands

Watershed Characterization

The Washington Department of Ecology completed the Watershed Characterization and Analysis of Clark County (2009) to assist in planning wetland and riparian habitat restoration and preservation projects.

Results pertaining to the Upper Fifth Plain Creek and Shanghai Creek subwatersheds are summarized below.

The Upper Fifth Plain Creek and Shanghai Creek subwatersheds are part of the Rain Dominated Terrace hydrogeologic unit. This unit is dominated by rain and has a westward to southwestern trending groundwater flow pattern. It has 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 11 depicts priority areas for protection and restoration of hydrologic and denitrification processes countywide based on an analysis of the relative importance and level of alteration in each subwatershed.

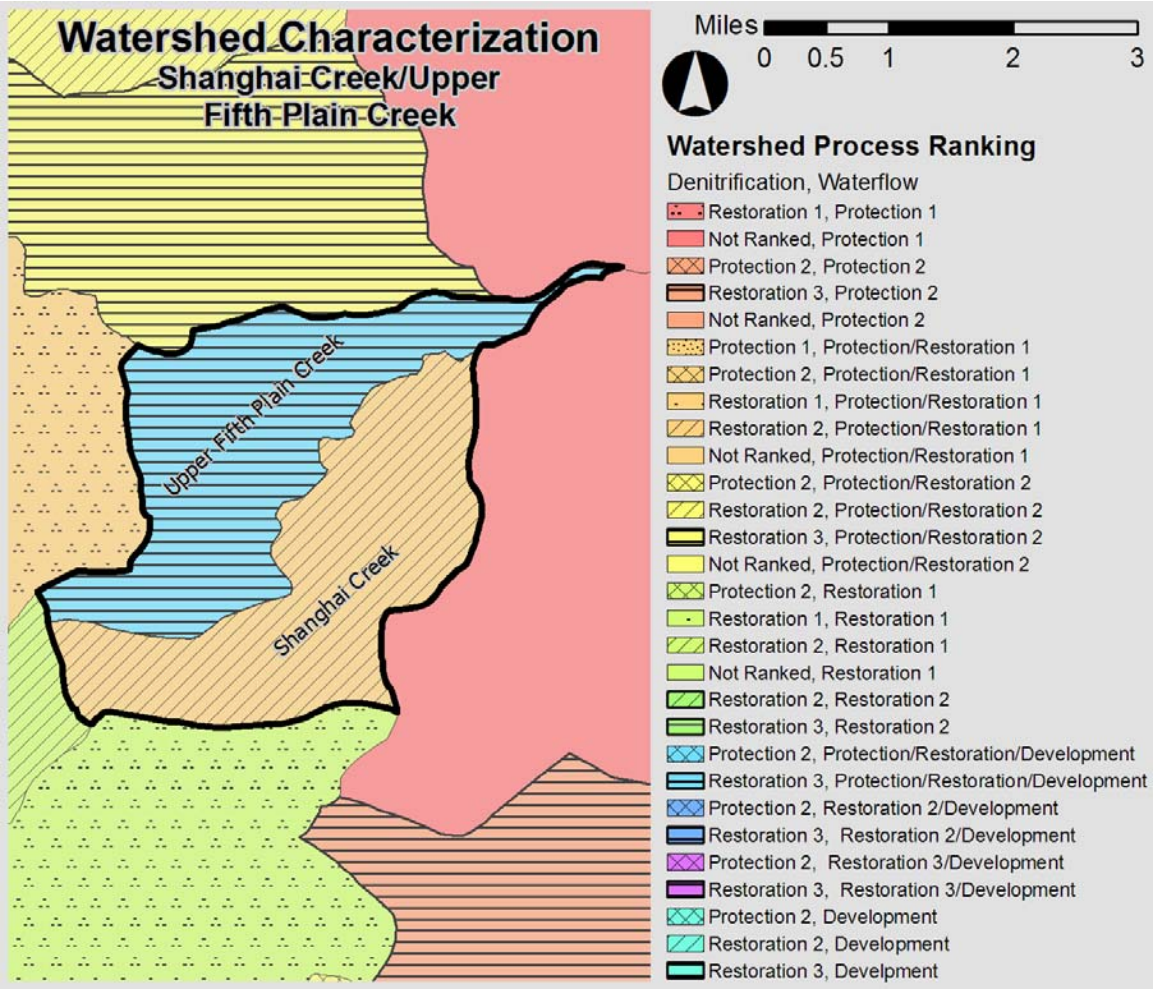

Figure 11: Priorities for suitability of areas for protection and restoration for the hydrogeologic process (from Watershed Characterization and Analysis of Clark County (Ecology, 2009))

In general, red 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. Green to blue areas have lower levels of importance for watershed processes and higher levels of alteration, and should be considered as more suitable for development. Because green, purple, and blue areas represent a transition from restoration areas, planning measures employing both restoration and appropriately sited development should be considered (Ecology, 2009). Hatch patterns represent the importance of denitrification processes.

Protection and restoration of hydrologic (waterflow) processes with appropriately sited development are recommended for the Upper Fifth Plain Creek subwatershed (blue). This subwatershed also is ranked for restoration of denitrification processes (horizontal line pattern). The Shanghai Creek subwatershed is recommended for protection and restoration of hydrologic processes (light orange) and restoration of denitrification (diagonal line pattern) processes.

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 10 metrics describing characteristics of stream biology, including: tolerance and intolerance to pollution; taxonomic richness; feeding ecology;reproductive strategy; population structure. Each metric was selected because it has a predictable response to stream degradation. For example, stonefly species often are the most sensitive and 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 were 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 10 individual metrics are added to produce an overall B-IBI score ranging from 10 to 50. Scores 10 to 24 indicate low biological integrity, 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 also are influenced by naturally occurring factors in a watershed. For example, the absence of gravel substrate can lower scores.

Data are available for the following locations in this study area:

- FPL050 (Fifth Plain Creek upstream of Davis Road)
- SGH050 (Shanghai Creek downstream of 91st Circle)

In the Upper Fifth Plain Creek subwatershed, samples were collected annually by CWP volunteer monitors from 2002-2004 at Station FPL050. This station also was sampled in 2009 by CWP staff. Station SGH050 was sampled by CWP staff in 2009.

Results

The average of four samples at FPL050 places this station in the category of low biological integrity. Individual annual scores ranged from 18 to 28. At SGH050, the single sample collected in 2009 falls at the low end of the moderate category.

Table 16 shows similar results for the two stations. There are four low, five moderate and one high score among the average results for individual metrics at Station FPL050, compared with four low, four moderate and two high at Station SHG050. Low scoring metrics for Number of Intolerant taxa and Percent Predator taxa at both stations suggest human disturbance. Intolerant taxa are typically the first to disappear as human disturbance increases, while predator taxa are a measure of food web complexity which decreases as human disturbance increases. Poor scores for Number of Mayfly taxa may indicate temperature issues (Fore, 1999).

Table 16: Station FPL050 and Station SHG050 Average Annual Macroinvertebrate Community Metrics and Total Scores from 2002 through 2009

B-IBI Metrics	FPL050 4-Year Averages			SHG050 2009		
	Value	Score	Category	Value	Score	Category
Total number of taxa	31.5	3	moderate	39.0	3	moderate
Number of Mayfly taxa	4.8	1	low	4.0	1	low
Number of Stonefly taxa	4.8	3	moderate	11.0	5	high
Number of Caddisfly taxa	4.3	1	low	8.0	3	moderate
Number of long-lived taxa	5.0	5	high	4.0	3	moderate
Number of intolerant taxa	0.8	1	low	2.0	1	low
Percent tolerant taxa	45.4	3	moderate	59.9	1	low
Percent predator taxa	6.1	1	low	4.6	1	low
Number of clinger taxa	15.5	3	moderate	29.0	5	high
Percent dominance (3 taxa)	63.5	3	moderate	62.6	3	moderate
Average annual B-IBI Score		23.5	low		26	moderate

Booth et al. (2004) found 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 B-IBI scores in the study area 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 12 indicates that scores for both stations are toward the lower end of the range of expected scores for subwatersheds with relatively low amounts of impervious area (estimated 2000 Total Impervious Area from Wierenga, 2005). This suggests factors other than impervious area are contributing to poor biological integrity and implies an opportunity to increase the level of biological health by improving habitat and stream conditions. Management strategies that limit further degradation and promote stewardship are important to realizing that opportunity.

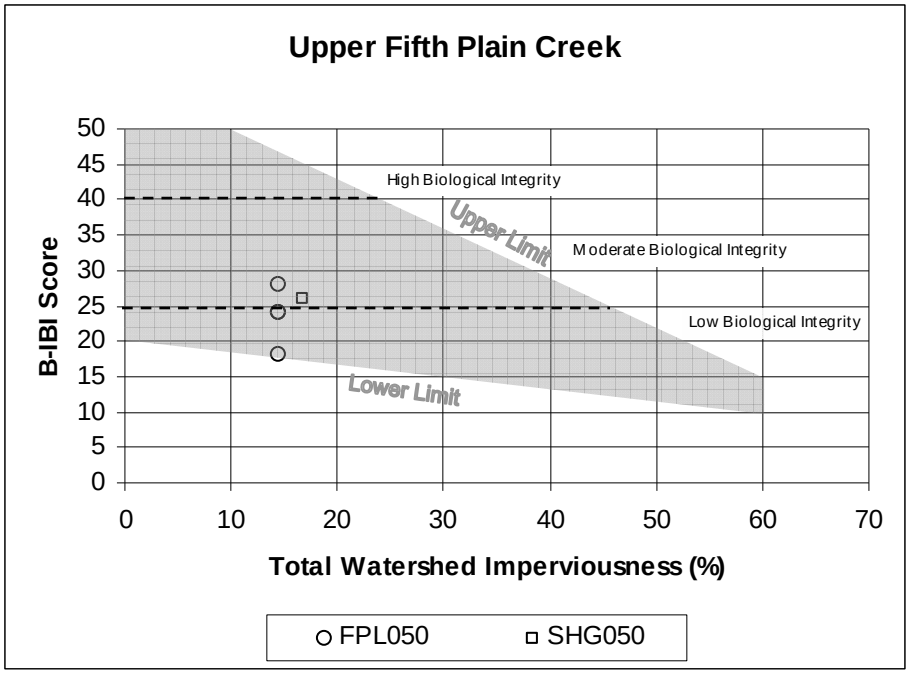

Figure 12: Approximate range of B-IBI in Puget Lowland watersheds, showing progressive decline with increasing imperviousness in the upstream watershed. Adapted from Booth et. al, 2004. Markers indicate B-IBI scores at Station FPL050 and Station SHG050 for particular years, versus estimated 2000 subwatersheds TIA.

Fish Use and Distribution

Purpose

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

Methods

Fish distribution for the Upper Fifth Plain Creek and Shanghai Creek subwatersheds is mapped from existing Clark County GIS information, which reflects data collected and analyzed by the Northwest Indian Fisheries Commission (NWIFC). Fish distribution data for Clark County are available on the County's website.

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

- WDFW passage barrier database
- SalmonScape (http://wdfw.wa.gov/mapping/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 also were reviewed for specific project opportunities in each subwatershed. Potential project sites have been reviewed and verified through field reconnaissance and detailed in the results section below.

Results/Summary

Distribution

The available evidence suggests there is no anadromous fish use within the Upper Fifth Plain Creek or Shanghai Creek subwatersheds.

Barriers

The WDFW barrier database provides the most complete assessment of barriers within the Upper Fifth Plain Creek and Shanghai Creek subwatersheds. There are no mapped barriers in these subwatersheds.

Recommendations

Because there is no known, presumed or potential anadromous fish usage and no mapped fish passage barriers in the Upper Fifth Plain Creek or Shanghai Creek subwatersheds, there are no project recommendations for fish passage at this time.

Hydrologic and Hydraulic Models

Hydrologic and Hydraulic modeling were not conducted.

Analysis of Potential Projects

The analysis of potential projects:

- Briefly summarizes stormwater conditions, problems and opportunities.
- Notes recently completed or current projects in 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 use 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 CWP actively coordinates with the Washington Department of Ecology, Lower Columbia Fish Recovery Board, Clark County Legacy Lands and Vancouver-Clark Parks and Recreation in efforts to improve stream health. In the study area, Ecology is collecting field data for a multi-parameter TMDL during 2010-2011. Clark County participates in the TMDL process.

There are no planned road improvement projects included in the 2010-2015 Clark County Transportation Improvement Program and no planned projects in the 2011-2012 stormwater capital program.

Broad-Scale Characterization

The study area is mainly rural residential at lower elevations and forested on steeper hills and higher elevations in the eastern part. The area rises from the relatively level Willamette Valley floor to the lowermost foothills of the Cascade Mountains, often called the Troutdale Bench in reference to the underlying Troutdale Formation gravel deposits. Several small streams and their tributaries drain the area. Soils are generally clayey and poorly drained. Hilltop areas tend to be hydrologic soil group C, and B soils formed on weathered gravel deposits.

Standard subwatershed scale metrics, such as percent forest and road density when compared with NOAA fisheries standards, suggest stream habitat is not properly functioning. Metrics stream crossing density and expected EIA are within the functioning category. Based on

subwatershed scale conditions, the study area is a good candidate for improving forest functions that could have a measurable impact on channel stability.

Water Quality Assessment
Multiple stream segments in this assessment area are included on the 2008 303(d) Ecology list of impaired water bodies. Both subwatersheds are included in ongoing TMDL development for fecal coliform, temperature, dissolved oxygen and pH in Lacamas Creek above Lacamas Lake.

Based on a limited available dataset, water quality in this assessment area is poor to fair. Water temperature in 2003-2004 greatly exceeded the state criterion. Observed water quality may have negative impacts on the listed beneficial use of core summer salmonid habitat.

Drainage System Inventory
Significant updates to the drainage mapping database were completed in 2008-2009. More than 1,700 stormwater infrastructure features were added during this time, bringing the total of mapped features in the study area to 2,114, including 25 stormwater facilities, 12 of which are publicly owned and operated. Capital project retrofit opportunities and maintenance evaluations generated one referral to Maintenance and Operations for needed maintenance activities. Outfall assessments generated no potential project opportunities.

Illicit Discharge Screening
Illicit discharge detection and elimination screening was not conducted.

Source Control
Source control visits were not conducted.

Stream Reconnaissance Feature Inventory
A feature inventory was conducted for nearly 3 miles of stream corridor in the assessment area. More than 500 features were recorded, primarily stormwater outfalls, culverts, impacted stream buffers and trash dumps. More than 80 potential opportunities were identified in 13 categories.

Physical Habitat
A physical habitat assessment was not conducted.

Geomorphology and Hydrology
A geomorphology assessment was not conducted.

Riparian Assessment
Riparian conditions in the Upper Fifth Plain Creek subwatershed as “Moderately Impaired” and in the Shanghai Creek subwatershed as “Impaired.” Large woody debris recruitment potential is moderate to high in the upper reaches of both Upper Fifth Plain and Shanghai Creek and low in the lower reaches of both creeks. Shade levels are most likely below state targets.

Wetland Assessment
The Upper Fifth Plain Creek and Shanghai Creek subwatersheds have predominately slope wetlands on the terraces in the vicinity of the creeks’ confluence.

Ecology's watershed characterization of Clark County places Upper Fifth Plain Creek subwatershed in a category suitable for protection and restoration of hydrologic processes with appropriately sited development. The Shanghai Creek subwatershed is recommended for protection and restoration of hydrologic processes and restoration of denitrification processes.

Macroinvertebrate Assessment
Based on samples collected from 2002-2004 and an additional sample in 2009, biological integrity is low in Upper Fifth Plain Creek. A sample collected in 2009 suggests that biological integrity is moderate in Shanghai Creek.

B-IBI scores indicate that both stations are toward the lower end of the range of expected scores for subwatersheds with relatively low amounts of impervious area, suggesting that factors other than impervious area are contributing to poor biological integrity.

Fish Use and Distribution
The available information suggests no anadramous fish use in this study area. The Lacamas watershed is blocked to anadramous fish by a natural waterfall below Lacamas Lake. Remnant populations of native cutthroat trout are believed to be in both subwatersheds.

There are no mapped barriers identified in either subwatershed.

Recently Completed or Current Projects

There are no stormwater projects planned for any of these four subwatersheds in the Stormwater Capital Program or the 2010-2015 TIP.

Analysis Approach

Purpose
The Analysis of Potential Projects narrows the initial list of possible opportunities to a subset of higher priority items. Listed opportunities in sections of the SNAP report include sites requiring immediate follow-up, possible stormwater capital improvement projects, internal followup by DES staff and, in some cases, information to be forwarded 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 capital planning process. Sites flagged for internal action by 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. Information forwarded 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 scope of DES work.

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, capital project opportunities are initially evaluated by considering problem severity, 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 opportunities are recommended for further consideration below.

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.

No projects of this type were identified.

Potential Stormwater Capital Projects

Stormwater Capital Improvement Projects include projects that create new or retrofit existing stormwater flow control or treatment facilities, substantial infrastructure maintenance projects, habitat enhancement projects, or property acquisition to mitigate for stormwater impacts. Facility retrofits refer to projects that will increase an existing facility's ability to control or treat stormwater in excess of the original facility's design goals.

Stormwater Facility Capital Improvement Projects
No projects of this type were identified.

Stormwater Infrastructure Maintenance CIPs
No projects of this type were identified

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

Habitat Rehabilitation/Enhancement Projects
No projects of this type were identified.

Property Acquisition for Stormwater Mitigation

Identifier	Basis for Project	Project Description	Action
Upper Fifth Plain Creek			

MI-105	Parcel with favorable topography and hydrology for wetland and riparian enhancement	Investigate the feasibility of obtaining properties (Tax lot 207886000) and developing/preservation of wetland complexes for habitat enhancement and water quality improvement	Refer to CWP Capital Planning
MI-107	Two parcels (7 acres total) with abandoned house; pond and degraded wetland; some intact riparian canopy with areas of cleared upland	Investigate the feasibility of obtaining properties (Tax lot 207800000 and 207796000) and developing wetland complexes for habitat enhancement and water quality improvement; evaluate pond and existing wetland areas	
Shanghai Creek			
OS-242	Parcel with favorable topography and hydrology for wetland and riparian enhancement	Investigate the feasibility of obtaining properties (Tax lot 168633-000) and developing wetland complexes for habitat enhancement and water quality improvement	Refer to CWP Capital Planning
MI-91	Substantial area of wetland/degraded wetland in upper watershed. Immediately downstream of Summer Hills subdivision	Investigate the feasibility of obtaining properties (Tax lot 208070000) and developing wetland complexes for habitat enhancement and water quality improvement	

Follow-up Activities for Referral within DES

This category includes opportunities other than capital projects that are dependent on DES programs or oversight. Examples include referrals to: Public Works Operations for public stormwater infrastructure maintenance or private facility inspection; DES Sustainability and Outreach for landowner letters regarding trash pickup or agricultural BMPS; the Illicit Discharge screening project; general reach information forwarded to DES engineers for capital planning purposes. Other opportunities such as possible fish barriers or culvert maintenance issues also may be included.

Private Stormwater Facilities Maintenance
No projects of this type were identified.

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

CWP Outreach/Technical Assistance

Identifier	Issue	Action
Upper Fifth Plain Creek		
WQ-87	Pool overflow/drainage to creek	Refer DES Source Control for technical visit
OT-274	Private stormwater facility does not meet county maintenance standards	
WQ-85 WQ-86	Livestock access to stream	Refer to DES Outreach; contact landowner
Shanghai Creek		
WQ-81	Duck pen on steep, bare dirt slope ending at stream	Refer to DES Outreach and Education
SCF-6	Road access across stream	
TR-77	Trash/debris in creek	

Identifier	Issue	Project	Action
Upper Fifth Plain Creek			
IB-296 IB-297	Widespread invasive plant species in riparian area. Predominantly reed canary grass and blackberry	Invasive plant removal and vegetation rehabilitation	Refer to DES Outreach and Education
CM-49	Concrete barrier wall, 60 feet long x 3 feet tall; old median blocks. Stream channelized away from historical wetland	Investigate the potential for removing the structure; reconnect flood plain and improve natural channel function	
Shanghai Creek			
IB-278 IB-280 IB-273 IB-274 IB-281	Native stream bank vegetation removed and landscaped or in pasture	Reestablish native undergrowth and canopy vegetation on floodplain and banks to shade out invasive plants, promote bank stability, and enhance riparian habitat.	Refer to DES Outreach and Education
ER-73 ER-74 ER-75	Erosion is most likely caused high flows and lack of native riparian cover	Reinforce bank to resist erosion and enhance habitat using LWD structures. Notify landowner of potential failure.	

IB-279 IB-275	Widespread invasive plant species in riparian area; predominantly ivy	Invasive plant removal and riparian vegetation rehabilitation	
CM-47 CM-48	Stream armored and channelized with landscaping rock; offline pond and channel; lawn to stream bank	Investigate the potential for removing or disconnecting pond; reconnect flood plain and improve natural channel function	
IB-270 IB-271 IB-272	Widespread invasive plant species in riparian area. Predominantly reed canary grass and blackberry	Invasive plant removal and vegetation rehabilitation	
CM-45	Channel straightened along roadway and armored with boulders	Investigate the potential for reconnecting flood plain and improvement of natural channel function	

CWP Infrastructure Inventory

No projects of this type were identified

CWP Capital Planning

No projects of this type were identified

CWP Illicit Discharge Screening

Identifier	Issue	Action
Shanghai Creek		
WQ-82	Unmapped pipe discharging to stream	Refer to DES IDDE Program

Other

Identifier	Issue	Project	Action
Upper Fifth Plain Creek			
MI-106	Water withdrawal from stream	Potential removal withdrawal point	DES Assessment and Monitoring to inform DOE
UT-13	Exposed conduit across stream channel	Site visit and evaluate	DES Assessment and Monitoring to inform CPU
Shanghai Creek			

SCC-232 SCC-233 SCC-234	Total fish barrier (1145773.464, 144653.173) (1145437.798, 144037.078) (1145565.266, 143310.511)	Removal or modification of culvert to allow fish passage	DES Assessment and Monitoring to inform WDFW
MI-90	Water withdrawal from stream	Potential removal of withdrawal point	DES Assessment and Monitoring to inform DOE
ER-73	Bank failure in natural gas ROW	Site visit and evaluate bank/channel stability	DES Assessment and Monitoring to inform NW Natural

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

- Continue research and mapping new stormwater infrastructure with the goal of maintaining a complete stormwater infrastructure inventory

Coordination of Stormwater Activities

- Continue to search for opportunities to coordinate or leverage projects with the Lower Columbia Fish Recovery Board through the 2010 WA Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan.

Mechanisms for public involvement

- Publish SNAP reports on CWP web page

Development Regulations for Stormwater and Erosion Control

- Implement development regulations to minimize impacts, particularly enhanced nutrient control regulations to protect Lacamas Lake

Stormwater Source Control Program for Existing Development

- Continue to expand efforts to design and build runoff reduction strategies in county right-of-way
- Focus on protecting reaches that are currently unstable or sensitive to future disturbance
- Conserve agricultural and forest lands and promote healthy practices

Operation and Maintenance Actions to Reduce Pollutants

- None

Education and Outreach to Reduce Behaviors that Contribute Stormwater Pollution

- Encourage landowners to adopt runoff reduction practices such as disconnecting downspouts
- Perform targeted technical assistance responding to results of field assessments
- Educate private landowners on importance of native riparian vegetation and intact riparian forests for shading streams and preserving hydrology
- Educate landowners to discourage disposal of trash and yard debris in streams or other receiving waters
- Provide landowners a list of suggested plants for stream re-vegetation and local nurseries that stock them
- Replace missing or deteriorated stream name signs

TMDL Compliance

- Continue collaboration in ongoing TMDL development for fecal coliform, temperature, dissolved oxygen and pH in Lacamas Creek above Lacamas Lake. Clark County fulfills its TMDL compliance obligations through ongoing implementation of the Stormwater Management Program

Monitoring Stormwater Program Effectiveness

None

Overall management actions that may lead to improved watershed health include:

- Assess Priority 2 and Priority 3 outfalls, which make up nearly all of the outfalls discharging to critical areas in these subwatersheds; offsite assessment activities may reduce downstream erosion problems by discovering potential issues before they become more serious
- Encourage appropriate agricultural practices that emphasize soil and water conservation and reduction in nutrient load to streams.
- Protect streams from future stormwater impacts by creating stream buffers, establishing conservation easements, and eliminating agricultural runoff inputs.
- Encourage reforestation

References

Booth, D.B. and C.R. Jackson. (1997). Urbanization of Aquatic Systems: Degradation Thresholds, Stormwater Detention, and the Limits of Mitigation: Journal of the American Water Resources Association, vol. 33, no. 5, p. 1077-1090.

Booth, D.B., Hartley, D., and Jackson, R. (June 2002). Forest Cover, Impervious-Surface Area, and the Mitigation of Stormwater Impacts: Journal of the American Water Resources Association vol. 38, no. 3. p. 835-845.

Booth, D. B., et al. (October 2004). Reviving Urban Streams: Land Use, Hydrology, Biology, and Human Behavior: Journal of the American Water Resources Association, pp. 1351-1364.

Center for Watershed Protection (March 2003). Impacts of Impervious Cover on Aquatic Systems: Watershed Protection Monograph No. 1.

City of Vancouver – Surface Water Management (May 2007). Burnt Bridge Creek Watershed Program. Vancouver, WA

Clark County Public Works Water Resources (June 2003). Standard Procedures for Monitoring Activities, pp. 46-48.

Clark County Public Works Water Resources (December 2003). Long-Term Index Site Monitoring Project: 2002 Physical Habitat Characterization, pp. 35.

Clark County Public Works Water Resources (2004). Clark County Stream Health, A comprehensive overview of the condition of Clark County's streams, rivers, and lakes, pp 46.

Clark County (2004). Regional wetland inventory and strategy: 51 pages.

Cornelius, L. (July 2006). Gee Creek Watershed Restoration Background Report: WSU Clark County Extension.

Cornelius, L. and J. Finley (January, 2008). Gee Creek Watershed Restoration Project 2007 Annual Report: WSU Clark County Extension.

Cramer, S.P. & Associates, Inc. (January 2005). Chapter 4: East Fork Lewis River Basin – Habitat Assessment, report prepared for the Lower Columbia Fish Recovery Board under contract to Clark County Water Resources.

Cude, C. (2001). Oregon Water Quality Index: A Tool for Evaluating Water Quality Management Effectiveness. Journal of the American Water Resources Association. Vol. 37, No.1.

Everts, Russel C. (2004). Geologic map of the Ridgefield 7.5' quadrangle, Washington: U.S. Geological Survey Scientific Investigations Map 2834, scale 1:24,000. (http://pubs.usgs.gov/sim/2004/2844).

Fore, L.S., City of Bellevue (March 1999). Measuring the Effects of Urbanization on Bellevue Streams, pp. 24.

Hill, K., and M.C. Bidwell (January 2003). A Rapid Land Cover Classification for Clark County: Washington: Department of Landscape Architecture and Urban

Ecology Lab, College of Architecture and planning, University of Washington, Seattle, Washington.

Hutton, R., and C. Hoxeng (April 2007). Clark County Long-term Index Site and Salmon Creek Monitoring Projects' Status and Trends Based on Oregon Water Quality Indices and Turbidity: Clark County Water Resources Program, Vancouver, Washington.

Karr, J.R. (1998). Rivers as Sentinels: Using the Biology of Rivers to Guide Landscape Management, River Ecology and Management: Lessons from the Pacific Coastal Ecosystems. Springer, NY, pp. 502-528.

Law, A.W. (1994). The effects of watershed urbanization on stream ecosystem integrity. Masters Thesis. University of Washington, Seattle Washington.

Lower Columbia Fish Recovery Board. (Dec. 2004). Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan. Volume II, Subbasin Plan Chapter G, North Fork and East Fork Lewis.

Lower Columbia Fish Recovery Board. (Dec. 2004). Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan. Volume II, Subbasin Plan Chapter H, Lower Columbia Tributaries Bonneville and Salmon.

Lower Columbia Fish Recovery Board. (Dec. 2004). Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan. Volume II, Subbasin Plan Chapter I, Washougal.

Lower Columbia Fish Recovery Board. (2007). Regional Culvert Inventory, Project #02-1658N, Final Report.

Lower Columbia Fish Recovery Board. (2008). East Fork Lewis River Community Habitat Restoration Plan and Project Design – Draft Technical Memorandum 1 and 2.

Montgomery, David R. and John M Buffington (1997). Channel-reach morphology in mountain drainage basins: GSA Bulletin; May 1997; v. 109; no. 5; p. 596–611.

National Marines Fisheries Service (August 1996). Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale: Environmental and Technical Services Division, Habitat Conservation Branch.

National Marines Fisheries Service (March 2003). ESA Guidance for Analyzing Stormwater Effects: NOAA Fisheries Service, Northwest Region.

Parametrix, Inc. (2002). Burnt Bridge Creek Riparian Habitat Assessment. Prepared for the City of Vancouver, 37 pp.

R2 Resource Consultants, Inc. (December 2004). Kalama, Washougal, Salmon, and Lewis River Habitat Assessments Chapter 1: Introduction and Methods, report prepared for the Lower Columbia Fish Recovery Board under contract to Clark County Water Resources.

R2 Resource Consultants, Inc. (December 2004). Kalama, Washougal, Salmon, and Lewis River Habitat Assessments Chapter 3: The North Fork Lewis River Basin, report prepared for the Lower Columbia Fish Recovery Board under contract to Clark County Water Resources.

R2 Resource Consultants, Inc. (December 2004). Kalama, Washougal, Salmon, and Lewis River Habitat Assessments Chapter 5: The Salmon Creek Basin, report prepared for the Lower Columbia Fish Recovery Board under contract to Clark County Water Resources

R2 Resource Consultants, Inc. (December 2004). Kalama, Washougal, Salmon, and Lewis River Habitat Assessments Chapter 6: The Washougal River Basin, report prepared for the Lower Columbia Fish Recovery Board under contract to Clark County Water Resources.

Schnabel, J. (December 2003). Long-Term Index Site Monitoring Project: 2002 Physical Habitat Data Summary: Clark County Public Works Department, Water Resources Program, Vancouver, Washington.

Schnabel, J. (September 2004). Salmon Creek Watershed: Summer 2003 Stream Temperature. Clark County Public Works Department, Water Resources Program, Vancouver, Washington.

Schueler, T. (1999). Microbes and Urban Watersheds: Ways to Kill ‘em. Watershed Protection Techniques. 3(1): 566-574.

S.P. Cramer & Associates, Inc. (January 2005). Chapter 4: East Fork Lewis River Basin – Habitat Assessment, report prepared for the Lower Columbia Fish Recovery Board under contract to Clark County Water Resources.

State of Oregon Department of Environmental Quality (July 2004). Draft Lower Willamette Subbasin TMDL.

Swanson, R.D. (July 2006). Prioritizing Areas for Stormwater Basin Planning: Clark County Public Works, Water Resources Program.

Vancouver Lake Watershed Partnership Technical Group. Technical Foundation for Future Management of Vancouver Lake (November 2008).

Turney, G.L. (1990). Quality of Groundwater in Clark County, Washington: US Geological Survey Water Resource Investigation Report 90-4149, 97 p.

United States Environmental Protection Agency (1986). Quality Criteria for Water 1986: EPA 440/5-86-011, Office of Water Regulations and standards, Washington, DC.

US Army Corps of Engineers (November 2007). Review of Biological Research on Juvenile and Adult Salmonid use of Vancouver Lake. Portland District.

U.S.G.S. (2002). Hydrologic Trends Associated with Urban Development for Selected Streams in the Puget Sound Basin: Western Washington (Water-Resources Investigations Report 02-4040), Tacoma, WA, pp. 40.

Washington Department of Ecology (November 2006). Water Quality Standards for Surface Waters of the State of Washington: Chapter 173-201A WAC. Publication # 06-10-091.

Washington Department of Ecology (April 2005). O'Brien, Ed. 2005 Stormwater Management Manual for Western Washington: Volume I -- Minimum Technical Requirements and Site Planning, Report 05-10-029, Olympia, WA.

Washington State Department of Ecology. Stormwater Management Manual for Western Washington (February 2005). Publication Numbers 05-10-029 through 05-10-033.

Washington Department of Ecology (April 2007). Draft Watershed Characterization of Clark County, Version 3: Shorelines and Environmental Assistance Program.

Washington Forest Practices Board Manual (March 2000).

Washington State University Vancouver (2009). Bollens, Stephen and Gretchen Rollwagen-Bollens. Year One Annual Report: Biological Assessment of the Plankton in Vancouver Lake, WA.

Wierenga, R., Clark County Water Resources, (January 2005). Technical Report: Subwatershed Characterization and Classification: Clark County Washington, pp. 17.

Wierenga, R. (2005.) Benthic Macroinvertebrate and Water Temperature Monitoring for Clark County Watershed Assessments in 2004. Clark County Public Works Department – Water Resources Program. Washington Department of Ecology Grant number G0300020 and Clark County Clean Water Program.