2007 Stormwater Needs Assessment Program

Gibbons Creek/Steigerwald
Subwatershed Needs Assessment Report

Clark County Public Works Water Resources

May 2008

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Acronyms and Abbreviations

B-IBI	Benthic Macroinvertebrate Index of Biological Integrity
BOCC	Board of County Commissioners
BMP	Best Management Practices
CCD	Clark Conservation District
CIP	Capital Improvement Program
CPU	Clark Public Utilities
CRFPO	Columbia River Fisheries Program Office
CWA	Clean Water Act
CWC	Clean Water Commission
CWP	Clean Water Program
EIA	Effective Impervious Area
EDT	Ecosystem Diagnostic and Treatment model
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
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 Scores
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 Areas
UIC	Underground Injection Control
USFWS	U.S. Department Fish and Wildlife Services
VBLM	Vacant Buildable Lands Model
WAC	Washington Administrative Code
WRIA	Water Resource Inventory Area
WSDOT	Washington Department of Transportation

Executive Summary

Study Area

This Stormwater Needs Assessment report includes the Gibbons Creek and Steigerwald subwatersheds in southeastern Clark County. Assessment effort focused on the unincorporated areas.

Intent

Stormwater Needs Assessment reports compile 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. The assessments are conducted at a subwatershed scale, providing a greater level of detail 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 Gibbons Creek watershed, including water quality, biological health, habitat, hydrology, and the stormwater system.

Ongoing Projects and Involvement

Gibbons Creek and Steigerwald combine to form a multi-jurisdictional watershed including US Fish and Wildlife property, the City of Washougal, and Clark County. Ecology is also involved in Gibbons Creek through an ongoing Total Maximum Daily Load (TMDL); all of the above-listed jurisdictions, as well as the Clark Conservation District, are actively participating in TMDL implementation and adaptive management activities.

There are currently no major projects sponsored by other regional entities such as Lower Columbia Fish Recovery Board, Clark County Legacy Lands Program, and Clark County Transportation Improvement Program.

There are no Clark County Clean Water Program stormwater projects in Gibbons Creek under the 2007-2012 Stormwater Capital Improvement Program.

Category	Status
Water Quality	
Overall	• Fair to good
Fecal coliform bacteria	• TMDL implementation ongoing; does not meet state criteria
Temperature	• Does not meet state criteria
Sediment	• High turbidity
Biological	
Benthic macroinvertebrates	• Moderate biological integrity
Anadramous fish	• Presumed Coho salmon and winter steelhead use; low regional recovery priority
Resident fish	• Status unknown
Habitat	
Reference condition	• No available reference habitat data
NOAA Fisheries criteria	• Forest cover, road density, stream crossing density, and impervious area percentage meet or nearly meet criteria for Functioning streams
Riparian	• Forest cover relatively intact • Invasive vegetation predominant as understory • Large woody debris and shade presumed moderate to good in Gibbons; poor in Steigerwald
Wetland	• Almost non-existent in Gibbons; Steigerwald is primarily wetland area • Restoration and protection of Steigerwald wetlands dependent on upstream protection of Gibbons Creek.
Hydrology and Geomorphology	
Overall hydrology	• No hydrology data available
Channel stability	• Most stream reaches are stable
Future condition	• Projected impervious area places Gibbons Creek in a category of uncertain channel stability
Stormwater (Unincorporated areas)	
System description	• Infrastructure almost non-existent; stormwater sources are roads and overland flow draining to road-side ditches • No known public stormwater facilities; one private facility
Inventory status	• Nearly complete (estimated 95 percent)
System adequacy	• Marginally adequate control and inadequate treatment • Projected impervious area indicates little future change in unincorporated areas. Development within Washougal UGA indicates need for updated control standards with investment in new and retrofit infrastructure
Condition	• Condition largely undocumented, presumed good

Opportunities

Projects listed in the SNAP report represent only a small part of those required to protect and restore Gibbons Creek. Immediate priorities based on current conditions and local program capabilities are listed. Several opportunities exist for stormwater-related watershed improvement, including the following:

- Focused stormwater outreach and education to streamside landowners based on assessment results.
- Retrofits to roadside ditches for enhanced control or treatment under the SCIP.
- Evaluation and removal of potential fish barriers.
- Investigation of one potential illicit discharge.
- Technical assistance visits to landowners with potential source control and water quality ordinance issues.
- Promotion of riparian enhancement projects.
- Treatment of Japanese Knotweed infestations at four locations.
- Cleanup of one near-stream dump site.
- Implementation of an additional feature inventory to locate potential bacteria sources and other stormwater-related issues within the Washougal UGA.

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. Management recommendations relevant to the Gibbons Creek watershed include:

- Coordinate and leverage opportunities with groups and agencies active in Gibbons Creek improvement, particularly through TMDL implementation.
- Replace missing or deteriorated stream name signs at road crossings.
- Encourage removal of invasive plants, particularly the identification and reporting of Japanese Knotweed, and riparian restoration through education, technical assistance and/or financial assistance.

Introduction

This report is a Stormwater Needs Assessment for the Gibbons Creek and Steigerwald 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 Water Resources 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 Water Resources mission of protecting water quality through stormwater management.

The overall goals of the SNAP are to:

- Analyze and recommend the best and most cost effective mix of improvement actions to protect existing beneficial uses, and to improve or allow for the improvement of lost or impaired beneficial uses consistent with NPDES objectives and improvement goals identified by the state GMA, ESA recovery plan implementation, 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.

Water Resources 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 initiating wetland banking systems, identifying mitigation opportunities, and providing a better understanding of stream and watershed conditions for use in planning county road projects. Similar information is also needed by county programs implementing critical areas protections and salmon recovery planning under the state Growth Management Act (GMA) and the ESA.

Scope

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

SNAP reports produce information related to three general categories:

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

Descriptions of potential projects and recommended program management actions are provided to county programs, including the Public Works CWP and Stormwater Capital Improvement Program (SCIP), several programs within the Department of Community Development, and the county's ESA Program. Potential project or leveraging opportunities are also referred to local agencies, groups, and municipalities as appropriate.

Assessment Approach

Priorities for Needs Assessment in Gibbons Creek

Clark County subwatersheds were prioritized into a five year schedule for the 2006-2011 SNAP using the procedures described in Prioritizing Areas for Stormwater Basin Planning (July 2006).

The Gibbons Creek subwatershed falls into the "Rural Residential with UGA fringe" category established in the above document. Subwatersheds in this category typically include both city and county jurisdictions. The level of SNAP implementation depends to some extent on coordination between municipalities. Priority for stormwater basin planning is often high in this category, leading to the use of a fairly wide range of SNAP tools.

The Steigerwald subwatershed falls into the "Wildlife Refuge and Open Space" category. Subwatersheds in this category typically have very limited urban development and stormwater infrastructure. The level of SNAP implementation is relatively low in this category, focusing on drainage inventory, stakeholder coordination, and broad-scale GIS characterization.

Assessment Tools Applied in Gibbons Creek

The SNAP utilizes a standardized set of tools for subwatershed assessment including desktop mapping analysis, modeling, outreach activities, and a variety of field data collection. Tools are based on existing protocols where feasible, and cover a range of information important to 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 marked with an asterisk (*) are those for which new data or analyses were conducted during the course of this needs assessment. The remainder of the tools were assessed based on pre-existing information.

Table 1: Stormwater Needs Assessment Tools	
Stakeholders *	Geomorphology and Hydrology Assessment*
Outreach And Involvement *	Riparian Assessment
Coordination with Other Programs *	Floodplain Assessment
Drainage System Inventory *	Wetland Assessment
Stormwater Facility Inspection *	Macroinvertebrate Assessment
Review Of Existing Data *	Fish Use And Distribution
Illicit Discharge Screening (Gibbons only) *	Water Quality Assessment
Broad Scale GIS Characterization *	Hydrologic Modeling
Rapid Stream Reconnaissance (Gibbons only) *	Hydraulic Modeling
Physical Habitat Assessment	

Assessment Actions

Outreach Activities

Outreach activities were limited to general materials designed to increase awareness about the SNAP effort. The following activities were completed:

- July 2007 -- press release to local media
- August 2007 – article in "Planning Stormwater Projects" flyer distributed at Clark County fair and other public events.
- September 2007 – article in Clean Water Program E-Newsletter
- Clean Water Program web pages updated to include the SNAP and SCIP
- March 31 of each year, a description of the SNAP is included in Clark County's stormwater management program plan submitted to Ecology

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

Coordination with Other Programs

Purpose

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

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

Methods

The CWP maintains a list of potential coordinating programs for each subwatershed area. The list was reviewed in early 2007 and general communications were planned. Coordination took the form of phone conversations, meetings, or electronic correspondence, and was intended to solicit potential project opportunities, encourage data and information sharing, and promote program leveraging.

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

Results

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

The following list includes departments, agencies, and groups contacted for potential coordination during the course of the Gibbons Creek needs assessment:

- Clark County Endangered Species Act program
- Lower Columbia Fish Recovery Board
- Clark County Transportation Improvement Program
- Clark County Legacy Lands Program
- Vancouver/Clark Parks and Recreation
- Washington Department of Ecology
- Clark County Weed Management
- City of Washougal Public Works
- Clark Conservation District

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 6 Year Habitat Workplan
- CC Volunteer project data
- Ecology 303(d) list
- Salmon Recovery Plan
- WRIA Limiting Factors Analysis
- U.S. Fish & Wildlife Service Gibbons Creek Watershed Analysis
- CC consproj GIS layer (conservation projects)
- CC 6-Year and 20-Year TIP
- Ecology EIM data
- CC Mitigation Opportunities Project
- CC 2004 Subwatershed summary
- CC 2003 Stream Health Report
- Clark Conservation District 2007 livestock inventory

Broad-Scale GIS Characterization and Metrics

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

Many of these characteristics are described in greater detail in later sections. For example, geology and soils form the cornerstone of the Geomorphology and Hydrology section.

The characterization includes three components:

- A set of three 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, conclusions about general subwatershed condition and potential future changes, and potential mitigation or improvement site identification.

Map Products

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

General Conditions and Subwatershed Metrics

General Geography

Gibbons Creek is along the eastern edge of Clark County and includes the westernmost part of the Columbia River Gorge Scenic Area. The watershed includes two subwatersheds. Gibbons Creek drains a southward sloping plateau between the Columbia River floodplain and the Washougal River. Gibbons Creek then passes into the Steigerwald subwatershed on the Columbia River floodplain and includes small streams draining to the floodplain (Figure 1). Gibbons Creek subwatershed also includes Campen Creek, which is the westernmost tributary to Gibbons Creek. Campen Creek is largely within the City of Washougal.

Unincorporated Gibbons Creek subwatershed is rural with large lots and pastures on hilltops and forest in deep stream canyons. Steigerwald subwatershed is a combination of wildlife refuge and farmland in the eastern two-thirds and urban and port facilities inside the City of Washougal. The Washougal UGA extends into most of the Campen Creek drainage basin.

Topography
The Gibbons Creek study area is characterized by two main features: the relatively high, southward dipping plateau incised by valleys of the Gibbons Creek drainage system, and the Columbia River floodplain and adjoining cliffs at the south edge of the plateau. The highest hills are small Ice Age volcanoes, Mount Norway and Nichols Hill. Each is about 1,100 feet above sea level. The plateau breaks to cliffs or terraces at 500 to 600 feet elevation. The steep topography leads to steep stream gradients for Gibbons Creek and its tributaries. Steigerwald is 10 to 20 feet above sea level and surrounded by dikes to prevent flooding.

Geology and Soils
Gibbons Creek and Steigerwald watershed is underlain by several geologic units; older semi-consolidated sandy gravel commonly referred to as the Troutdale Formation or Troutdale gravels, Ice Age volcanic rocks, sandy to gravelly Ice Age catastrophic flood deposits, and sandy alluvium on the Columbia River floodplain. Recent mapping by Evarts (2004) provides a good level of detail for most of the area.

The Troutdale Formation is sandy ancestral Columbia River deposits that at depth underlie the entire watershed. It is exposed as weathered reddish deposits on hills above about 400 feet altitude. Where streams are eroded into the Troutdale Formation, it forms steep valley walls and hard gravely substrate under stream channels. Pebbles, cobbles and sand eroded from the Troutdale Formation form much of the bed load in Gibbons Creek.

Ice Age volcanoes at Mount Norway and Nichols Hill were intruded through and cap the Troutdale Formation.

Ice Age catastrophic flood deposits form terraces at elevations up to 400 feet along the south facing cliff at the north edge of Steigerwald subwatershed and lower Gibbons and Campen Creeks. These deposits are about 14,000 to 12,000 years old and were deposited by a succession of giant floods of the Columbia River caused by ice dam failures near Missoula, Montana.

The youngest deposits are modern alluvium on the Columbia River floodplain.

Soils formed on the Troutdale Formation and volcanic rocks tend to be fairly clayey and most of Gibbons Creek subwatershed is hydrologic soil group C. Floodplain deposits are Hydrologic Soil Group B or wetlands mapped as Group D.

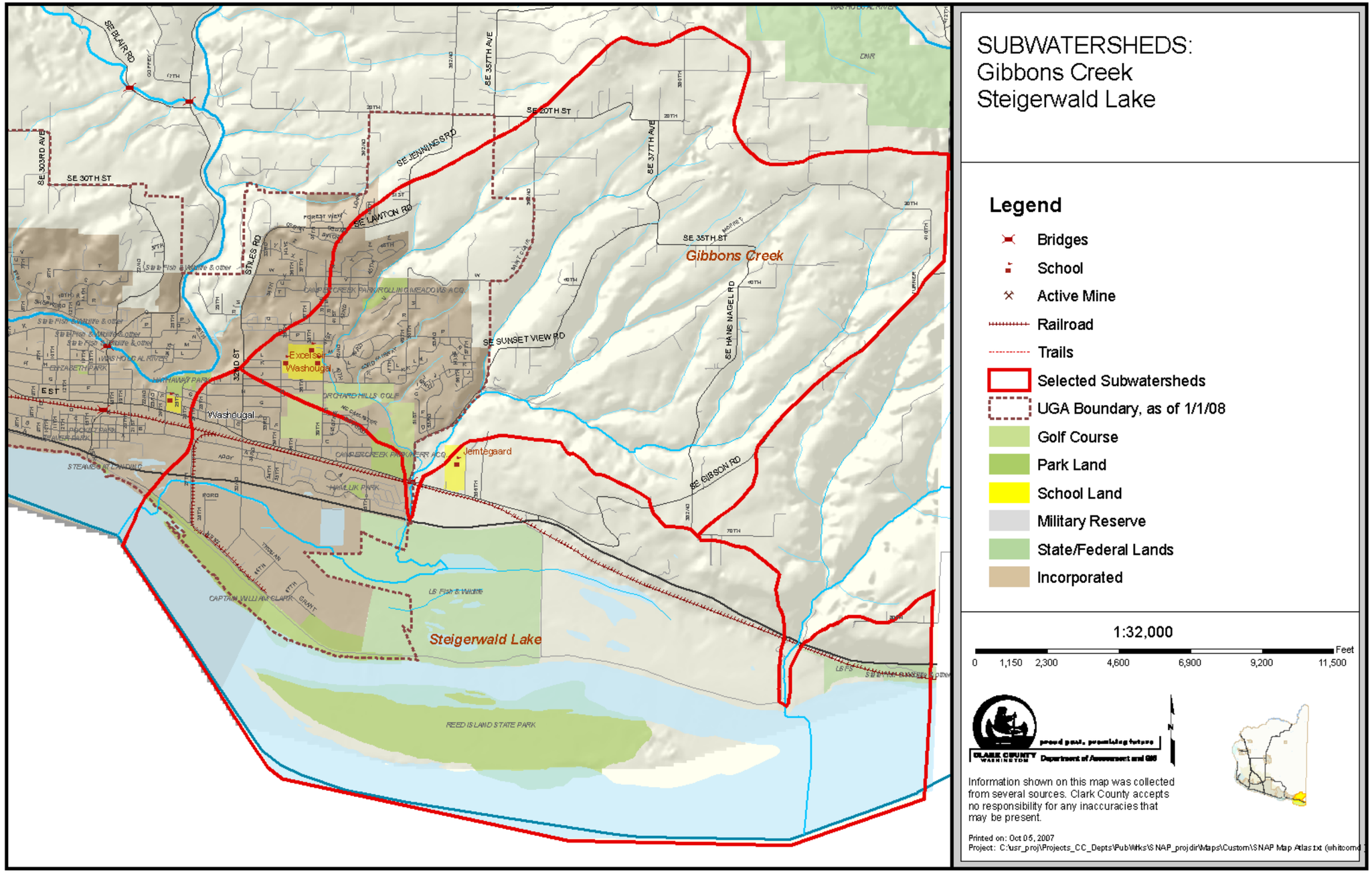

Figure 1: Subwatershed Map: Gibbons Creek, Steigerwald Lake

Hydrology

As with the geology and topography, the study area has two distinct settings. Gibbons Creek has a trellis-like drainage system with four steep southwest trending drainages collect to a single drainage point at the confluence of Campen and Gibbons Creeks. After crossing Highway 14, Gibbons Creek enters an elevated channel intended to carry the stream and migrating salmon past the diked floodplain. See the geomorphology and hydrology section for a more detailed description of conditions.

Stream channels in Gibbons Creek subwatershed are in steep canyons, 200 to 300 feet deep, cutting into the elevated Troutdale Formation gravels. Stream gradients are steep; the mainstem of Gibbons Creek drops almost 400 feet between Hans Nagel Road and Highway 14, a distance of about two miles. Little or no floodplain deposits are present along Gibbons Creek.

Steigerwald subwatershed includes the Columbia River floodplain. There does not appear to be any streams draining from the coarse-grained Ice Age catastrophic flood deposits forming terraces along lower Gibbons Creek and northern Steigerwald subwatersheds.

No stream gauge data are available for Gibbons Creek. Gibbons Creek has a history of carrying large amounts of gravel out of its channel onto the Columbia River floodplain, clogging flow control structures on the elevated channel.

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 Gibbons Creek, above the Columbia River floodplain, has fairly good conditions for a stream in the Willamette Valley Ecoregion (Table 2). Metrics meet or nearly meet functioning criteria, despite significant urbanization in the Campen Creek drainage. The watershed scale metrics do not apply well to Steigerwald because is not a watershed drained by a stream system.

Table 2: Watershed Scale Metrics				
Metric	**Gibbons**	**Steigerwald**	**Functioning**	**Non-functioning**
Percent Forested (2000 Landsat)	40	13	> 65 %	< 50 %
Percent TIA (2000 Landsat)	15	15	< 5 %	> 15 %
Road Density 2007 data (miles/mile2)	7	4	< 2	> 3
Stream Crossing Density (crossings per stream mile)	1.5	0.7	< 3.2/mile	> 6.4/mile
Percent EIA estimated from the Comprehensive Plan	12	9	< 10 %	> 10 %

Forest Cover

The proportion of a watershed in forest 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.

The Gibbons Creek basin, outside of Washougal, has significant amounts of forest land; a visual estimate suggests about 50 percent forest. This forest land is mainly in steep canyons with flatter hilltop areas converted to pastures and home sites. A comparison to 1955 aerial photos shows very similar forest coverage and perhaps more forest in the present due to regrowth of clear cut areas visible in 1955. Forest cover is not a consideration for Steigerwald which is managed as open grasslands and marshes.

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 of less than five percent as fully functional and greater than 15 percent as non-functional habitat is a reasonable indicator of habitat quality. While overall Gibbons Creek is 15 percent, it is much lower outside of Washougal.

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, almost all of Clark County is non-functioning. Urban streams have road densities approaching 15 to 20 miles per square mile. Overall, Gibbons Creek road density is typical of rural and mixed suburban and rural settings.

Stream Crossing Density
Stream crossing densities are easily measured using available road and stream channel data. The salmon protection standard considers larger fills over 60 feet wide, which would be approximately five to ten foot high road fill. According to the NOAA fisheries criteria, Gibbons Creek is functional for salmon habitat.

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

The 2008 Comprehensive Plan guides development for the next few years and when used to estimate effective impervious area; it can provide a metric for potential hydrologic impacts due to expected development. Future EIA for both Gibbons Creek and Steigerwald are near the non-functional criteria. Campen Creek is slated to receive most of the new development in Gibbons Creek. Outside of Campen Creek and the Washougal UGA, little change is likely.

Estimated Channel Stability Based on Forest and EIA
In a recent publication by Booth, Hartley, and Jackson (June 2003), a relationship between forest and percent EIA was presented as a graphic (Figure 2). According to this figure, Gibbons Creek is likely in or near the zone of uncertain channel stability based on expected hydrologic conditions.

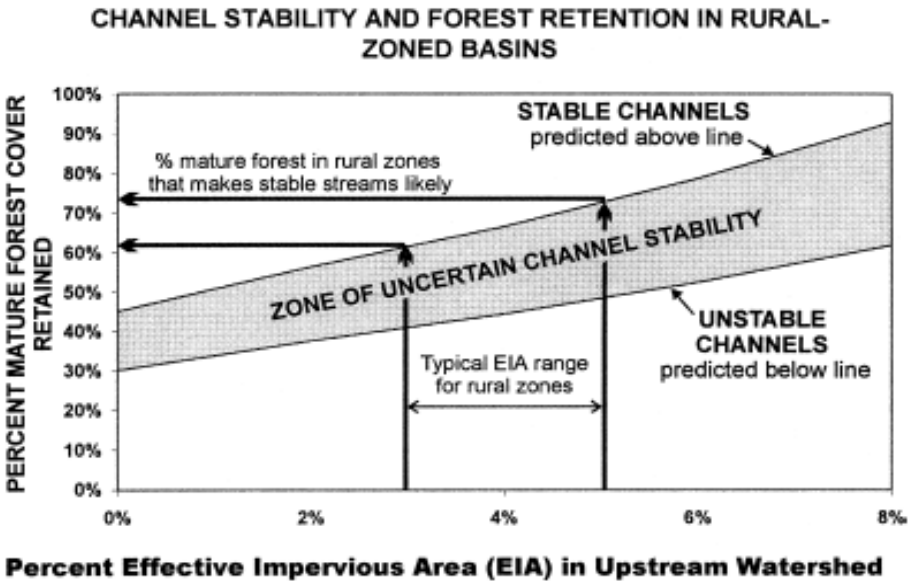

Figure 2: Channel stability in rural areas (Booth, Hartley, and Jackson, June 2002).

Water Quality Assessment

This section briefly summarizes and references available water quality data from the Gibbons Creek watershed. 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 current Washington State water quality standards, Gibbons Creek is to be "protected for the designated uses of: Salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values" (WAC 173-201A-600).

Table 3 summarizes currently applicable water quality criteria for Gibbons Creek.

Table 3: Applicable Water Quality Criteria for Gibbons Creek (November 2006)

Characteristic	2006 Ecology Criteria
Temperature	≤ 17.5 °C (63.5 °F)
Dissolved Oxygen	≥ 8.0 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 100 colonies/100mL, and not more than 10% of samples exceeding 200 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 2002/2004 303(d) list of impacted waters may be found on the Ecology website at:

http://www.ecy.wa.gov/programs/wq/303d/index.html.

Several segments of Gibbons Creek and it primary tributary, Campen Creek, are Category 4a listed (polluted waters that have an approved TMDL) for fecal coliform. A TMDL is the amount of pollutant loading that a given water body can receive and still meet water quality standards. For non-point pollution sources, TMDLs are typically implemented through Load Allocations and non-regulatory programs. Implementation activities by several local agencies are ongoing under the Gibbons Creek fecal coliform TMDL.

Several segments of the Gibbons Creek remnant channel (through Steigerwald NWR) are Category 2 listed (waters of concern) for arsenic, chromium, dissolved oxygen, pH, and temperature. Segments of the remnant channel are also Category 1 listed (meets tested standards for clean waters) for dissolved oxygen, pH, ammonia-N, chromium, copper, lead, mercury, nickel, zinc, and temperature.

Clark County Stream Health Report

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

Based on available data, including fecal coliform bacteria, general water chemistry (temperature, pH, and dissolved oxygen), and benthic macroinvertebrate scores, overall stream health in the Gibbons Creek watershed scored in the fair range. Though data were available for only 11 percent of the stream miles in the watershed, a simple land-use model predicted poor stream health in the remainder of the watershed.

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

Available Data

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

Table 4: Data and Information Sources	
Source	**Data and/or Report**
Clark County Clean Water Program	Volunteer Monitoring Program 2004 Stream Health Report and draft reports 2006 Gibbons Creek Data Summary (volunteer TMDL study)
Ecology	303(d) List of Impaired Waterbodies Station 28H070 and 28G070 data

A fair amount of historical data exists for the Gibbons Creek watershed; however, most of the dataset is quite dated and is incorporated sparingly or by reference in this report.

Ecology has conducted monitoring on several occasions, including October 1991- September 1992, September and November 1994, January 1995, and October 2001 through September 2002 as part of TMDL assessments and the ambient monitoring program.

More recently, Clark County performed a two-year investigation of fecal coliform and turbidity from April 2004 through March 2006 after Ecology initiated renewed TMDL efforts. Clark County also maintained a volunteer stream monitoring station collecting general water quality data during 2005 and 2006. Reports from these two efforts are available on Clark County's web site at:

http://www.clark.wa.gov/water-resources/documents.html#mon

Water Quality Summary

The following water quality summary is based primarily on results found in existing reports. Much of the following text and graphics are taken directly from Gibbons Creek Data Summary Part 1 –Effectiveness and Trend Monitoring by Volunteers (Wierenga, July 2006), and Water Quality Monitoring 2005 Annual Report for Volunteer Stream Sites in Clark County, Washington (Wolf, November 2006). See the full reports at the above link for additional detail.

Figure 3 shows the approximate locations of Clark County monitoring stations within the Gibbons Creek watershed.

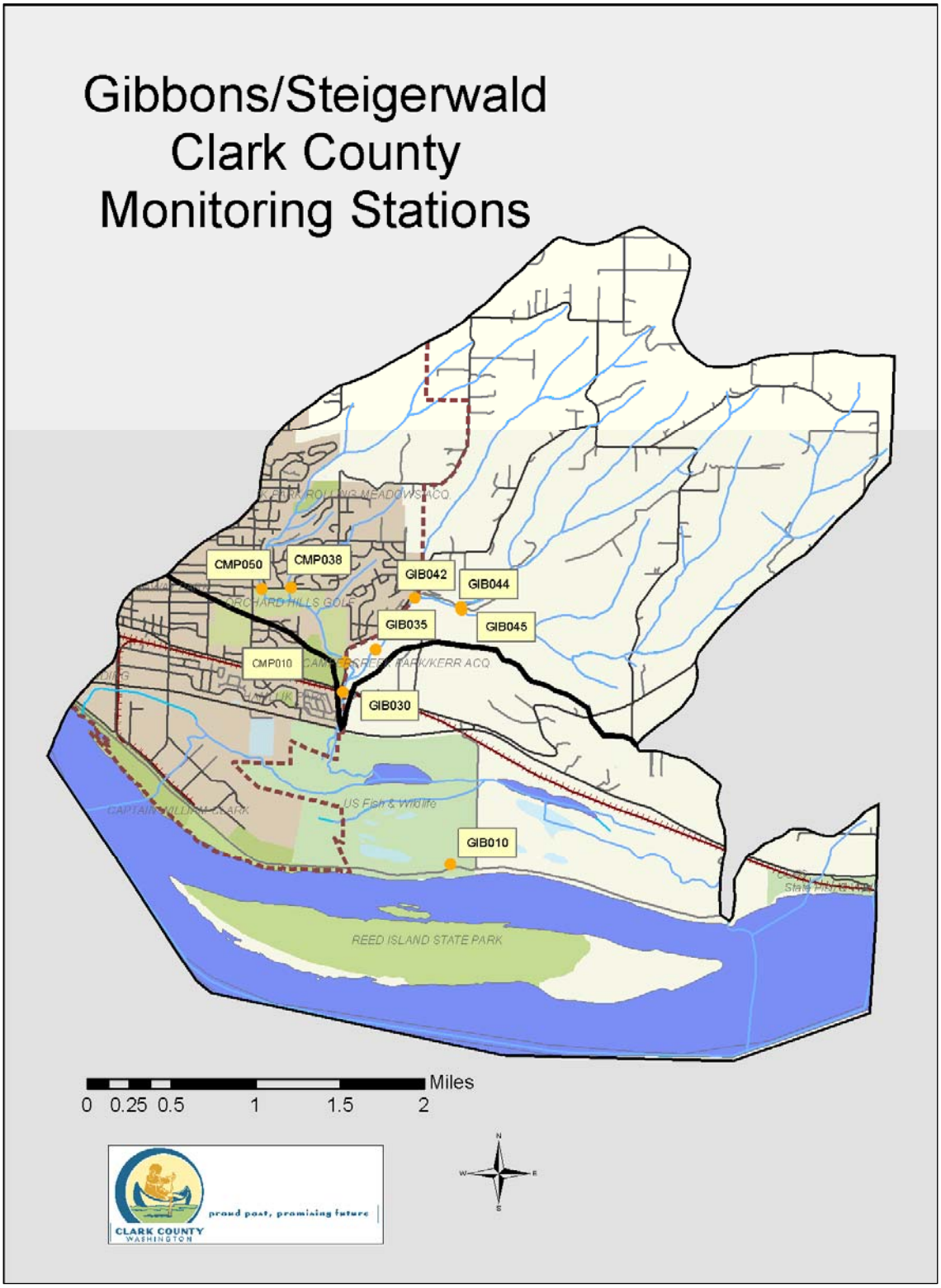

Figure 3: Clark County Gibbons Creek Monitoring Stations

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

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

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

Based on a very limited dataset of four samples collected by Clark County volunteers during 2005, Gibbons Creek had an overall OWQI score of 89, placing it in the "good" category.

Trends over time
The Gibbons Creek dataset is not large or consistent enough to enable calculations of long-term trend with any statistical significance.

Fecal Coliform Bacteria
Due to the Gibbons Creek fecal coliform TMDL, fecal coliform is the most substantial dataset available and has been the primary focus of most water quality studies in the watershed.

Table 5 summarizes fecal coliform data from several historical monitoring projects. Geometric mean values and 90th percentile values (used to evaluate the 10 percent exceedances criterion) were calculated to evaluate the data relative to the water quality criteria.

Table 6 summarizes overall results from the Clark County TMDL study during 2004 through 2006. Geometric mean values and 90th percentile values (used to evaluate the 10 percent exceedances criterion) were calculated to evaluate the data relative to the water quality criteria.

Table 5: Summary of Fecal Coliform Data from Previous Monitoring Programs

Monitoring Station	Monitoring Date Range	Range of Fecal Coliform Concentration	Geometric Mean Fecal Coliform Concentration	90th Percentile Fecal Coliform Concentration
Gibbons Creek at Evergreen Highway (Ecology ID 28G070)	October 1991-September 1992	37-900 cfu/100mL	230 cfu/100mL	705 cfu/100mL
Gibbons Creek at Evergreen Highway (Ecology ID 28G070)	October 2001-September 2002	6-1,300 cfu/100mL	119 cfu/100mL	635 cfu/100mL
Campen Creek mouth above confluence (Ecology ID 28H070)	October 2001-September 2002	12-1,200 cfu/100mL	158 cfu/100mL	1,052 cfu/100mL

(From Wierenga, 2006)

Table 6: Summary of fecal coliform sample data from April 2004 to April 2006; highlighted values indicate cases where state water quality criteria were not met (WAC173-201A-200).

Monitoring Station Code	Number of Samples	Range of Fecal Coliform Concentrations cfu/100 mL	Geometric Mean Fecal Coliform Concentration cfu/100 mL	90th Percentile Fecal Coliform Concentration cfu/100 mL
CMP010	22	1-6,080	317	2075
CMP038	23	2-3,520	181	656
CMP050	22	1-1,030	188	922
GIB030	23	20-5,260	159	564
GIB042	22	1-2,960	97	602
GIB044	22	1-2,160	35	158
GIB045	22	1-640	32	219

(From Wierenga, 2006)

Bacteria levels at most of the monitoring stations in the watershed exceeded one or both of the water quality criteria over the two-year monitoring period. Four of the seven stations violated both fecal coliform water quality criteria.

Along the Gibbons Creek mainstem, the two stations representing the upper watershed; GIB044 located at the Wooding Road tributary, and GIB045, the upstream-most sample station on Gibbons Creek, nearly met both criteria. The

GIB042 station on a tributary draining the northern part of the watershed that runs along Sunset View Road showed occasionally high levels of fecal coliform and exceeded the 90th percentile criterion nearly three-fold. The downstream-most location at GIB030, Gibbons Creek at the Evergreen Highway, had consistently higher bacteria levels than the other Gibbons Creek stations.

Each of the monitoring stations in the Campen Creek drainage showed poor water quality. The monitoring station on the lower mainstem Campen Creek, located near the creek's confluence with Gibbons Creek, had a geometric mean concentration nearly three times the water quality criterion and a 90th percentile value nearly 10 times the criterion. Stations located in upper Campen Creek also showed degraded conditions, with the upper mainstem station at CMP050 typically having higher fecal coliform levels than the tributary represented by station CMP038.

After combining the data from all of the stations in the Gibbons Creek watershed, the following inferences were made relative to weather and seasons:

- Although geometric mean and 90th percentile fecal coliform values are higher during wet weather than dry weather, the difference is not statistically significant.
- Fecal coliform levels are significantly higher during the dry season than the wet season.
- Wet weather during the dry season resulted in the highest fecal coliform levels.
- Dry weather during the wet season resulted in the lowest fecal coliform levels.

Figure 4 shows the fecal coliform data grouped into categories of weather and season (e.g. Dry/Dry indicates "Dry weather during the Dry season". Dry and wet weather were determined with a 48-hr rainfall total of 0.1 inches, and dry and wet seasons were determined by the sample month (June through October is the dry season).

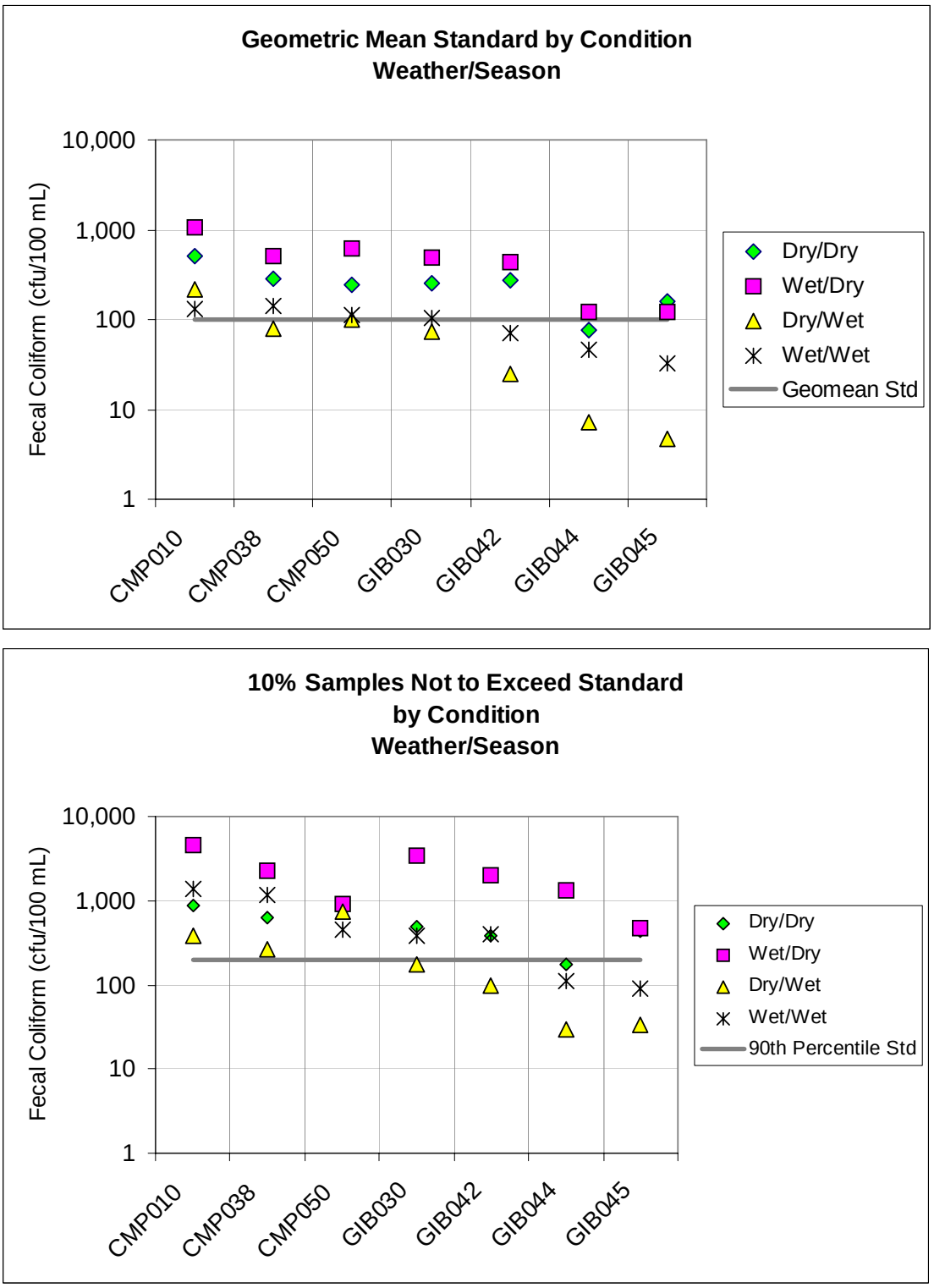

Figure 4: Fecal coliform levels for each of the stations showing data grouped into categories of weather and season, for example, 'Dry/Dry' is the category for 'Dry Weather during the Dry Season'. Dry and wet weather were determined with a 48-hour rainfall total of 0.1 inches, and dry and wet seasons were determined by the sample month (June through October is the dry season).(From Wierenga, 2006)

Overall, the results showed that the upper mainstem and tributaries of Gibbons Creek are in good condition relative to the other tributaries. Sources of bacteria certainly exist in the upper drainages; however, expending resources locating and removing these sources is currently not as crucial as in other locations. Campen Creek and the Gibbons Creek tributary following Sunset View Road should be the focus of future monitoring and source removal programs. Campen Creek, at stations in both the lower and upper reaches, consistently had higher levels of bacteria than upper Gibbons Creek.

The patterns observed in the data also indicate that there are likely multiple sources of fecal coliform pollution entering the creeks. Bacteria and turbidity levels were often higher during rain events, particularly the late summer and early fall events. Therefore, stormwater runoff appears to be an important pathway for conveying pollutants accumulating on impervious surfaces to the waterways. Furthermore, routinely high fecal coliform levels during dry weather in the dry season indicate continuous, non-stormwater runoff related sources of bacteria, such as illegal discharges and failing septic systems. July through October appears to be the most critical period for controlling large pulses of fecal coliform and turbidity to the creeks. (Wierenga, 2006)

Nutrients

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

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

Based on Ecology ambient monitoring program data from the 2002 water year, median total phosphorus values were 0.081 mg/L in lower Campen Creek and 0.058 mg/L in lower Gibbons Creek. TP values exceeded 0.100 mg/L from July through November at the lower Campen Creek station. Nitrate values were elevated at both stations throughout the winter.

Turbidity

It is difficult to establish an exact background turbidity level for Gibbons Creek because no data exists from a time when Gibbons Creek was not impacted by human activities. However, based on data from the least-impacted streams monitored by the CWP, we estimate that natural background turbidity in most Clark County streams would have been in the range of 0.5 to 2 NTU. Based on this estimate, the turbidity criterion for Gibbons Creek is likely between 5.5 and 7 NTU.

Results of the 2004 through 2006 Clark County TMDL monitoring project indicated turbidity problems throughout the watershed, with an estimated criterion of six NTU exceeded between 40 percent and 70 percent of the time (Wierenga, 2006).

As with the fecal coliform data above, combining the data from all of the stations enabled the following inferences about turbidity levels relative to weather and seasons:

- Turbidity levels are significantly higher during wet weather than dry weather, in either season.
- Turbidity levels are significantly higher during wet weather in the dry season than wet weather during the wet season.
- Turbidity levels are *not* significantly higher during dry weather in the dry season than dry weather during the wet season.

Table 7 shows turbidity data grouped by categories of weather and season.

Table 7: Turbidity Calculations from All Stations, Grouped by Categories of Weather and Season

Event Category	Event Count	Range of Turbidity Values NTU	Average Turbidity NTU	Number of Samples
Dry Weather/Dry Season	5	2.5-13.1	6.1	31
Wet Weather/Dry Season	6	4.0-96.8	25.6	42
Dry Weather/Wet Season	8	1.7-13.8	5.3	49
Wet Weather/Wet Season	6	2.8-337.0	23.2	42

The results for Wet Weather/Wet Season were skewed upward by a single very high turbidity event in March 2005. Removing this outlier decreased the range and average for Wet Weather/Wet Season to 2.8 -14.6 NTU and 6.9 NTU, respectively. Overall, the report reached the conclusion that wet weather during the dry season typically produces the most elevated turbidity levels, and that the critical period for turbidity appears to be wet weather from June to October. (Wierenga, 2006)

Stream Temperature

The most recent stream temperature data for Gibbons Creek was collected from May through October in 2004 and 2005 by Clark County.

Compliance with the 2006 state criterion (≤ 17.5 °C (63.5 °F) is based on the maximum of the 7-day moving average of daily maximum water temperatures (7-DAD Max). Figure 5 shows the 7-DAD-Max values for Gibbons Creek stations during summer 2004 (Wierenga, 2006).

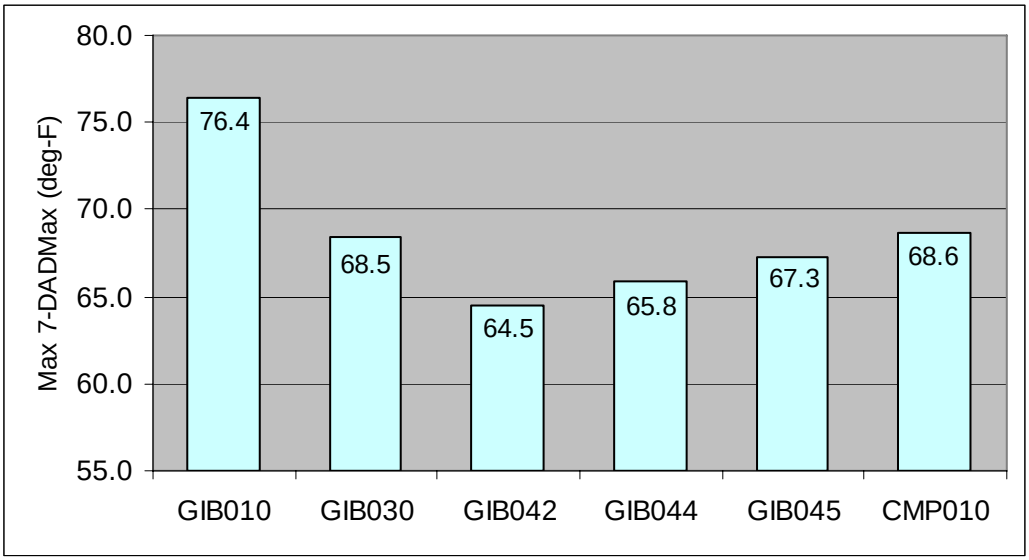

Figure 5. Water temperature data statistics for the Gibbons Creek watershed from May to October 2004. Data reported is the maximum 7-day moving average of the daily maximum (Max 7-DADMax) water temperature. (from Wierenga, 2006)

Gibbons and Campen Creek both exceeded water quality criteria for water temperature. The Gibbons Creek tributary stations at GIB042 and GIB044 were relatively close to the revised 63.5 degrees F standard, while the other mainstem sites at GIB030 and GIB045 were four to six degrees above the standard. Campen Creek, near its confluence with Gibbons Creek, was about five degrees above the standard, similar to the downstream station at GIB030.

The GIB010 station, located at the mouth of Gibbons Creek at the Columbia River, was established for a cooperative project with the Steigerwald Lake Wildlife Refuge and US Fish and Wildlife Service. Maximum water temperature at the GIB010 station was much higher than the other stations. Prior to 1992, the lower reach of Gibbons Creek flowed westerly for the lower mile before discharging into the Columbia River. Since 1992, this channel has been significantly modified and it drains nearly due south from the highway crossing, through the wildlife refuge, to the Columbia River. For most of this lower mile, the creek flows through an artificial, elevated channel before discharging into the Columbia River through a fish ladder structure. (Wierenga, 2006)

In 2005, the 7-DAD Max for the volunteer station at GIB035 was 64.9 degrees F, exceeding the criterion by just over one degree F.

Impacts to Beneficial Uses and Potential Sources

General water quality in Gibbons Creek is good according to limited OWQI data as described above. However, fecal coliform and turbidity remain significant issues and ongoing TMDL implementation has not brought fecal coliform levels into compliance with state criteria. Beneficial uses are degraded by current levels of fecal coliform, turbidity, and stream temperature.

Observed levels of these characteristics may have negative impacts on the listed beneficial uses of: salmonid spawning, rearing, and migration; primary contact recreation; wildlife habitat; and aesthetic values. Table A at the conclusion of this section summarizes the primary water quality impacts to beneficial uses in Gibbons Creek and probable sources of the observed impact.

Fecal Coliform Bacteria

Primary contact recreation is impacted by elevated counts of fecal coliform bacteria, which indicate the possible presence of pathogens. Although water contact may take place year-round, elevated bacteria counts are of particular concern during the summer months when the majority of water contact recreation occurs. Available analyses indicate that the highest fecal coliform levels in Gibbons Creek often occur during this time period. Although Gibbons Creek has no developed swimming or wading areas, it is likely that some local residents, particularly children, utilize the creek for recreation. If so, there is ongoing risk of illness associated with bacterial contamination.

Results of 2004 through 2006 Clark County monitoring showed that the upper mainstem and tributaries of Gibbons Creek are in good condition relative to the other tributaries. Sources of bacteria certainly exist in the upper drainages; however, expending resources locating and removing these sources is currently not as crucial as in other locations. Campen Creek and the Gibbons Creek tributary following Sunset View Road should be the focus of future monitoring and source removal programs. Campen Creek, at stations in both the lower and upper reaches, consistently had higher levels of bacteria than upper Gibbons Creek.

The patterns observed in the data also indicate that there are likely multiple sources of fecal coliform pollution entering the creeks. Bacteria and turbidity levels were often higher during rain events, particularly the late summer and early fall events. Therefore, stormwater runoff appears to be an important pathway for conveying pollutants accumulating on impervious surfaces to the waterways. Furthermore, routinely high fecal coliform levels during dry weather in the dry season indicate continuous, non-stormwater runoff related sources of bacteria, such as illegal discharges and failing septic systems. July through October appears to be the most critical period for controlling large pulses of fecal coliform and turbidity to the creeks. (Wierenga, 2006)

Turbidity and Solids

The 2004 through 2006 data indicates Gibbons Creek exhibits relatively high routine turbidity levels compared to other Clark County streams, and is susceptible to very high short-term turbidity during rain events.

The primary sources of excessive turbidity and silt load in Gibbons Creek are probably related to soil and bank erosion. Both off-site erosion (development, agriculture, and recreational vehicle use) and in-stream erosion (bank scour, slumping, and re-suspension of sediments during high flows) likely contribute significantly to the elevated turbidity during rain events.

Turbid water may limit foraging ability and indicate the presence of fine silt that clogs gills and spawning beds. Fine sediment deposits compromise gravel spawning areas, smothers eggs, and impacts food availability by suppressing benthic macroinvertebrate populations.

Water Temperature

Based on the most recent Clark County data, water temperature in Gibbons Creek does not meet state criteria; however, temperatures in Gibbons Creek appear to be lower than in many other Clark County streams.

Temperature may be a significant impediment to salmonid use in lower Gibbons Creek, particularly in the elevated channel downstream of SR14.

In particular, elevated temperatures have a detrimental impact on salmonid rearing. Migration and spawning tend to occur during cooler times of year, but juveniles are exposed to elevated summer temperatures during rearing. Temperature-related impacts to salmonids begin to occur at stream temperatures greater than 64 degrees F. Impacts include: decreased or lack of metabolic energy for feeding, growth or reproductive behavior; increased exposure to pathogens; decreased food supply; and increased competition from warm-water tolerant species (ODEQ, 2004 draft).

Solar radiation is the primary driver of water temperature. The susceptibility of a stream to solar radiation is influenced by several factors including stream flow, channel form, canopy cover (shade), ponds, and the extent of groundwater influence.

Gibbons Creek has relatively good riparian canopy cover throughout much of the watershed, though some areas do receive direct solar radiation and could benefit from riparian enhancement.

<u>Implications for Stormwater Management</u>

Table 8 lists the primary known water quality concerns and potential solutions for each. Solutions listed in bold indicate areas where CWP activities can have a positive impact. It should be noted that CWP activities, though important, are not likely to achieve water quality improvement goals on their own. Other county departments, local agencies, and not least of all, the public, must all contribute to water quality improvement.

Among the CWP activities most likely to have a positive impact on water quality are:

- Effective stormwater system designs, retrofitting, and maintenance
- Source detection and removal projects; and
- Public education programs

Table 8: Known Water Quality Concerns, Sources, and Solutions for Gibbons Creek				
Characteristic	**Beneficial Use Affected**	**Potential Sources**	**Mechanism**	**Solutions (bold indicates direct Clean Water Program involvement)**
Fecal coliform bacteria	Primary contact recreation	failing septic systems	groundwater seeps storm sewers	**Storm sewer screening for source identification and removal** **Education programs** **Storm water facility designs/retrofits to optimize bacteria reduction** Agricultural Best Management Practices Septic and sanitary sewer system inspection and maintenance
		sanitary sewer leaks	groundwater seeps storm sewers	
		livestock, pets, wildlife	overland runoff storm sewers direct access	
Water temperature	Salmonid rearing (anadromous) Salmonid spawning and rearing (resident)	vegetation removal	direct solar radiation	**Streamside planting/vegetation enhancement/riparian preservation through acquisition** **Education programs**
		low summer flows	decreased resistance to thermal inputs	
Turbidity	Salmonid spawning, rearing, and migration; Aesthetic enjoyment	erosion (development projects; land clearing; cropland; impervious surfaces; channel erosion)	overland runoff storm sewers channel dynamics	Erosion control regulations **Storm water facility designs/retrofits to optimize settling and removal of suspended silt/clay** Agricultural Best Management Practices Stream bank stabilization/rehabilitation **Storm water outfall/facility retrofits to reduce flow-induced channel erosion**
		algae	in-stream growth due to excess nutrients	

Drainage System Inventory

Clark County's drainage system inventory resides in the StormwaterClk GIS database and is available to users through the county's Department of Assessment and GIS, or through the Digital Atlas located at:

http://gis.clark.wa.gov/imf/imf.jsp?site=digitalatlas&CFID=56651&CFTOKEN=98300052

The drainage system inventory is an ongoing CWP programmatic element focused on populating and updating the StormwaterClk database to include all existing stormwater drainage infrastructure.

Priority effort in the Gibbons Creek report area was directed toward identifying and mapping previously unmapped discharge points to support the Illicit Discharge Detection and Elimination Screening project (IDDE). Stormwater infrastructure in the unincorporated areas of the watershed is limited almost exclusively to roadside ditches. Table 9 indicates the number of features previously inventoried in StormwaterClk prior to the 2007 SNAP work, and the number of features added to the database as a result of the 2007 SNAP implementation.

The drainage system inventory for the Gibbons Creek subwatershed was nearly complete at the conclusion of the 2007 implementation. Inventory completion is ongoing in 2008 and 2009 as part of a county-wide inventory update.

Table 9: Drainage System inventory Results, Gibbons Creek Watershed

Database Feature Category	Previously Inventoried	Added to Database during 2007 SNAP
Inlet	0	0
Discharge Point	0	131
Flow Control	0	0
Storage/Treatment	0	0
Manhole	0	0
Filter System	0	0
Channel	30	8
Gravity Main	51	43
Facilities	1	0

Stormwater Facility Inspection

At the time of the assessment, there were no publicly owned stormwater facilities within the Gibbons Creek watershed.

Illicit Discharge Detection and Elimination (IDDE) Screening

Purpose

The purpose of the IDDE Screening project is to detect, isolate, and eliminate illicit connections and illicit discharges to Clark County's municipal separate storm sewer system (MS4).

The IDDE screening project is designed to meet the requirements of Clark County's 2007 NPDES permit which requires identifying and removing illicit connections to the county's MS4.

Methods

IDDE screening includes checking every stormwater outfall for potential illicit discharges, conducting follow-up investigations to track down suspected discharges or connections, and referrals to the proper agencies for termination. Field work is primarily conducted during the dry summer season.

IDDE Screening activities were completed in Gibbons Creek subwatershed during 2007.

Results

Based on the county's StormwaterCLK database, as of August 2007, there were 131 mapped stormwater outfalls in the Gibbons Creek subwatershed consisting primarily of pipe outfalls and roadside ditches. One hundred and twenty-nine of these outfalls were screened for IC/ID, and two mapped outfalls were found to be inaccurately designated as outfalls and were eliminated from the sample set. Four additional outfalls were screened based on dry weather flows observed in unmapped outfalls discovered in the field.

Figure 6 summarizes notable screening activities including general outfall locations, outfalls where water samples were collected, follow-up investigations performed, referrals made, and sources removed for Gibbons Creek subwatershed.

As summarized in Table 10, 133 outfalls were screened and samples were collected at seven outfalls. No follow-up investigations were initiated.

Table 10: IDDE Screening Project Activity Summary of Gibbons Creek Subwatershed as of December 2007.	
Metric	**Number**
# of outfalls screened	133
# of outfalls with sufficient flow to collect water samples	7
# of suspected illicit discharges	0
# of suspected illicit connections	0
# of investigations initiated	0
# of illicit discharge sources located	0
# of illicit connections identified	0
# of outfalls to be re-visited in 2008	0
# of referrals	0
# of illicit discharges removed	0
# of investigations and referrals ongoing	0
# of illicit connections terminated	0
# of cases closed without resolution	0

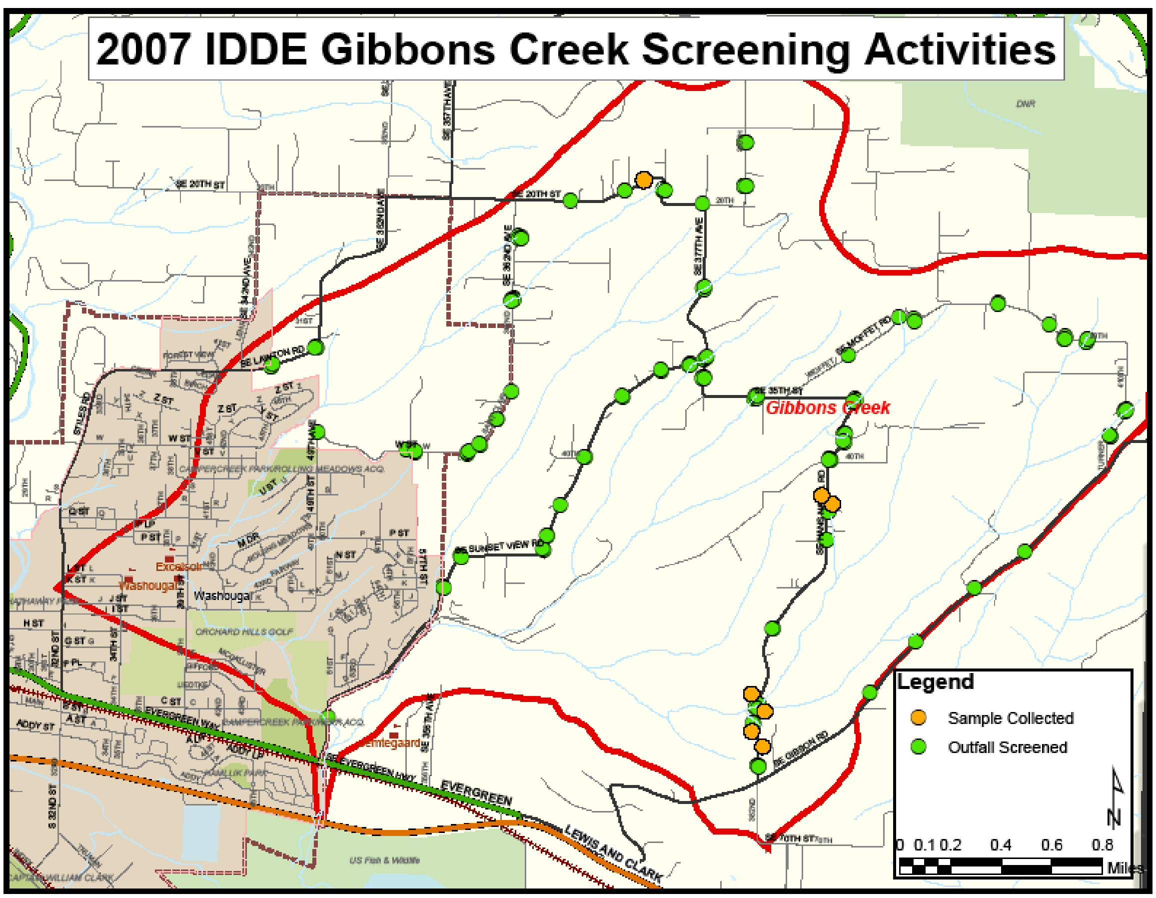

Figure 6: Summary of 2007 IDDE Screening project activities in Gibbons Creek watershed.

Stream Reconnaissance and Feature Inventory

Reach Reconnaissance Survey

No rapid reach assessment was completed for Gee Creek

Inventory Summary – Gibbons Creek Subwatershed

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.

Methods/Limitations

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.

The County, with input from Herrera Environmental Consultants, established a geographic scope of the Feature Inventory by 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 11.

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

A GPS position, digital photos, and relevant attribute information were collected for each logged feature. All data and linked photos are stored in the Feature Inventory Geodatabase located on the Clark County server at: W:\PROJECT\011418, Stream Reconnaissance SNAP\GIS\Data\Geodatabase. Feature data includes field observations, estimated measurements, and/or notes describing important feature characteristics or potential projects.

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

For additional information pertaining to the Feature Inventory SNAP tool, see Volume 1 of the SNAP.

Study Area

The extent of the completed Feature Inventory in the Gibbons Creek subwatershed is shown in Figure 7. Approximately 4.4 miles of the stream

corridor were assessed in the subwatershed. No notable stream reaches were omitted from the planned extent of the Feature Inventory survey. A GPS signal was unavailable on one reach of the Gibbons Creek tributary that flows from north to south between SE Sunset View Road and 57th Street. No features were logged for approximately 2,800 feet between feature TR-6 and IB-82. In that reach, there were no features of interest other than impacted stream buffers resulting from widespread blackberry.

Results/Findings

A total of 90 features were identified in the Gibbons Creek subwatershed. A breakdown of recorded features by type is presented in Table 11. Impacted stream buffers (primarily due to the presence of invasive plant species) were the most prevalent feature type identified, followed by stream crossings, bank erosion, and stormwater outfalls.

Table 11: Summary of Features Recorded in Gibbons Creek Subwatershed

Feature Type	Number of Recorded
AP – Access point	4
ER – Severe bank erosion	9
CM – Channel modification	5
IB – Impacted stream buffer	48
IW – Impacted wetland	0
MI – Miscellaneous point	1
MB – Miscellaneous barrier	0
OT – Stormwater outfall	8
SC – Stream crossing	11
TR – Trash and debris	1
UT – Utility impact	0
WQ – Water quality impact	3
Total	90

A map showing the location and type of all recorded features is shown in Figure 8. A larger, poster-sized version of the same map is on file at the County. In addition, specific information collected at each feature can be accessed by using the Feature Inventory Geodatabase.

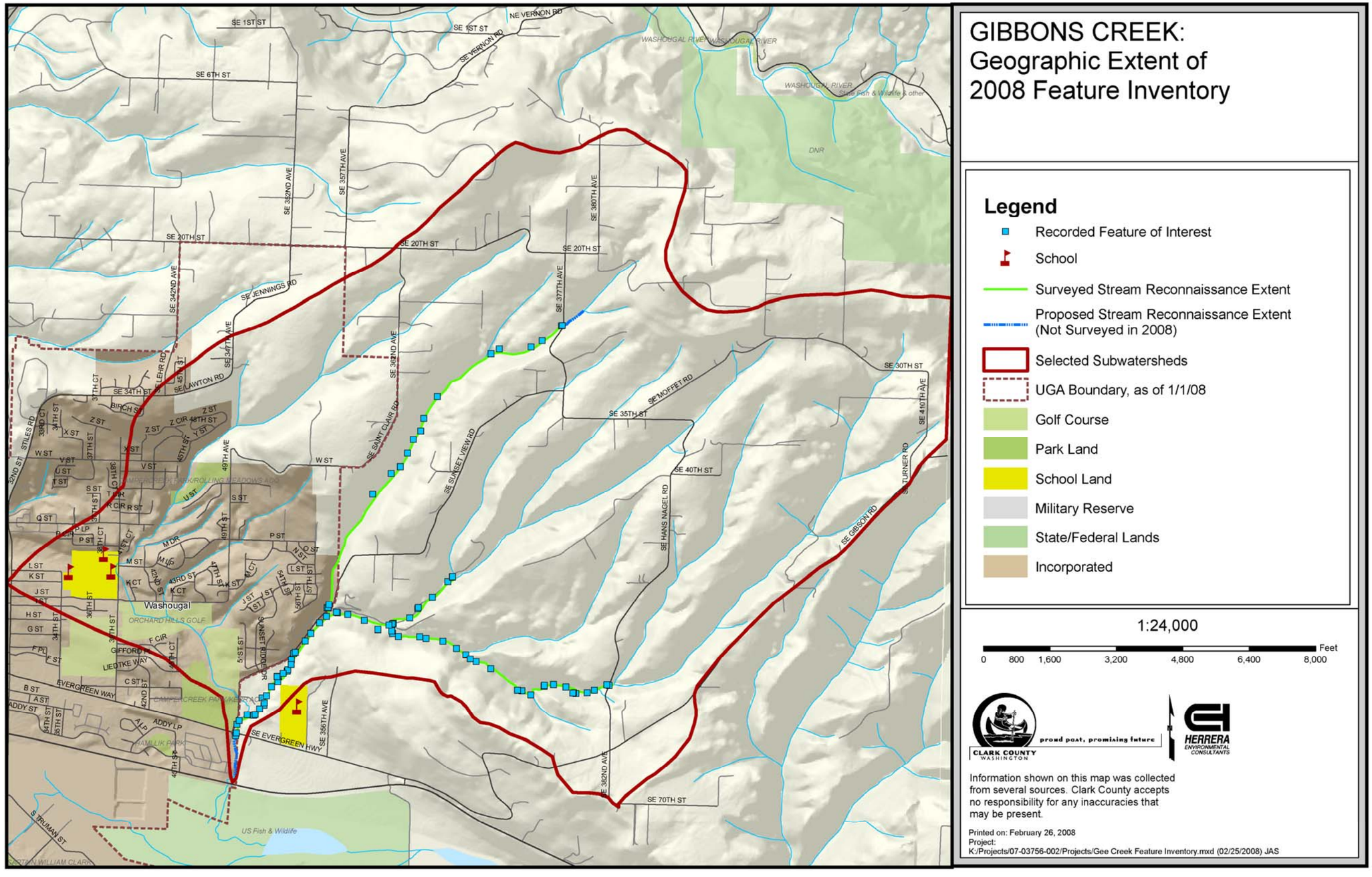

Figure 7: Extent of the Completed Feature Inventory in Gibbons Creek

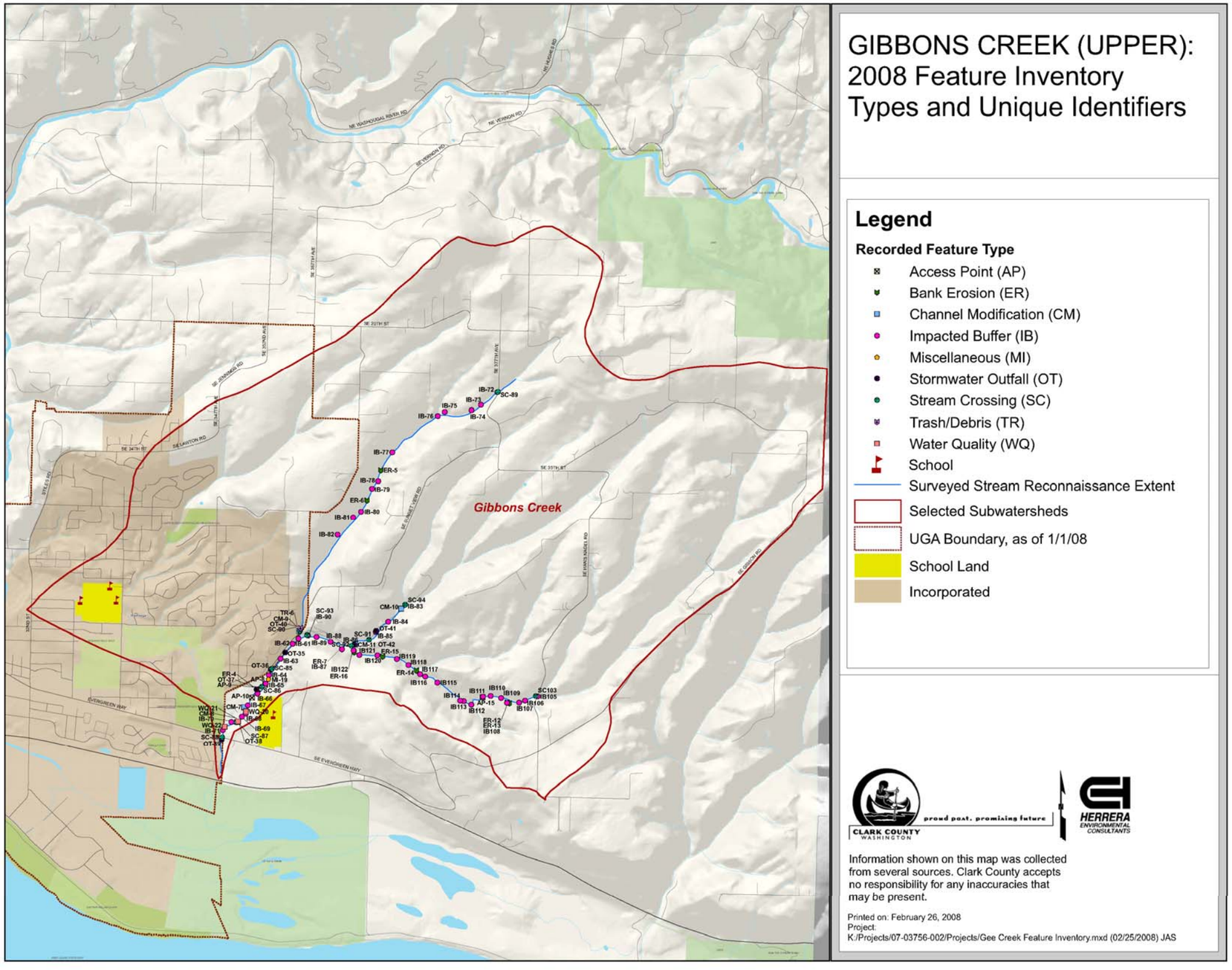

Figure 8: The Location and Type of All Recorded Features in Gibbons Creek

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

Stormwater Infrastructure
The surveyed areas of the Gibbons Creek subwatershed are primarily undeveloped and forested. Within the surveyed areas, the stormwater conveyance to Gibbons Creek and its tributaries is mainly via overland flow and roadside ditches. Flow in the subwatershed is predominately northeast to southwest. The predominant source of stormwater in the surveyed areas of the subwatershed is road surfaces, specifically roads running parallel to the streams. Suburban residential development is a more significant source of stormwater on the mainstem of Gibbons Creek downstream of the intersection of SE Sunset View Road and SE Wooding Road.

Riparian Vegetation
The majority of surveyed stream reaches have established riparian forest canopy. Nevertheless, impacted stream buffers are prevalent in the Gibbons Creek subwatershed. While the riparian forest canopy is in good condition, undergrowth in much of the riparian corridor is dominated by invasive plant species. Blackberry is the most prevalent invasive plant species, and reed canary grass is common in areas with less dense canopy cover. Knotweed is present in the lower watershed, downstream of IB-67, becoming more common farther downstream.

Channel Condition
Generally, stream channels within the surveyed reaches are stable, but have simplified cross-section and plan view geometry. The typical channel morphology is plane bed (Montgomery and Buffington 1997) with cobble and gravel substrate. Channel gradient is fairly steep throughout the subwatershed and exhibits little diversity in bedforms and habitat. A limited number of forced-pool channel types (Montgomery and Buffington 1997) were observed in areas where woody debris was present in the channel. Sand and gravel deposition was observed in a limited number of locations, specifically in the low-energy channel margins of forced-pool channel types.

Surveyed reaches generally are not experiencing severe bank erosion. Isolated sections of eroding bank occur where the channel comes in contact with steeper valley walls. This erosion is natural, and essential for recruiting spawning gravel into the system. There is evidence that the original channel was mechanically altered in the lower reaches of the watershed. These reaches are presently stable.

Excellent channel restoration potential exists in the undeveloped, forested reaches on the mainstem and tributaries of Gibbons Creek. These areas are desirable for restoration because of the lack of development and other conflicting

land uses within the floodplain. These areas also represent lengthy, contiguous reaches where unfragmented habitat value may be greatly increased for a small investment. Engineered structures designed to facilitate bedform development and capture/sort gravels could improve conditions in the short-term while the forest matures to the point where it can act as a significant source of natural woody debris.

Additional Results

In other subwatersheds, features of interest were often discovered when field crews ventured up small, first-order tributary channels outside of the area defined by the geographic scope of work. This result indicates that significant stream impairments, potential environmental and safety hazards, and potential project opportunities may exist outside of the geographic scope of this Feature Inventory. However, because there are very few first-order tributaries originating in developed or developable areas of the Gibbons Creek subwatershed (outside of Washougal, Washington), the likelihood that features of interest are present is greatly reduced.

Potential Project Opportunities

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

Potential project opportunities were identified based on the results of the Feature Inventory conducted in the Gibbons Creek subwatershed. The CWP will evaluate the potential projects for further development or referral to the appropriate organization. Each potential project is listed in Tables 13 through 17, including the basis for the project and a description of the potential project. The location of each potential project is shown in Figures 9 through 11. Potential project opportunities were categorized into six groups based on the nature of the potential work. A total of 68 potential projects were identified. A summary of identified project opportunities by potential project category is shown in Table 12.

Table 12: Breakdown of Potential Project Opportunities by Category

Potential Project Category	Potential Projects Identified
Emergency/Immediate Actions	0
Stormwater Facility Capital Improvement Projects	8
Stormwater Infrastructure Maintenance Projects	0
Habitat Restoration/Enhancement Projects	1
Property Acquisition for Stormwater Mitigation	0
Referral Projects for other Groups/Agencies	59

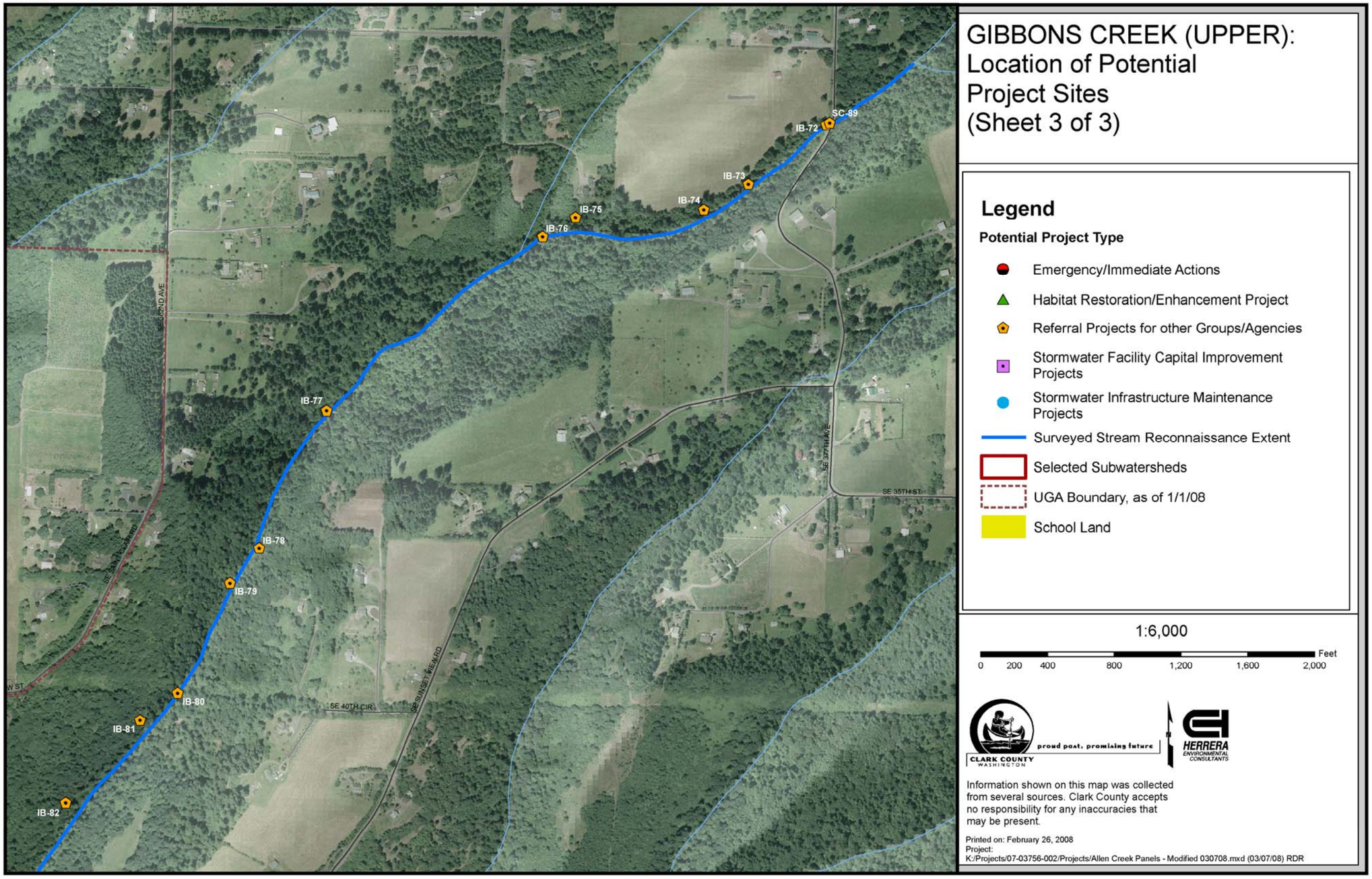

Figure 9: Potential Projects Noted in Feature Inventory

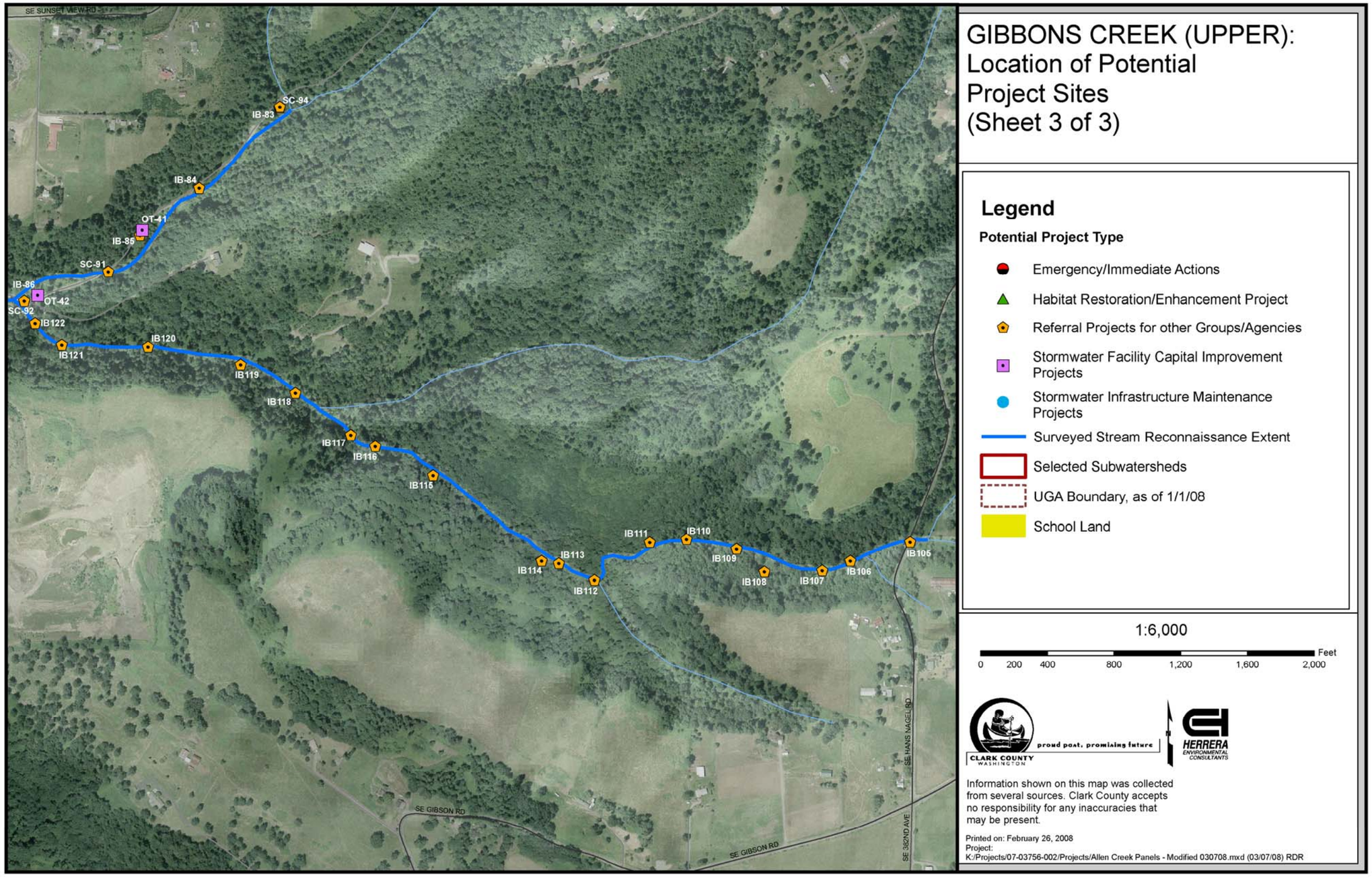

Figure 10: Potential Projects Noted in Feature Inventory

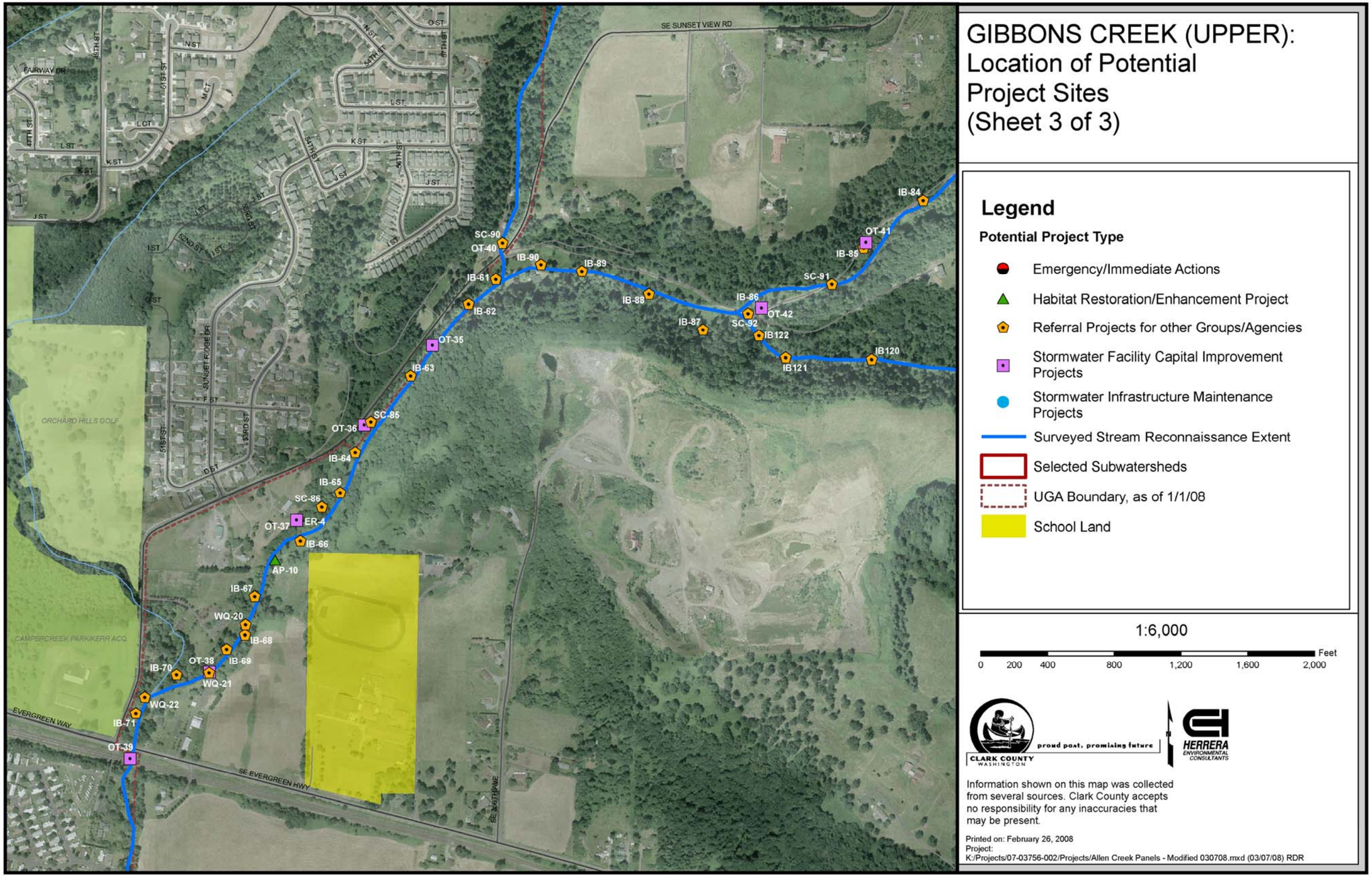

Figure 11: Potential Projects Noted in Feature Inventory

Emergency/Immediate Actions
Emergency/Immediate Actions require an immediate site response project to address a potential or imminent threat to public heath, safety, or the environment. No projects of this type were identified in surveyed reaches of the Gibbons Creek subwatershed.

Stormwater Facility Capital Improvement Projects
Stormwater Facility Capital Improvement Projects are projects that create new stormwater flow control, treatment facilities, or retrofit existing ones. Facility retrofits include projects that will increase an existing facility's ability to control or treat stormwater in excess of the original facility's design goals. Stormwater Facility Capital Improvement Projects identified based on the results of the Feature Inventory are described in Table 13.

Table 13: Description of Potential Project Opportunities

ID	Basis for Project	Project Description
OT-33	A 1.5-foot-diameter corrugated metal outfall pipe drains stormwater directly to the stream from an unidentified source – likely Sunset View Road. Stormwater is likely untreated. No energy dissipater.	Investigate source of stormwater and construct a new stormwater facility to detain and treat runoff appropriately.
OT-41	An 8-inch-diameter plastic outfall pipe drains stormwater to the stream corridor from SE Wooding Road. Stormwater is untreated. No energy dissipater.	Investigate source of stormwater and construct a new stormwater facility to detain and treat runoff appropriately.
OT-42	A 1-foot-diameter plastic outfall pipe drains stormwater to the stream from SE Wooding Road. Stormwater is untreated. No energy dissipater.	Investigate source of stormwater and construct a new stormwater facility to detain and treat runoff appropriately.
OT-35	A 1.5-foot-diameter concrete outfall pipe drains stormwater directly to the stream from an unidentified source. Stormwater is likely untreated and outfall is stained with rust-colored algae. No energy dissipater.	Investigate source of stormwater and construct a new stormwater facility to detain and treat runoff appropriately.
OT-36	Point source of stormwater input to stream corridor. Sheet/overland flow (no defined channel) from SE Sunset View Road. Stormwater is untreated.	Investigate source of stormwater and construct a new stormwater facility to detain and treat runoff appropriately.
OT-37	A 3-inch-diameter ABS pipe draining stormwater directly from gutters of house to the stream. Stormwater is untreated.	Encourage landowner to disconnect downspouts and infiltrate stormwater if possible.
OT-38	A 3-inch-diameter pipe draining stormwater directly from gutters of house to the stream. Stormwater is untreated.	Encourage landowner to disconnect downspouts and infiltrate stormwater if possible.
OT-39	A 1.5-foot-diameter corrugated metal	Investigate source of stormwater and

Table 13: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
	outfall pipe drains stormwater directly to the stream from an unidentified source at the railroad bridge crossing. Stormwater is likely untreated. Some sediment deposition is evident.	construct a new stormwater facility to detain and treat runoff appropriately.

Stormwater Infrastructure Maintenance Projects
Stormwater Infrastructure Maintenance Projects include potential projects which address and repair maintenance defects affecting existing stormwater infrastructure. Infrastructure maintenance projects are required by the County NPDES municipal stormwater permit. Projects in this category with estimated costs exceeding $10,000 are considered under the SCIP process. Projects addressing simpler maintenance defects are referred directly to Public Works Operations and Maintenance staff. No projects of this type were identified in surveyed reaches of the Gibbons Creek subwatershed.

Habitat Restoration/Enhancement Projects
Habitat Restoration/Enhancement Projects include potential projects which result in the restoration or enhancement of wetlands, upland forest, or riparian habitat. In-stream channel habitat and bank protection projects do not fall within the scope of Clark County's CWP, and are placed under the category of Referral Projects for other Groups/Agencies. Habitat Restoration/Enhancement Projects identified based on the results of the Feature Inventory are described in Table 14.

Table 14: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
AP-10	Lack of riparian vegetation along the riparian corridor due to landscaping.	Reestablish native riparian vegetation through plantings. Educate landowners on benefits of native plants.

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

No projects of this type were identified in surveyed reaches of the Gibbons Creek subwatershed.

Referral Projects for other Groups/Agencies
Referral Projects for other Groups/Agencies include potential projects that do not fall within the defined scope of Clark County's CWP. This includes, but is not limited to, in-channel restoration, agricultural BMPs, fish passage barrier

removals, and invasive plant management. It also includes referrals within Clark County departments for projects such as trash removal, stream culvert repairs/maintenance, and drainage projects. Referral Projects for other Groups/Agencies identified based on the results of the Feature Inventory are described in Table 15.

Many of the potential project opportunities listed below are invasive plant species removal and riparian restoration projects that could potentially be combined into a few, large-scale projects.

Table 15: Description of Potential Project Opportunities

ID	Basis for Project	Project Description
SC-89	Perched outlet and culvert hydraulics may be limiting fish passage through culvert under SE 377th Avenue. Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Conduct additional barrier analysis to determine if culvert retrofit or replacement is required. Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
SC-90	Culvert hydraulics may be limiting fish passage through culvert under SE Sunset View Road. Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Conduct additional barrier analysis to determine if culvert retrofit or replacement is required. Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
SC-94	Perched outlet and culvert hydraulics may be limiting fish passage through culvert under SE Wooding Road. Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Conduct additional barrier analysis to determine if culvert retrofit or replacement is required. Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
SC-91	Hydraulic conditions may be limiting fish passage through culverts under SE Wooding Road. Double-barrel culverts appear undersized.	Conduct additional barrier analysis to determine if culvert retrofit or replacement is required.
SC-92	Hydraulic conditions may be limiting fish passage through culverts under SE Wooding Road.	Conduct additional barrier analysis to determine if culvert retrofit or replacement is required.
SC-86	New footbridge with very low freeboard. Old bridge likely blown out	Educate landowners on interacting with streams. Consider removing

Table 15: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
	in December 2007 floods. Bridge is causing local widening of stream channel.	or replacing footbridge.
ER-4	Severely eroding bank with no significant vegetation is migrating into a homeowner's backyard. Source of fine sediment to the stream. No immediate risk to infrastructure.	Educate landowners on interacting with streams. Recommend bank resloping (using coir lifts if necessary) and aggressive revegetation to stabilize bank.
IB-61	Widespread invasive plant species within and immediately adjacent to the floodplain. Reed canary grass, blackberry, and ivy.	Eradicate reed canary grass, blackberry, and ivy. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-62	Widespread invasive plant species within and immediately adjacent to the floodplain. Reed canary grass, blackberry, and ivy.	Eradicate reed canary grass, blackberry, and ivy. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-63	Widespread invasive plant species within and immediately adjacent to the floodplain. Reed canary grass, blackberry, ivy, and nightshade.	Eradicate reed canary grass, blackberry, ivy, and nightshade. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-64	Widespread invasive plant species within and immediately adjacent to the floodplain. Primarily reed canary grass.	Eradicate reed canary grass. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-65	Widespread invasive plant species within and immediately adjacent to the floodplain. Primarily reed canary grass and blackberry.	Eradicate reed canary grass and blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-66	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance

Table 15: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
		riparian habitat.
IB-67	Widespread invasive plant species within and immediately adjacent to the floodplain. Primarily reed canary grass and blackberry with some knotweed.	Eradicate knotweed, reed canary grass, and blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-68	Invasive plant species within and immediately adjacent to the floodplain. Knotweed.	Eradicate knotweed. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-69	Widespread invasive plant species within and immediately adjacent to the floodplain. Primarily reed canary grass and blackberry with some knotweed.	Eradicate knotweed, reed canary grass, and blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-70	Invasive plant species within and immediately adjacent to the floodplain. Ivy. Overall lack of riparian vegetation due to landscaping	Eradicate ivy. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-71	Widespread invasive plant species within and immediately adjacent to the floodplain, extending from GPS point downstream to SE Evergreen Highway. Primarily reed canary grass and blackberry with some knotweed.	Eradicate knotweed, reed canary grass, and blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-72	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-73	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-74	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance

Table 15: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
		riparian habitat.
IB-75	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-76	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-77	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-78	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-79	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-80	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-81	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-82	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-83	Widespread invasive plant species within and immediately adjacent to the	Eradicate blackberry. Reestablish native undergrowth and canopy

Table 15: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
	floodplain. Predominantly blackberry.	vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-84	Widespread invasive plant species within and immediately adjacent to the floodplain. Primarily blackberry with some reed canary grass.	Eradicate blackberry and reed canary grass. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-85	Widespread invasive plant species within and immediately adjacent to the floodplain. Primarily blackberry with some reed canary grass.	Eradicate blackberry and reed canary grass. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-86	Widespread invasive plant species within and immediately adjacent to the floodplain. Primarily reed canary grass.	Eradicate reed canary grass. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-87	Widespread invasive plant species within and immediately adjacent to the floodplain. Primarily blackberry with some reed canary grass.	Eradicate blackberry and reed canary grass. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-88	Widespread invasive plant species within and immediately adjacent to the floodplain. Blackberry and reed canary grass.	Eradicate blackberry and reed canary grass. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-89	Widespread invasive plant species within and immediately adjacent to the floodplain. Ivy, blackberry, and reed canary grass.	Eradicate ivy, blackberry, and reed canary grass. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-90	Ivy and bamboo on left bank planted as landscaping.	Work with landowner to remove invasive plants and reduce the risk of spreading them in the stream corridor.

Table 15: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
IB-105	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-106	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-107	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-108	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-109	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-110	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-111	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-112	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-113	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade

Table 15: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
		out invasive plants and enhance riparian habitat.
IB-114	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-115	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-116	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-117	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-118	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-119	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-120	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-121	Widespread invasive plant species within and immediately adjacent to the floodplain. Predominantly blackberry.	Eradicate blackberry. Reestablish native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
IB-122	Widespread invasive plant species	Eradicate blackberry. Reestablish

Table 15: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
	within and immediately adjacent to the floodplain. Predominantly blackberry.	native undergrowth and canopy vegetation on floodplain to shade out invasive plants and enhance riparian habitat.
WQ-20	An 8-inch diameter, corrugated pipe in concrete footing partially buried in stream bed. Unknown source.	Investigate for potential septic or stormwater inputs.
WQ-21	Small pumping station withdrawal point. Stream water likely used for landscaping	Investigate water rights records. Proceed accordingly.
WQ-22	Exposed dirt within 30 feet of left bank. Appears to be a small dirt bike track or topsoil stock pile that is likely contributing sediment to the stream.	Work with landowner to segregate exposed dirt and eliminate impact to stream through installation of silt fence and planting vegetation to stabilize bare ground.
SC-85	Old bridge being used as a dump site. Significant accumulation of old tires and other trash.	Remove trash and debris.

Stormwater Management Recommendations

A number of general stormwater management measures should be implemented throughout the Gibbons Creek subwatershed:

- Educate private landowners concerning the importance of invasive plant removal, and suggest removal techniques. Teach landowners how to identify knotweed and encourage them to report it to Clark County immediately.
- Educate private landowners on the importance of native riparian vegetation and intact riparian forests for shading streams and preserving hydrology.
- Emphasize conservation of undeveloped and forested areas, especially within the riparian corridor and floodplain.
- Provide a list of suggested plants for stream revegetation and local nurseries that stock them for distribution to landowners.
- Reduce direct and indirect input of untreated stormwater from roads running parallel to streams by installing appropriate flow control and treatment facilities.
- Educate landowners to discourage disposal of yard debris in streams or other receiving waters.
- Post stream identification signs where roads cross streams. Repair or replace deteriorated signs if necessary.

Physical Habitat Assessment

Purpose

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

Methods

Gibbons Creek has physical habitat measurements made in the late 1990s by the US Fish and Wildlife Service (August 2003). The surveys were completed to help assess the suitability of Gibbons Creek as salmon habitat after completion of the elevated fish channel across the Columbia River floodplain. The study used the standard US Forest Service Level II protocols, with variations to collect greater number of field measurements instead of visual estimates. Table 16 describes the survey reaches.

Table 16: USFW Survey Reaches, Gibbons Creek

Reach	Start Point	End Point
GC1	Confluence with Columbia River	Evergreen Highway Bridge
GC2	Evergreen Highway Bridge	Hans Nagel Road
GC3	Hans Nagel Road Culvert	Spring
CC1	Confluence with GC	Acker Road ("Q" Street)
CC2	Acker Road ("Q" Street)	362nd Avenue
CC3	362nd Avenue	Spring (near 20th Street)
WC1	Confluence with GC	Power line right-of-way
WC2	Power line right-of-way	Spring (near SE 380th Avenue
TT1	Confluence with GC	First tributary (0.7 km from confluence)
TT2	First tributary	Natural falls
TT3	Natural Falls	Spring (near Moffet Road)

Results

Results from the survey are summarized as reach totals or averages in Table ??. Report narrative summarizes the results and provides additional observations.

Generally, the survey found high amounts of fine sediment (< 6 mm). Canopy cover was good, but the riparian zone was dominated by young alder that provide poor large woody debris delivery, which in turn is reflected in poor woody debris conditions. The survey did not separate shallow plain bed channels from riffles, and there may be long stretches of plain bed and riffle in these reaches lacking sufficient woody debris to force riffles and pool structure.

Table 17:USFW Gibbons Creek Habitat Survey Results											
	Reach										
Parameter	**GC1**	**GC2**	**GC3**	**CC1**	**CC2**	**CC3**	**WC1**	**WC2**	**TT1**	**TT2**	**TT3**
Distance surveyed (km)	3.58	2.59	2.93	2.75	2.59	1.14	1.25	2.56	0.70	1.07	2.02
Percent Habitat Area											
Side Channels (%)	0.7	1.4	4.0	0	0.1	2.7	4.3	9.7	0.8	0.0	0
Riffles (%)	33.8	85.2	59.2	60.4	92.2	97.3	87.2	79.9	86.3	83.6	94.9
Pools (%)	65.5	13.4	35.0	39.4	6.5	0.0	8.5	4.5	12.5	4.0	2.0
Pool Quality											
Pools/km	11.4	17.8	23.9	19.7	17.7	0.0	23.1	19.6	25.8	14.0	11.4
Total Pool Area m^2	14265	1202	3266	2319	387	0.0	269	264	208	114	94
Average Residual Pool Depth (m)	0.68	0.38	0.40	0.40	0.17	--	0.29	0.20	0.30	0.23	0.21
Large Wood Per Km											
Large & Medium	2.3	5.8	7.9	1.1	5.0	0.0	8.8	4.3	1.4	1.9	8.9
Small	11.4	21.7	6.5	5.8	10.8	6.2	27.9	19.1	7.1	12.1	7.9
All Classes	13.7	27.5	14.4	6.9	15.8	6.2	36.7	23.4	8.5	14.0	16.8
Riparian Canopy Density											
% Canopy Density	64.9	84.6	96.5	63.5	92.5	88	84.9	93.6	78.9	87.3	96.4
(stan. dev.)	(31.9)	(17.7)	(12.4)	(43.0)	(15.1)	(20.8)	(18.0)	(10.3)	(25.2)	(11.0)	(5.0)
% of Total in Substrate Class											
Sample Size											
Substrate Size	2	3	3	3	10	3	2	10	2	7	9
<6 mm	49.6	19.4	21.8	53.5	34.4	63.3	32.5	37.2	39.6	44.7	21.3
6-64 mm	30.7	38.7	43.5	38.5	35.9	30.5	33.3	36.4	29.4	30.6	38.7
65-128 mm	15.5	24.3	27.7	5.5	16.1	2.7	18.0	12.5	15.4	12.8	20.4
>129 mm - bedrock	4.4	17.6	7.0	0.6	16.5	3.5	16.3	13.7	15.7	12	19.7
Sinuousity	1.02	1.15	1.26	134	1.22	1.00	1.03	1.16	1.00	1.19	1.0
Rosgen Type	C4	C3b	C4b	C4	C4b	B6a	B4a	C4b	B4a	B4a	B6a

Geomorphology and Hydrology Assessment

The geomorphology and hydrology assessment was completed as a stand-alone report after the bulk of this document was finalized. When available, this report will be attached as Appendix A.

Riparian Assessment

Purpose

The riparian assessment characterizes existing conditions based on available data, to identify general riparian needs and potential areas for rehabilitation projects.

The need for riparian rehabilitation tends to be widespread and exceeds the scope and resources of the Clean Water Program mission of stormwater management. Therefore, many potential riparian projects are referred to agencies such as LCFRB, Lower Columbia Fish Enhancement Group (LCFEG), Clark Public Utilities, and the Clark Conservation District for possible implementation.

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

Method

Where possible, the assessment is based on GIS data from existing reports, primarily the 2004 Watershed Characterization and Habitat Assessment reports prepared for the Lower Columbia Fish Recovery Board (R2, 2004 and SP Cramer, 2004). 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 2004 LCFRB characterization, an examination of current orthophotographs is used to make a general assessment of riparian condition.

Many riparian project opportunities are discovered through other SNAP activities, including Rapid Stream Reconnaissance feature inventories and geomorphological assessments. Potential projects discovered through these activities are discussed in the respective sections.

The 2004 LCFRB Habitat Assessment reports are also reviewed for specific project opportunities within each subwatershed.

Results

Gibbons Creek subwatershed was not included in the 2004 LCFRB Habitat Assessment.

Large Woody Debris Delivery:

Observations made of orthophotographs indicate that LWD recruitment potential for Gibbons Creek for the majority of the subwatershed above Steigerwald Lake national Wildlife Refuge and State Route 14 could be moderate to high. This subwatershed has a relatively high gradient and many incised gullies that tend to support riparian forest canopy.

Shade

The Forest canopy cover and riparian vegetation observed in the orthophotographs indicate that Gibbons Creek may have a moderate to high level of shade.

Potential Projects

No specific projects for the Gibbons Creek subwatershed are listed in the 2004 LCFRB Habitat Assessment report.

Floodplain Assessment

No floodplain assessment was conducted for the Gibbons Creek subwatershed.

Wetland Assessment

Purpose

Wetlands perform important hydrologic, water quality, and habitat functions. The primary reasons for the wetlands assessment 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; and
- Make management recommendations for wetlands related to stormwater management.

The 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.

Methods

Detailed field evaluations and extensive review of existing data were not applied in the Gibbons Creek subwatershed. The assessment includes review of existing GIS data for wetlands. Primary information sources are the county wetlands atlas, Draft Watershed Characterization of Clark County Version 3 (Ecology, 2007), and personal communication with other county programs.

Stream Reconnaissance feature inventories and Geomorphology/Hydrology assessments may also discover potential wetland-related project opportunities.

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 12 shows potential wetland areas within the Gibbons Creek watershed based on data from the county wetlands atlas, including the Clark County wetland model, National Wetlands Inventory, and high-quality wetlands layer.

Much of the Steigerwald subwatershed consists of Columbia River floodplain and associated wetlands. Potential wetlands are almost non-existent within the unincorporated areas of Gibbons Creek.

Stormwater project opportunities related to wetlands are minimal in the Gibbons Creek subwatershed. The Clark County Regional Wetland Inventory and Strategy Study did not recommend any mitigation opportunities within the Gibbons Creek or Steigerwald subwatersheds, and there are no tax exempt

parcels in Gibbons Creek that overlap with potential wetlands from the Clark County wetlands model. Much of the Steigerwald subwatershed is under Federal ownership and likely represents the best project possibilities.

Draft Watershed Characterization
The Draft Watershed Characterization may be found on the Clark County website at http://www.clark.wa.gov/mitigation/watershed.html. Results pertaining to the Gibbons Creek subwatershed are summarized below.

Gibbons Creek is part of the Columbia floodplain hydrogeologic unit. It is located "in a rain zone, has sub-surface water flow patterns which are influenced by groundwater discharge from the adjacent upland units and recharge from the river surface waters, geologic deposits consisting primarily of relatively recent river alluvium (sand and silt), and a riverine floodplain and valley walls formed by fluvial action of the river" (Ecology, 2007).

Figure 13 depicts priority areas for protection and restoration of hydrologic processes county-wide based on an analysis of the relative importance and level of alteration in each subwatershed.

In general, green areas have higher levels of importance for watershed processes and limited alteration and should be considered for protection. Yellow areas have a higher level of importance for watershed processes and a higher level of alteration and should be considered for restoration unless watershed processes are permanently altered by urban development. Orange to red areas have lower levels of importance for watershed processes and higher levels of alteration and should be considered as more suitable for development. Because orange areas represent a transition from restoration areas, planning measures employing both restoration and appropriately sited development should be considered. (Ecology, 2007)

The Steigerwald area is shown as suitable for restoration (dark yellow) due to its relatively high level of importance for watershed processes and relatively lower level of alteration. Suggested restoration measures include increasing floodplain connectivity through removal of ditches, dikes, and berms. The success of restoration or protection activities in the Steigerwald area is identified as being dependent upon protection and restoration of upstream contributing basins (shown in light green and including Gibbons Creek) (Ecology, 2007).

Potential Projects
This assessment did not discover any high priority stormwater CIP projects related to wetlands within the Gibbons Creek subwatershed.

Potential project locations for further exploration by other agencies based on this wetland assessment include:

- Steigerwald National Wildlife Refuge

Stormwater management recommendations

The Washington Department of Ecology has identified continued protection of intact hydrologic processes in the Gibbons Creek subwatershed as critical to the success of floodplain restoration downstream in the Steigerwald subwatershed. Stormwater management actions taken by Clark County in the unincorporated areas and by the City of Washougal in the growing urban areas should focus on limiting degradation of hydrologic processes.

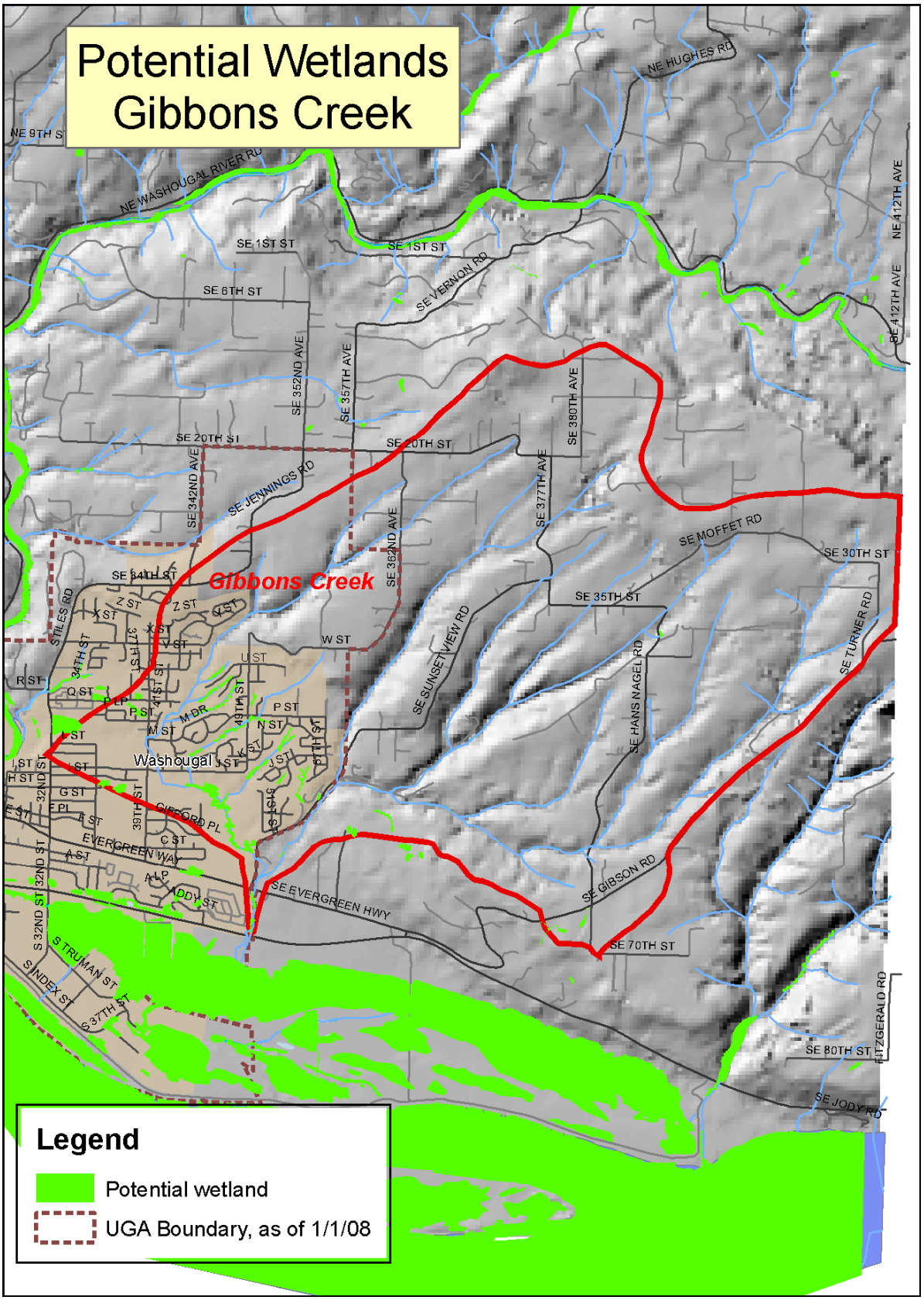

Figure 12: Potential Wetlands in Gibbons Creek Subwatershed

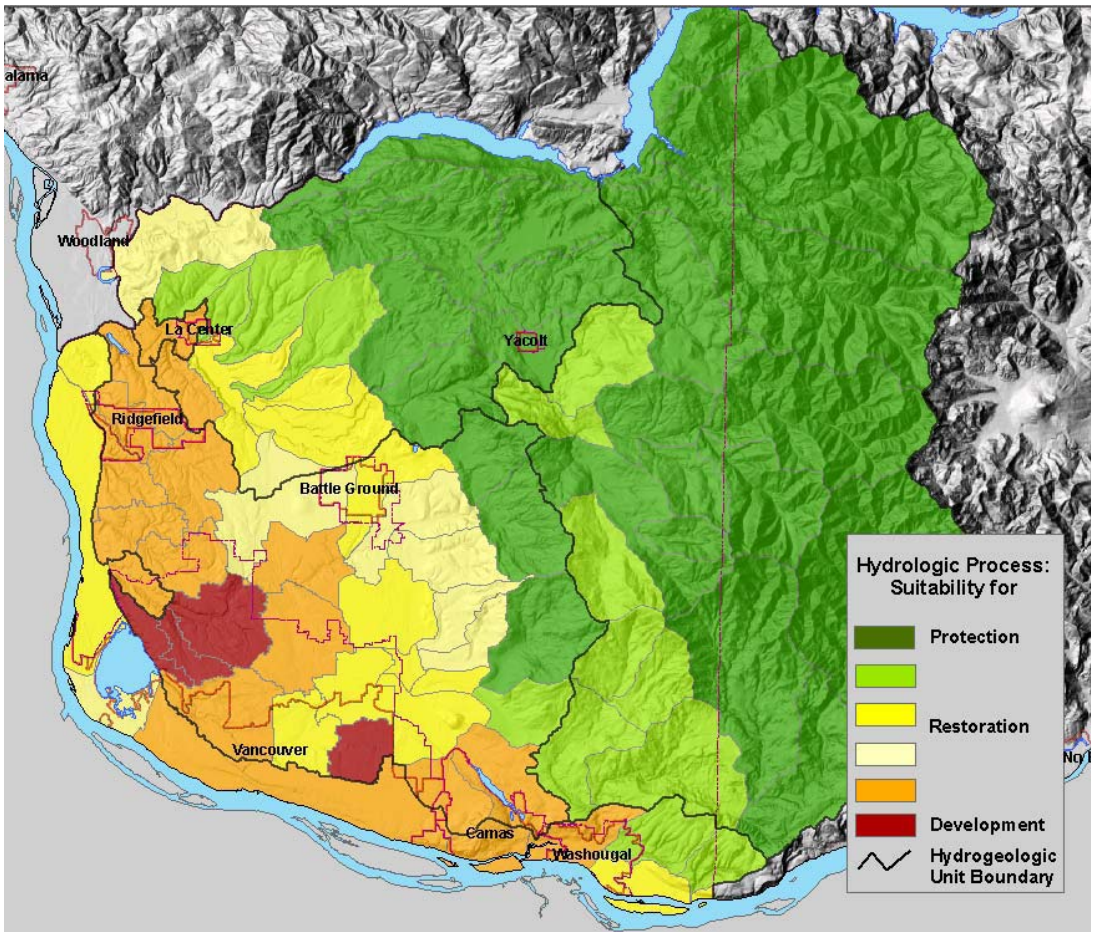

Figure 13: Priorities for suitability of areas for protection and restoration for the hydrologic process (from Draft Watershed Characterization of Clark County (Ecology, 2007)).

Macroinvertebrate Assessment

Purpose

The Benthic Macroinvertebrate Index of Biological Integrity, or B-IBI (Karr, 1998), is a widely used measure 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 chronic and acute pollutant sources, hydrology modifications, and habitat changes.

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

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

Methods

All field and laboratory work followed Clark County's standardized protocols for macroinvertebrate sampling and analyses (Clark County Public Works Water Resources, 2003). Samples are collected during late summer, preserved, and delivered to a contracted laboratory for organism identification, enumeration, and calculation of B-IBI metrics.

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

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

Gibbons Creek macroinvertebrate samples were collected at station GIB035, near Jemptegaard Middle School, during 2005 and 2006. (See Figure X in the Water Quality Assessment section).

Results

The Total B-IBI scores of 34 and 38 from the years 2005 and 2006 fall within the mid-to-upper range of moderate biological integrity (Table 18). The scores are

well within typical inter-annual B-IBI variability of less than five points observed for Puget Sound region streams (Karr 1998 and Law 1994) and in Clark County data.

Table 18: GIB035 Macroinvertebrate Community Metrics from 9/17/05 and 10/05/06

	2005			2006		
B-IBI Metrics	Value	Score	Category	Value	Score	Category
Total number of taxa	50	5	high	43	5	high
Number of Mayfly taxa	9	5	high	9	5	high
Number of Stonefly taxa	9	5	high	5	3	moderate
Number of Caddisfly taxa	7	3	moderate	7	3	moderate
Number of long-lived taxa	7	5	high	3	3	moderate
Number of intolerant taxa	2	1	low	2	1	low
Percent tolerant taxa	12	5	high	16	5	high
Percent predator taxa	5	1	low	6	1	low
Number of clinger taxa	35	5	high	30	5	high
Percent dominance (3 taxa)	51	3	moderate	58	3	moderate
Total B-IBI score		38	moderate		34	moderate

Results from 2005 and 2006 were very similar. Examining the individual metric results shows that only two metrics, Number of Intolerant taxa and Percent Predator taxa, had low ratings and remained so for both 2005 and 2006. The low scoring metrics for intolerant taxa and percent predators, suggest signs of degraded water and habitat quality since intolerant taxa are among the first organisms to disappear as human disturbances increase (Fore, 1999). Also, the site's low score for Percent Predators may reflect decreasing diversity in prey items.

As part of an earlier study to identify habitat restoration and protection opportunities within the Gibbons Creek watershed (U.S.F.W.S., 2003), macroinvertebrates were sampled in 1998 at several locations and scored using a slight variation on the standard B-IBI methodology. Samples rated "good" for Gibbons Creek reaches approximately one-half mile and further upstream from GIB035, as well as for the upper portion of its Campen Creek tributary. However, scores were poor for lower Campen Creek near the confluence with Gibbons Creek.

Booth et. al. (2004), found that there is a wide but well-defined range of B-IBI scores for most levels of development, but observed overall that B-IBI scores decline consistently with increasing watershed total impervious area. Figure 14 shows that GIB035 2005 and 2006 Total B-IBI scores fall in the middle to upper range of expected scores (estimated 2000 Total Impervious Area from Wierenga, 2005). By comparing Gibbons Creek to the likely range of conditions for watersheds with similar amounts of development, measured as impervious area, it

is possible to make some general statements about the potential benefits from improving stream habitat.

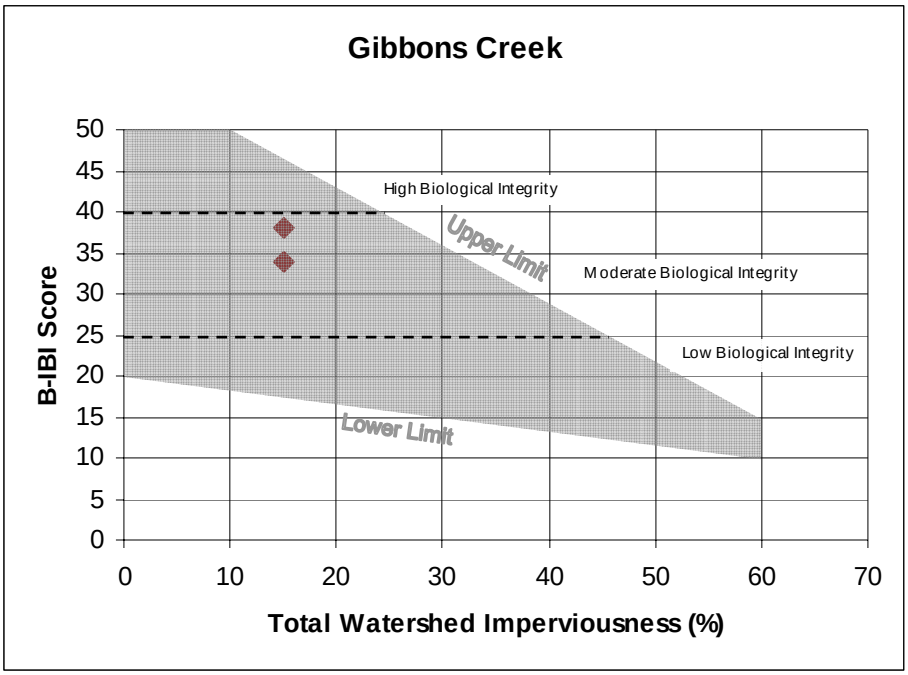

Figure 14: Approximate range of B-IBI in Puget Lowland watersheds, showing progressive decline with increasing imperviousness in the upstream watershed. Adapted from Booth et al., 2004. Markers indicate BIBI scores at GIB035 for 2005 and 2006, versus estimated 2000 subwatershed TIA.

Given that available Total B-IBI scores fall in the upper half of the expected range for a watershed with 15 percent impervious area, it is likely that other factors are supporting and contributing to better-than-average biological integrity. In particular, the GIB035 site is upstream from urbanized areas and its contributing area remains partly forested possibly due to its protection within the Columbia River Gorge Scenic Area.

These results suggest management strategies to protect existing stream condition are important for sustaining its moderately healthy biological status. They also imply that further slight increases to a high level of biological integrity may be possible if watershed conditions improve.

Physical Habitat Factors

Physical habitat is discussed in more detail in the Physical Habitat Assessment section. The latest survey of stream habitats within the Gibbons Creek watershed during 1998 and 1999 (USFWS, 2003), assessed physical habitat conditions for eleven stream reaches. One of the survey reaches, GC2, contains the GIB035 station location. Side channels, riffles, and pools were reported as one percent, 85 percent, and 13 percent, respectively, of the total habitat area in this reach. Substrate classes were reported as: 19 percent fines, 39 percent gravels, 24 percent cobble and 18 percent boulder. At less than 20 percent, the level of fines

was the lowest in the watershed and somewhat below reported degradation thresholds of around 30 percent (Hicks et al., 1991, Kondolf, 2000).

Additionally, the USFWS surveys indicated 85 percent riparian canopy density. However, the riparian zones were usually dominated by young alder trees, which were reflected in a predominantly small class of Large Woody Debris (LWD). The USFWS noted LWD was critical for sediment storage, stream stability, pool formation, and nutrient retention (Lassetre and Harris, 2001).

Overall, a combination of the following factors probably benefits the upper Gibbons Creek macroinvertebrate community: available habitat, steeper stream gradient, abundant gravel sources with relatively few fines and good riparian conditions albeit consisting mostly of young trees.

Water Quality

Continuous summer temperature data was collected at six stations, between 2004 and 2006 (Wierenga, 2006). While overall stream temperatures failed to meet state criteria, the station nearest GIB035 was usually in compliance. Monthly turbidity readings collected between 2004 and 2006 exceeded background conditions during 40 to 70 percent of sampling events throughout the drainage. Recent data do not suggest that water quality is seriously impairing the macroinvertebrate community; however, observed temperature and turbidity conditions are likely contributors to the low occurrence of predators and pollution-intolerant taxa.

Stormwater Management Recommendations

Based on moderate biological integrity and relatively intact habitat conditions in the unincorporated areas of Gibbons Creek, stormwater management efforts should support protection of existing intact habitat. Secondarily, projects to improve degraded areas may have significant benefits.

The USFWS (2003) concluded that the Gibbon's Creek watershed has four primary habitat impacts: habitat fragmentation due to road culverts, riparian vegetation removal, instream habitat simplification due to reduced LWD, and spawning habitat degradation from heavy inputs of fine sediment.

Suggested stormwater management activities that may protect and improve aquatic habitats include:

- Acquisition and preservation of high quality habitats.
- Storm sewer and roadside ditch screening for illicit discharge detection and elimination.
- Identification and mitigation of sediment sources through education, technical assistance, and enforcement.
- Riparian habitat improvement projects.

Fish Use and Distribution

Purpose

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

Methods

Fish distribution is mapped from existing Clark County GIS information, which reflect data collected and analyzed by the Northwest Indian Fisheries Commission (NWIFC). Fish distribution data for Clark County is available on the County's website.

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

- WDFW passage barrier database
- Salmon Scape (http://wdfw.wa.gov/mapping/salmonscape/)
- Clark County 1997 passage barrier data clarkgis\avdata\shapes\resource\fishpass.shp)
- 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 (roads.shp) with LiDAR-derived stream data from StrmCntr.shp.

Results/Summary

Distribution

The available evidence suggests that anadromous fish use of Gibbons Creek subwatershed includes both Coho salmon and winter steelhead (Figure X). The LCFRB has not assigned a Tier or Group designation to the Gibbons Creek subwatershed.

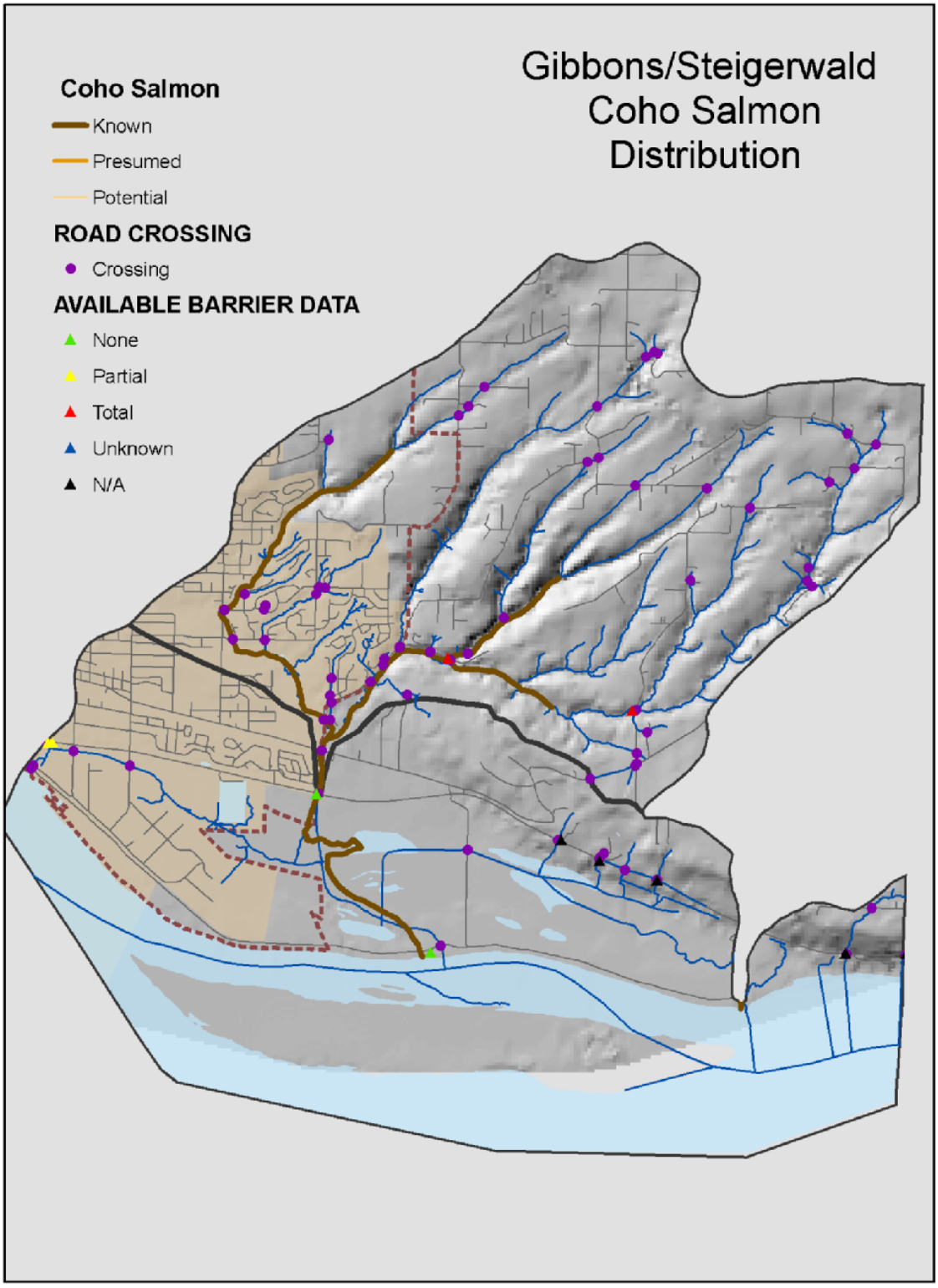

Figure 15: Coho Distribution and Barriers

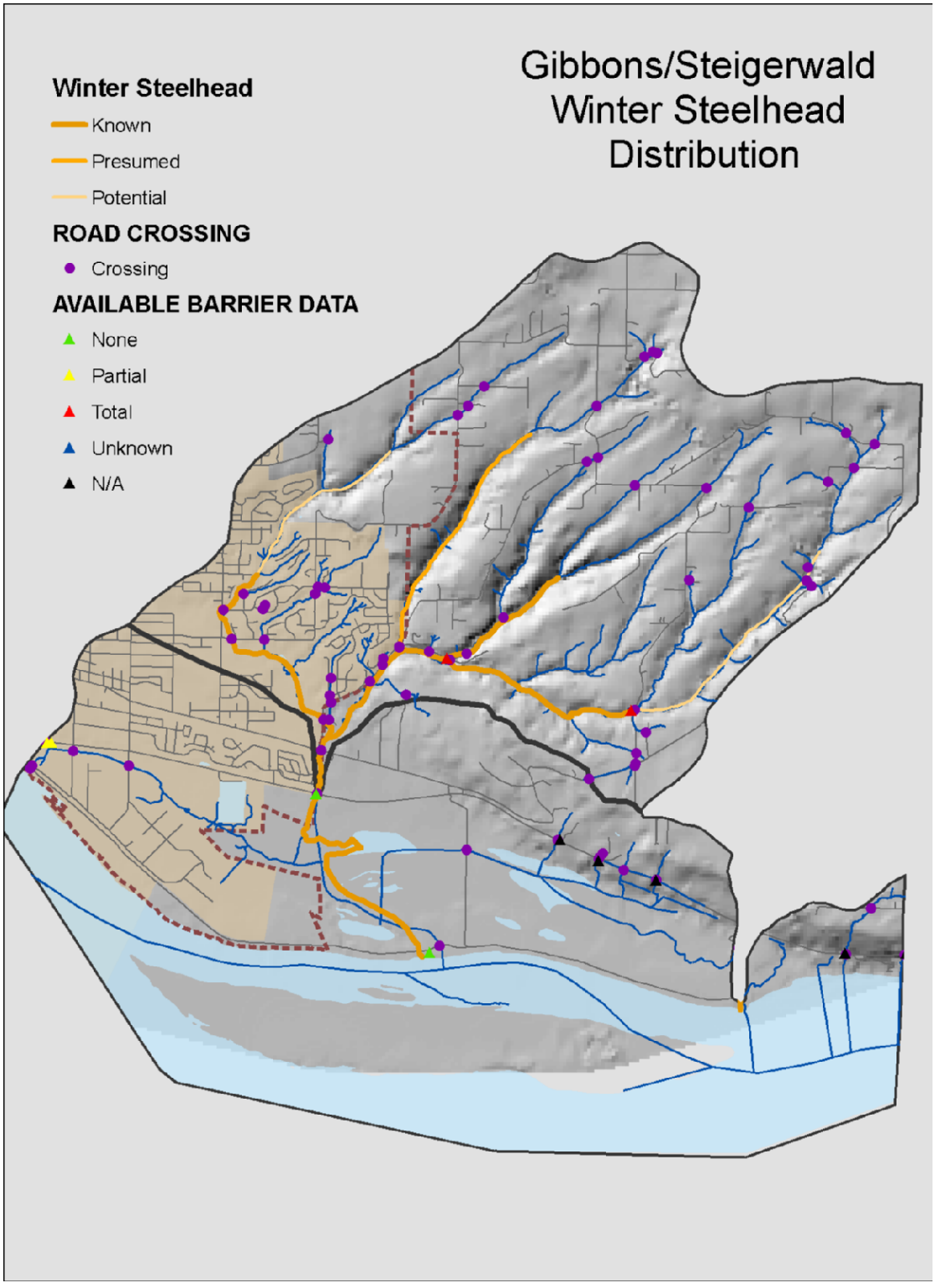

Figure 16: Winter Steelhead Distribution and Barriers

Barriers

The WDFW barrier database and the 2007 LCFRB Regional Culvert Survey provide the most complete assessment of barriers in the Gibbons Creek subwatershed (Figure X). There are two known blockages. The first is located where Sunset View Road crosses Gibbons Creek near the intersection with SE Wooding Road and the second is located where Hans Nagel Road crosses Gibbons Creek between Moffet Road and 40th Avenue.

There is an elevated fish passage channel that crosses the Steigerwald Refuge. This section of Gibbons Creek starts at the Columbia River and ends where the creek crosses SR 14, approximately 5,500 linear feet from the mouth.

Recommendations

Removal of the two known barriers is recommended. The barrier where Hans Nagel Road crosses Gibbons Creek is just downstream from another likely barrier that is located on private property. Replacing the barrier at Hans Nagel Road without also addressing the upstream barrier, would provide very little benefit to fish. In addition, barriers should be removed over time as stream crossing infrastructure is replaced or upgraded.

Overall recommendations for Gibbons Creek in the 2004 LCFRB Salmon and Steelhead Recovery Plan include restoring degraded water quality (with emphasis on temperature), restoring degraded hillslope processes, and providing for adequate instream flows.

Hydrologic and Hydraulic Modeling

Hydrologic and hydraulic modeling was not conducted for the Gibbons Creek watershed.

Analysis of Potential Projects

This section provides a brief summary of stormwater problems and opportunities, notes recently completed or current projects within the study area that may be relevant to SNAP project selection, describes the analytical approach, and lists recommended projects and activities for further evaluation. Projects or activities are placed in one of six categories.

Summary of Conditions, Problems, and Opportunities

Conditions and Problems

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

Coordination with Other Programs:

Gibbons Creek and Steigerwald combine to form a multi-jurisdictional watershed including US Fish and Wildlife property, the City of Washougal, and Clark County. Ecology is also involved in Gibbons Creek through an ongoing TMDL. All of the above-listed jurisdictions, as well as the Clark Conservation District, are actively participating in TMDL implementation and adaptive management activities.

A 2007 livestock survey conducted by CCD found relatively low animal numbers in the watershed and limited evidence of livestock-related water quality issues.

Future Phase II NPDES permit implementation by the City of Washougal should provide additional opportunities for coordination and leveraging with Clark County.

There are currently no major watershed-specific projects by other regional entities including LCFRB, Clark Public Utilities, and Clark County Transportation Improvement Program.

Broad-Scale Characterization:

Gibbons Creek soils fall primarily in Group C (poorly-drained). Stream gradients are steep and channels tend to lie in deep canyons cut into Troutdale gravels. Most of the watershed has little or no floodplain, with the exception of the Steigerwald subwatershed which lies entirely within the Columbia River floodplain.

Standard metrics based on NOAA fisheries standards indicate fairly good conditions for a Willamette Valley stream, with watershed-wide conditions meeting or nearly meeting functioning criteria for forest cover, TIA and EIA, road density, and stream crossing density. The Campen Creek tributary within the City of Washougal UGA has significantly higher levels of urbanization and impact than the remainder of Gibbons Creek.

Based on current and future predicted EIA and forest cover, channel stability in Gibbons Creek is uncertain. Campen Creek is slated to receive most of the new development, while outside the Washougal UGA little change in land use is likely.

Water Quality Assessment:
Gibbons Creek is 303(d) listed for fecal coliform under Category 4a (existing TMDL), and the remnant channel through Steigerwald is Category 2 listed (waters of concern) for arsenic, chromium, dissolved oxygen, pH, and temperature.

Adaptive management and implementation activities are ongoing for the fecal coliform TMDL.

The county Stream Health Report (2004) scored Gibbons Creek in the fair range for overall stream health, and a limited 2005 dataset indicated good water quality index scores.

Stream temperature was elevated during summer 2004 and 2005, exceeding current state criteria by one to five degrees F. Temperatures at the mouth of Gibbons Creek after flowing through the elevated channel were much higher than any other station, exceeding the state criteria by nearly 15 degrees F in 2004.

Based on 2004 through 2006 monitoring, fecal coliform pollution persists in the watershed, with seven of eight monitoring stations failing to meet one or both components of the state criteria. The Campen Creek tributary had consistently higher concentrations than Gibbons Creek.

Drainage System Inventory:
Drainage mapping is nearly complete. Additional inventory will be conducted in 2008 and 2009.

Stormwater Facility Inspection:
There were no public stormwater facilities in the unincorporated areas of Gibbons Creek at the time of the assessment.

Illicit Discharge Screening:
Screening conducted at 133 known stormwater outfalls did not discover any illicit discharges or connections.

Stream Reconnaissance Feature Inventory:
Significant stream impairments, potential environmental and safety hazards, and stormwater project opportunities were recorded for approximately 4.4 miles of stream corridor. A total of 90 significant features were identified, primarily impacted stream buffers. Sixty-eight potential projects were identified in six categories, with the majority being projects outside the scope of CWP activities

and subsequently recommended for referral to outside groups or agencies.

General observations from the feature inventory included:

- Predominant sources of stormwater are roads and overland flow draining to roadside ditches.
- Impacted buffers are prevalent throughout the watershed; although riparian forest canopy is well-established, the understory is dominated by invasive species. Japanese Knotweed was noted in several locations in the lower watershed.
- Stream channels are mostly stable, but exhibit simplified geometry.

During 2008, Ecology and CCD staff will conduct an additional feature inventory in Campen Creek within the Washougal UGA, with support from CWP and the City of Washougal.

Physical Habitat:
Surveys conducted by USFWS in the late 1990s indicated high levels of fine sediment, poor woody debris conditions, and good riparian canopy cover consisting primarily of young deciduous trees.

Geomorphology and Hydrology:
See Appendix A for results of these assessments. Results were not available at the time of report completion.

Riparian Assessment:
Gibbons Creek was not included in the 2004 LCFRB Habitat Assessment. A qualitative review of 2007 aerial photography suggests that LWD recruitment and shade conditions may be moderate to good.

Wetland Assessment:
Potential wetlands are almost non-existent in the unincorporated areas of Gibbons Creek subwatershed, while almost the entire Steigerwald subwatershed lies within the Columbia River floodplain and associated wetlands.

The Clark County regional wetland inventory did not recommend any mitigation opportunities within the Gibbons Creek or Steigerwald subwatersheds.

Ecology's draft wetland characterization places the watershed in categories suitable for wetland restoration and protection due to a relatively high level of importance for regional watershed processes and a relatively lower level of alteration from historical condition. The success of restoration or protection actions in the Steigerwald subwatershed is identified as being dependent upon protection of upstream contributing basins in Gibbons Creek.

Macroinvertebrate Assessment:
Based on samples collected in 2005 and 2006, Gibbons Creek exhibits moderate

biological integrity. Scores are near the middle of the predicted range of B-IBI scores for areas with similar TIA. It is possible that biological integrity could increase into the "high" category through improvements to habitat and stream conditions.

Fish Use and Distribution:
The available data suggests that anadramous fish use of Gibbons Creek includes Coho salmon and winter steelhead.

Gibbons Creek is not a regional priority for salmon recovery; however, the 2004 LCFRB Salmon and Steelhead Recovery Plan identifies restoration of degraded water quality and hillslope processes, as well as protection of adequate instream flows as priority recovery efforts.

There are two documented barriers in the watershed and a number of currently unassessed road crossings.

Recently Completed or Current Projects
There are no stormwater projects in Gibbons Creek under the 2007 through 2011 SCIP.

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

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

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

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

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

Emergency/Immediate Actions

None found.

Potential Stormwater Capital Projects

Stormwater Capital Facility Improvement Projects

Identifier	Issue	Project	Action
OT-35, 36, 39, 40-42	Ditch outfalls with no detention/treatment or energy dissipators	Retrofit ditches for detention/treatment; package as a single larger project or address as several small CIP <25K	Evaluate for 2008 SCIP

Stormwater Infrastructure Maintenance CIPs

No potential projects found.

Stormwater Class V Underground Injection Control projects:

None exist in Gibbons Creek.

Habitat Rehabilitation/Enhancement Projects

None are recommended for SCIP.

Property Acquisition for Stormwater Mitigation

No specific acquisition sites were discovered.

Follow-up Activities for Referral within CWP

Private Stormwater Facilities Maintenance

No problems documented.

Public Works stormwater infrastructure maintenance

No problems documented.

CWP Outreach/Technical Assistance

Identifier	Issue	Action
OT-37	Untreated roof drain piped directly to creek	Refer to CWP outreach for technical assistance visit
OT-38	Untreated roof drain piped directly to creek	Refer to CWP outreach for technical assistance visit
AP-10 and ER-4	Lack of riparian vegetation, both banks due to landscaping; severely eroding bank with no vegetation	Refer to CWP outreach; contact landowners about BMPs and CCD assistance

CWP Infrastructure Inventory

Identifier	Issue	Action
WQ-20	8-inch corrugated pipe outfall, unknown source	Refer to Infrastructure Inventory; conduct IDDE Screening

Projects for Referral to other Departments/Agencies/Groups

Identifier	Issue	Action
SC-86, 89, 90, 91, 94	Perched culvert outlets or hydraulics may be limiting fish passage	Refer to WDFW for possible barrier analysis
IB-67, 68, 69, 71	Japanese knotweed	Refer to Clark County Weed Board
SC-85	Old bridge being used as a dump site; significant accumulation of tires and trash	Refer to City of Washougal

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 Gibbons Creek subwatersheds, by permit component, include:

Storm Sewer Mapping and Inventory

- None; being completed by CWP.

Coordination of Stormwater Activities

- The City of Washougal is a Phase II permittee. The CWP is currently coordinating TMDL implementation activities with the City and should pursue future collaborative activities in response to permit requirements where feasible.

Mechanisms for public involvement

- Publish SNAP reports on CWP web page.

Development Regulations for Stormwater and Erosion Control

- Ecology has identified continued protection of intact hydrologic processes in Gibbons Creek as critical to floodplain restoration in the Steigerwald subwatershed. Future stormwater management actions should focus on limiting degradation of hydrologic processes.

Stormwater Source Control Program for Existing Development

- None.

Operation and Maintenance Actions to Reduce Pollutants

- Evaluate tools to reduce direct and indirect input of untreated stormwater from roads running parallel to streams by installing flow control and treatment facilities.

Education and Outreach to reduce behaviors that contribute stormwater pollution

Areas where increased outreach could improve stream conditions include:

- Perform targeted technical assistance responding to results of field assessments.
- Invasive plants are ubiquitous in Gibbons Creek and Clark County; eradication and/or control of these plants is beyond the resources of public agencies and requires actions by private landowners. Increased education and technical support would be beneficial, including removal techniques and lists of suggested plants for re-vegetation.
- Develop a process to promote the identification and reporting of Japanese Knotweed infestations

- Replace missing or deteriorated stream name signs.

TMDL Compliance

- Continue to support and participate in TMDL adaptive management and implementation activities
- During 2008, Ecology and CCD staff plans to conduct a feature inventory for Campen Creek within the Washougal UGA, with support from CWP and the City of Washougal.

Monitoring Stormwater Program Effectiveness

- None

References

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.

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.

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.

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 Marine Fisheries Service (NMFS) (1996). Making Endangered Species Act determinations of effect for individual or grouped actions at the watershed scale: National Marine Fisheries Service, Environmental Technical Services Division, Habitat Conservation Branch.

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.

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.

Schueler, T. (1999). Microbes and Urban Watersheds: Ways to Kill 'em. Watershed Protection Techniques. 3(1): 566-574.

SP 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.

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.

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 State Department of Ecology website: http://www.ecy.wa.gov/programs/wq/303d/2002/2004_documents/wq_assessment_cats2004.html

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 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 Department of Ecology (April 2006). Draft Watershed Characterization of Clark County, Version 3: Shorelines and Environmental Assistance Program.

Wierenga, R. (January 2005). Subwatershed Characterization and Classification: Clark County Water Resources Program, Vancouver, Washington.

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

Appendices

Appendix A — Geomorphology and Hydrology Assessment