2010 Stormwater Needs Assessment Program

Cedar Creek (Upper)/Chelatchie Creek Subwatershed Needs Assessment Report

Clark County Department of Environmental Services

March 2011

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Acronyms and Abbreviations

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

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

Executive Summary

Study Area

This Stormwater Needs Assessment report includes the Cedar Creek (Upper) and Chelatchie Creek subwatersheds in the North Fork Lewis River watershed.

Intent

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

Findings

Watershed Conditions

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

Ongoing Projects and Involvement

The DES coordinates with the Washington Department of Ecology, Lower Columbia Fish Recovery Board and Vancouver-Clark Parks and Recreation in efforts to improve stream health. Fish First is active in fish recovery efforts in the Cedar Creek watershed.

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

Category	Status
Water Quality	
Overall	• Good in both; Chelatchie Creek ranked third best among 15 monitored creeks as of 2007
Fecal coliform bacteria	• Meets standards
Temperature	• Chelatchie Creek 303(d) listed as a water of concern for temperature; Cedar Creek (Upper) not listed • Available data suggests Chelatchie colder than Cedar
Biological	
Benthic macroinvertebrates	• Moderate biological integrity • Any decline in upper Chelatchie Creek would cause fall to poor category; any increase in Cedar Creek would cause rise to good
Anadramous fish	• Coho, fall and spring Chinook, and winter steelhead; moderate regional recovery priority
Habitat	
NOAA Fisheries criteria	• Road density falls into the Non-Functioning category • Stream crossing density is in the Properly Functioning category; impervious area and forest cover are between Properly and Not Properly Functioning thresholds
Riparian	• Cedar Creek rated 'moderately impaired'; Chelatchie 'impaired' • Large woody debris recruitment potential is variable, ranging from poor to good • Shade levels are below state targets
Wetland	• Wetlands 10 percent of overall area • Primarily associated with main stream channel; Chelatchie has large complexes primarily in pasture and fields • Opportunities for improvement are limited; protection and restoration of hydrologic processes recommended
Hydrology and Geomorphology	
Overall hydrology	• At or near natural forested conditions
Future condition	• Projected impervious area should remain at levels that do not alter hydrology if forest cover is retained or expanded
Stormwater (unincorporated areas)	
System description	• Limited infrastructure, primarily road-side ditches; 4 stormwater facilities (zero public)
Inventory status	• Complete; 2510 stormwater infrastructure features mapped
System adequacy	• Largely unknown
Retrofit opportunity	• None
Maintenance evaluation	• No public facilities
Offsite assessment	• 22 offsite assessments conducted; all sites in compliance

Opportunities

No specific project opportunities were discovered in this assessment area.

Riparian restoration:

There are numerous locations where riparian areas are narrow or absent. Reforestation of these areas would provide improved LWD recruitment and channel shading and should be encouraged. No specific projects were identified because Clark County owns little land in this area. In most cases, working with private landowners would be required.

Non-project recommendations address activities that may promote more effective mitigation of stormwater problems or overall stream improvement. Management recommendations relevant to the assessment area include:

- Conserve existing agricultural and forest lands and promote healthy practices
- Restore stream channels
- Protect and/or enhance existing wetlands
- Encourage and support riparian planting efforts by private landowners

Introduction

This Stormwater Needs Assessment includes the Cedar Creek (Upper) and Chelatchie Creek subwatersheds in the Lewis River watershed. The Clean Water Program (CWP) is gathering and assembling information to support capital improvement project (CIP) planning and other management actions related to protecting water bodies from stormwater runoff.

Purpose

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

The overall goals of SNAP are to:

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

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

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

Scope

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

SNAP reports produce information related to three general categories:

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

Descriptions of potential projects and recommended program management actions are provided to county programs, including: Public Works CWP, Stormwater Capital Improvement Program (SCIP) and Development Engineering; Community Planning; Public Health; Legacy Lands; ESA. Potential project or leveraging opportunities also are referred to local agencies, groups and municipalities as appropriate.

Assessment Approach

Priorities for Needs Assessment in Cedar Creek (Upper) and Chelatchie Creek

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

For SNAP purposes, the Cedar Creek (Upper) subwatershed is categorized as "Largely Forested Land." Subwatersheds in this category contain significant amounts of private land zoned for industrial forestry and DNR forest lands. These areas have few county roads and stormwater management is limited to mapping and evaluating the area draining to county outfalls, and possible habitat protection or restoration to mitigate for stormwater impacts to other parts of a watershed.

The Chelatchie Creek subwatershed is categorized as "Rural Residential with No UGA." Subwatersheds in this category are generally not heavily forested but have limited stormwater management needs due to the lack of urbanization. Assessment efforts for these subwatersheds focus primarily on summarizing existing information to identify potential restoration projects.

Assessment Tools Applied in Cedar Creek (Upper) and Chelatchie Creek

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

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

Table 1: Stormwater Needs Assessment Tools

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

Assessment Actions

Outreach Activities

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

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

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

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

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

Review of Existing Data

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

- LCFRB Habitat Characterization (2004)
- LCFRB 6-Year Habitat Workplan
- Ecology 303(d) list
- WRIA 27/28 Plan
- Ecology EIM data
- Clark County 2004 Subwatershed summary

- Clark County 2010 Stream Health Report
- Clark County LISP/SCMP/ Project data
- Clark County 6-Year TIP

Broad-Scale GIS Characterization and Metrics

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

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

The characterization includes three components:

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

Map Products

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

General Conditions and Subwatershed Metrics

General Geography

The study area comprises two Cedar Creek subwatersheds in the North Fork Lewis watershed. Cedar Creek drains to the North Fork Lewis River near the city of Woodland. Land use in the study area is primarily forest and some agriculture. There is little developed area, mostly centered around Amboy, WA (Figure 1). Non-forested areas tend to be flatter areas cleared long ago for agriculture.

Topography

Historically, mountain glaciers covered most of the study area. Receding glaciers left behind alluvial and terraced valleys and bedrock hills locally mantled by glacial till. Cedar Creek follows a large, roughly east-west trending valley. Chelatchie Prairie is a notable feature, sloping from Tukes Mountain down to the town of Amboy. Most of the area outside of Chelatchie Prairie is low mountains cut by steep stream valleys.

Geology and Soils

Volcanic and shallow intrusive rocks underlie the study area. Alluvial processes have been strongly influenced by regional uplift of the Cascade Range. Glaciation and structural deformation in the Cascade Range shaped the terrain, forming valleys containing glacial and alluvial deposits underlying Chelatchie Prairie. Outside of Chelatchie Prairie, glacial till deposits cover much of the area.

Soils are primarily well-drained Cinebar Silt Loam. Slopes in the study area are varying but are primarily 8-20 percent, with significant portions up to 70 percent.

Hydrology

Geology and topography play the main role in determining hydrologic framework. Steep slopes in the Cedar Creek tributaries carrying sediment and available gravel in glacial and alluvial deposits along Cedar Creek create a pool-riffle morphology.

Other than Chelatchie Creek, tributary streams in the study area drain primarily forest and some agriculture lands. The stream hydrology is at or close to natural forested conditions. There are no stream gauges in the study area.

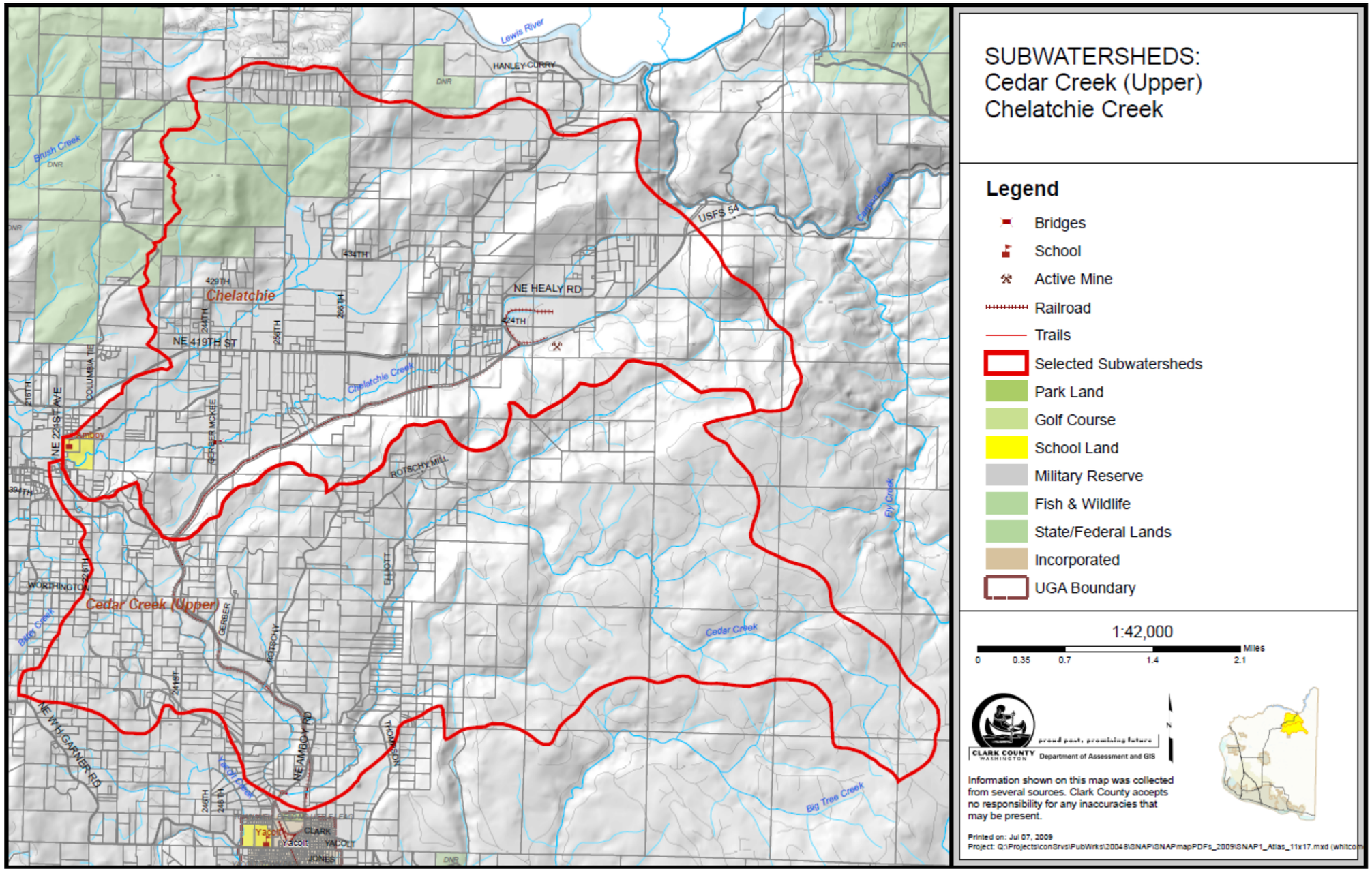

Figure 1: Subwatershed Map: Cedar Creek (Upper) and Chelatchie Creek

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

Overall, these metrics suggest that the study area has partially functioning stream habitat (Table 2) with road density and percent forested being of concern.

Table 2: Watershed Scale Metrics

Metric	Cedar Creek (upper)	Chelatchie	Functioning	Non-functioning
Percent Forested (2000 Landsat)	50.0	50.0	> 65 %	< 50 %
Percent TIA (2000 Landsat)	8.7	8.6	< 5 %	> 15 %
Road Density 2007 data (miles/mile2)	6.38	5.48	< 2	> 3
Stream Crossing Density (crossings per stream mile)	2.03	2.15	< 3.2/mile	> 6.4/mile
Percent EIA estimated from the Comprehensive Plan	0.59	3.27	< 10 %	> 10 %

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

The study area encompasses one of the least developed areas of Clark County, primarily rural residential and commercial logging. The 2000 Landsat land cover tends to underestimate forest cover due to difficulty separating recently logged forest land from urban land covers. Based on 2009 aerial photography, forest cover in Upper Cedar Creek is much greater than 50 percent.

TIA (Total Impervious Area)
Total impervious area is one of the most widely used indicators of urbanization and coincident watershed degradation (Center for Watershed Protection, March 2003). Total impervious areas are estimated from land cover data in Hill and Bidwell (January 2003). While various

organizations and publications categorize stream condition based on TIA, the NOAA fisheries standard is less than 5 percent as fully functional and greater than 15 percent as non-functioning. Values for both subwatersheds are just beyond the threshold for functioning habitat.

Road Density
Road density, including all public and private roads, is an easily calculated development measure. Based on criteria set by NOAA Fisheries to protect salmon habitat, road densities are close to twice as dense as the threshold for non-functioning (>3 road miles/mi^2).

Stream Crossing Density
Stream crossing densities are easily measured using available road and stream channel data. The salmon protection standard considers larger fills more than 60 feet wide, which would be approximately five- to 10-foot high road fill. The study area subwatersheds both have stream crossing densities in the functioning category (<3.2 crossings/stream mile NOAA Fisheries criteria).

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

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

Estimated Channel Stability Based on Forest and EIA
In a recent publication by Booth, Hartley, and Jackson (June 2002), a relationship between forest and percent EIA was presented as a graphic (**Error! Reference source not found.**). According to this figure, streams in the Cedar Creek (Upper) would be expected to be fairly stable. Chelatchie Creek, however, has uncertain channel stability.

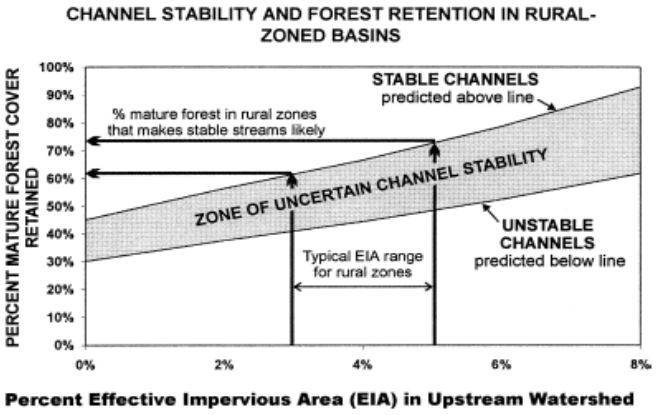

Figure 2: Channel stability in rural areas (Booth, Hartley and Jackson)

Water Quality Assessment

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

Water Quality Criteria

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

Under Washington state water quality standards, the Lewis River from Houghton Creek (including tributaries) to Lake Merwin is to be protected for the designated uses of: "Core Summer Salmonid Habitat; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values" (WAC 173-201A-600, Table 602).

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

Table 3: Applicable Water Quality Criteria for Cedar Creek (Upper) and Chelatchie Creek Subwatersheds

Characteristic	Ecology criteria
Temperature	≤ 16° C (60.8° F)
Dissolved Oxygen	≥ 9.5 mg/L
Turbidity	shall not exceed 5 NTU over background when background is 50 NTU or less
pH	6.5 – 8.5 units
Fecal coliform bacteria	Geometric mean fecal coliform concentration not to exceed 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 2008 303(d) list of impaired waters is on the Ecology website at: http://www.ecy.wa.gov/programs/wq/303d/index.html

Chelatchie Creek is Category 2 listed (Waters of Concern) for dissolved oxygen. There are no listings in the Cedar Creek (Upper) subwatershed.

Clark County Stream Health Report

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

Based on the available dataset, including water quality, biological health and stream flow patterns, overall stream health in the Cedar Creek (upper) and Chelatchie Creek subwatersheds scored in the fair range.

The 2010 Stream Health Report may be viewed on the county website at: http://www.clark.wa.gov/water-resources/stream.html.

Available Data

A considerable dataset is available for this assessment area. However, the majority of the data comes from the Chelatchie Creek subwatershed.

A full review and summary of available data and studies are beyond the scope of this document. This summary focuses on water quality data collected by the CWP, including monthly water quality data from Chelatchie Creek (2002 - 2009) and temperature data collected during the summer of 2004. Associated reports may be viewed on the CWP website at: http://www.clark.wa.gov/water-resources/documents-monitoring.html#strmac

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

Table 4: Data Sources

Source	Data and/or Report
Clark County Clean Water Program	2002-2009 Long-term Index Site Project 2010 Stream Health Report Benthic Macroinvertebrate and Water Temperature Monitoring for Clark County Watershed Assessments in 2004
Clark Public Utilities	CPU routine monitoring

Water Quality Summary

Long-term monthly data and summer temperature data are collected at Station CHL010 (Chelatchie Creek at SR 503).

Stream temperature was recorded continuously during summer 2004 at the following stations:

- CED070 (Cedar Cr upstream of Amboy)
- CED080 (Cedar Cr upstream of CC RR culvert)

- CHL030 (Chelatchie Creek (Chelatchie Cr upstrm of NFk confl)

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 calculated.

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

Since 2003, annual OWQI scores for CHL010 have ranged from 72 to 88, with scores in the 'good' category in six of seven years. The most recent dataset in WY2009 fell in the upper end of this range with an OWQI score of 86. Among 15 long-term monitoring stations countywide between 2002-2006, Station CHL010 ranked third-best in overall water quality (Hutton and Hoxeng, 2007).

Monthly OWQI values in WY2009 ranged from Fair to Excellent, although for most months (eight out of 12 months sampled) OWQI values were in the Good or Excellent categories. Monthly sub-index scores for fecal coliform, temperature and dissolved oxygen were consistently excellent, but every score for nitrogen was in the poor range. Total phosphorus scores were typically excellent, with a few scores in the good range. Total solids scores were in the fair category for seven of 12 months; scores were poor for the other five months. Scores for pH ranged from poor to excellent.

Trends Over Time
An analysis of potential statistical trends in OWQI scores based on the 2002-2006 dataset found no significant trends in water quality at Station CHL010.

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

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

Total phosphorus samples from Station CHL010 during WY2009 ranged from 0.010 mg/L to 0.092 mg/L. No samples exceeded the EPA criterion.

Turbidity

The exact background turbidity level for the assessment area is difficult to establish because no data exist from a time when it was not impacted by human activities. However, based on data from the least-impacted streams monitored by 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 is likely between 5.5 and 7 NTU.

The median of 12 samples collected in WY2009 was 3 NTU, with a range of 1 to 4 NTU.

Fecal Coliform Bacteria

Based on 12 monthly samples collected in WY2009, fecal coliform levels met both parts of the state criteria. Geometric mean concentration at Station CHL010 was 20 cfu/100mL and the 90th percentile value was 80 cfu/100mL. One of 12 samples (8 percent) exceeded 100 cfu/100mL.

Stream Temperature

One summer of continuous temperature monitoring (2004) at Stations CED070, CED080 and CHL030 indicated that water temperature in Cedar Creek exceeded target levels, while Chelatchie Creek met target levels. The maximum of the 7-day moving average of daily maximum temperatures (7-DAD Max) at the time of the study was not to exceed 64º F. As of 2006, the temperature criterion changed to 60.8º F for all of these stream segments. Table 5 summarizes results from all three stations.

Table 5: Cedar Creek and Chelatchie Creek water temperature summary, summer 2004. Adapted from Wierenga, November 2005)

Station	Date	7-DADMax temperature	Duration >64 deg F
CHL030	7/26/04	62.7	0
CED070	7/25/04	67.1	36
CED080	8/13/04	68.2	38

Due to the negative effects of chronic high temperatures on salmonids and other cold-water biota, the amount of time spent with elevated temperatures also is of interest. Table 5 indicates the number of days on which the *daily* maximum temperature exceeded 64º F at each station. Sixty-four degrees was the Class A criterion prior to November 2006 and is a threshold above which salmonids are known to suffer deleterious effects. At the Cedar Creek stations, daily temperatures exceeded 64º F on nearly 40 days in July and August. Daily temperature at CHL030 never exceeded 64º F.

Impacts to Beneficial Uses and Potential Sources

General water quality in this assessment area is good according to the overall OWQI and other measures discussed above. Observed water temperatures may have negative impacts on the listed beneficial uses of core summer salmonid habitat. Table 6 at the conclusion of this section

summarizes the primary water quality impacts to beneficial uses in the study area and probable sources of the observed impact.

Implications for Stormwater Management

Table 6 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 contribute to water quality improvement.

Table 6: Known Water Quality Concerns, Sources and Solutions for Chelatchie Creek

Characteristic	Beneficial Use Affected	Potential Sources	Mechanism	Solutions (bold indicates direct Clean Water Program involvement)
Water temperature	Core summer salmonid habitat	vegetation removal	direct solar radiation	**Streamside planting/vegetation enhancement/riparian preservation through acquisition** **Education programs** Pond removal or limitation
		low summer flows	decreased resistance to thermal inputs	

Drainage System Inventory and Condition

Inventory

Clark County's drainage system inventory resides in the StormwaterClk GIS database and is available to users through the county's GIS.

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

Table 7 indicates the number of features currently inventoried in StormwaterClk. Of the 4 stormwater facilities, none is publicly owned and operated.

Table 7: Drainage System Inventory Results, Cedar Creek (Upper)/Chelatchie Creek

Database Feature Category	Inventoried prior to 2007	Added during 2007-2009	Total Features
Inlet	1	48	47
Discharge Point (outfall)	0	422	422
Flow Control	0	2	2
Storage/Treatment	1	28	29
Manhole	0	2	2
Filter System	0	0	0
Channel	7	1322	1329
Gravity Main	90	583	673
Facilities	3	1	4

Condition

Stormwater system condition is assessed based on three components:

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

Component 1: Retrofit Evaluation

Purpose

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

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

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

Results
Based on the county's StormwaterClk database, as of August 2010, there were no mapped public stormwater facilities in the Cedar Creek (Upper) and Chelatchie Creek subwatersheds.

Component 2: Inspection and Maintenance Evaluation

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

Methods
The inspection and maintenance evaluation is conducted at public stormwater facilities in conjunction with retrofit evaluations. Evaluations are done at public stormwater facilities that contain detention ponds, treatment wetlands, wet ponds, pre-settling cells, open filters or bioswales and discharge to surface waters or stormwater drainage infrastructure that eventually discharges to surface waters.

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

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

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

Results
Based on the county's StormwaterClk database, as of August 2010, there were no mapped public stormwater facilities in the Cedar Creek (Upper) and Chelatchie Creek subwatersheds.

Component 3: Offsite Assessment

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

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

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

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

Stormwater outfalls are prioritized into three categories:

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

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

Results
Based on the county's StormwaterClk database, as of August 2010, 144 mapped outfalls were in the Cedar Creek (Upper) subwatershed and 151 mapped outfalls in Chelatchie Creek subwatershed were discharging to critical areas.

In the Cedar Creek (Upper) subwatershed, there were 10 Priority 1 outfalls, 13 Priority 2 outfalls and 121 Priority 3 outfalls.

In the Chelatchie Creek subwatershed, there were eight Priority 1 outfalls, seven Priority 2 outfalls and 136 Priority 3 outfalls.

Figure 3 and Figure 4 summarize notable outfall assessment activities, including general outfall locations in each subwatershed.

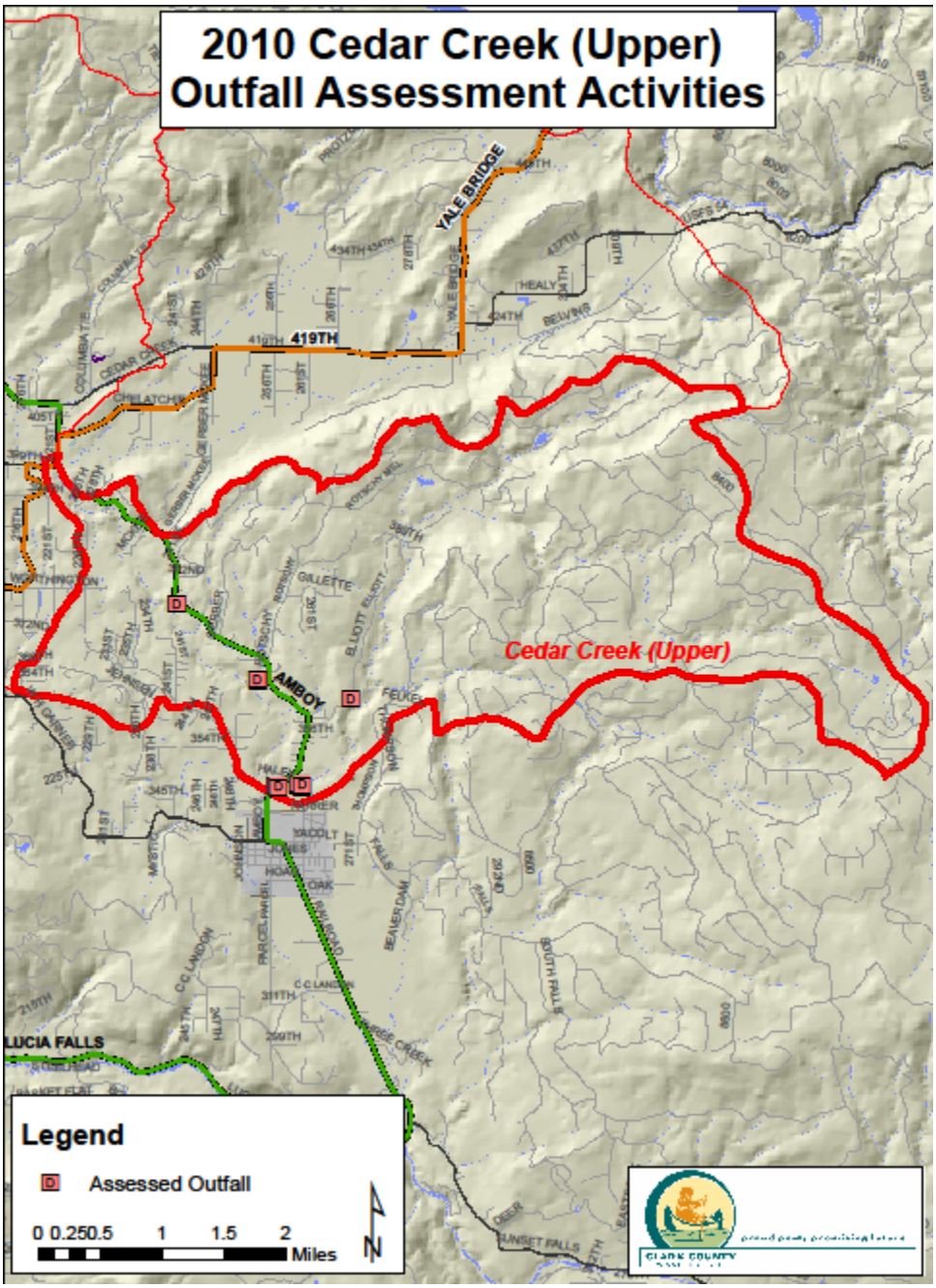

Figure 3: Summary of 2010 Off-site Assessment Activities in the Cedar Creek (Upper) subwatershed

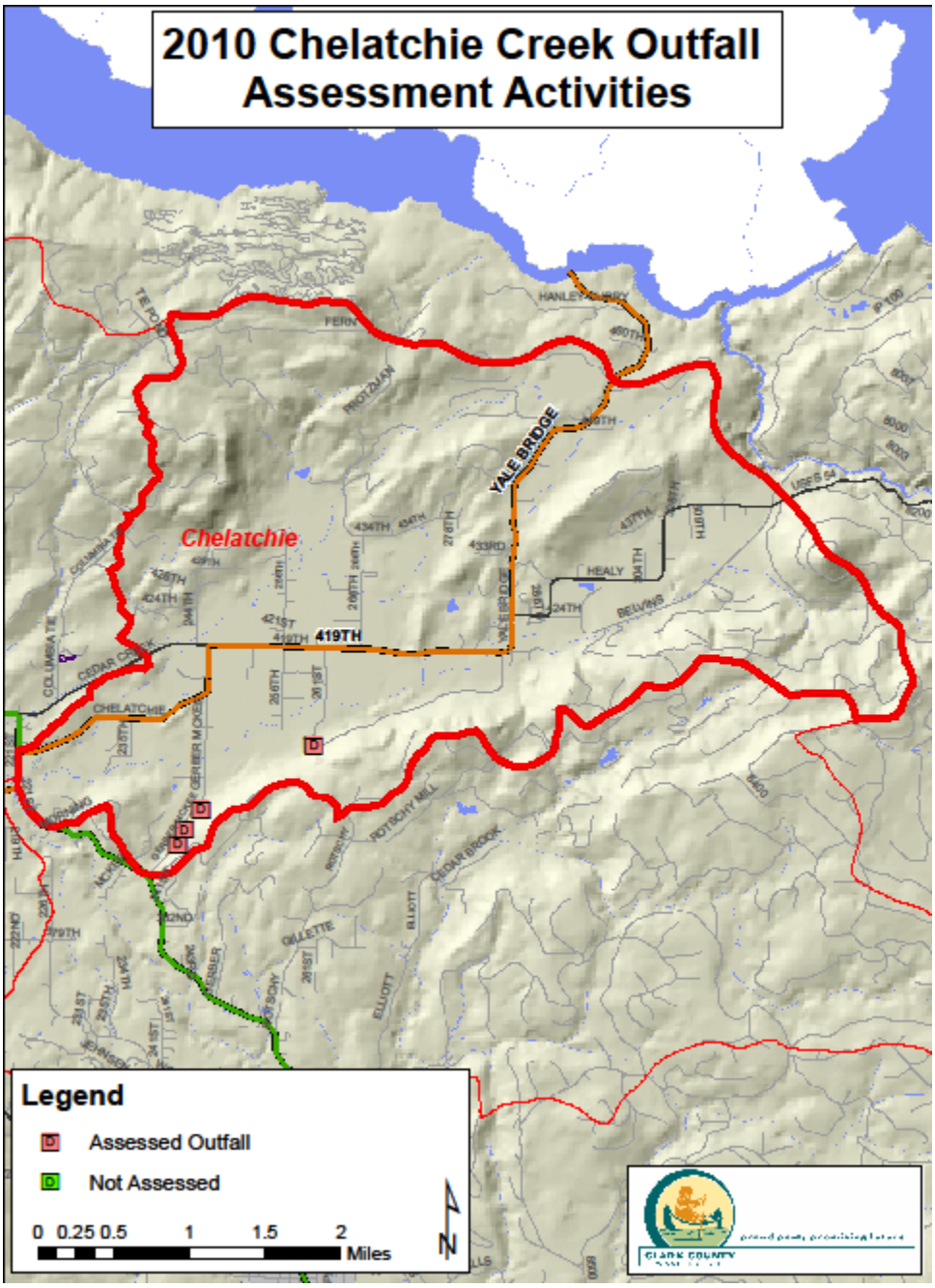

Figure 4: Summary of 2010 Off-site Assessment Activities in the Chelatchie Creek subwatershed

Table 8 summarizes results from Cedar Creek (Upper) subwatershed. There were 144 mapped outfalls discharging to critical areas. Ten Priority 1 outfalls were assessed and found to be in compliance. One Priority 2 outfall was assessed and found to be in compliance, and 12 other Priority 2 outfalls were not assessed. Four Priority 3 outfalls were assessed and found to be in compliance, and 117 other Priority 3 outfalls were not assessed.

Table 8: 2010 Off-site Assessment Project Activity Summary for Cedar Creek (Upper) subwatershed

Metric	Number of Outfalls		
	Priority 1	Priority 2	Priority 3
Total number of mapped outfalls	10	13	121
# of outfalls assessed	10	1	4
# of outfalls compliant	10	1	4
# of noncompliant outfalls	n/a	n/a	n/a
# of referrals initiated	n/a	n/a	n/a
# of referrals ongoing	n/a	n/a	n/a
# of outfalls fixed	n/a	n/a	n/a

Table 9 summarizes results from the Chelatchie Creek subwatershed. There were 151 mapped outfalls discharging to critical areas. Seven Priority 1 outfalls were assessed and found to be in compliance. One of the eight Priority 1 outfalls was inaccessible and not assessed. Seven Priority 2 outfalls and 136 Priority 3 outfalls were not assessed.

Table 9: 2010 Off-site Assessment Project Activity Summary for Chelatchie Creek (r.m. 00.60) subwatershed

Metric	Number of Outfalls		
	Priority 1	Priority 2	Priority 3
Total number of mapped outfalls	8	7	136
# of outfalls assessed	7	0	0
# of outfalls compliant	7	n/a	n/a
# of noncompliant outfalls	n/a	n/a	n/a
# of referrals initiated	n/a	n/a	n/a
# of referrals ongoing	n/a	n/a	n/a
# of outfalls fixed	n/a	n/a	n/a

Potential Projects
The offsite assessment project yielded no potential project opportunities.

Management Recommendations

Drainage system inventory is an ongoing CWP work effort focused on updating the StormwaterClk database to include all existing stormwater drainage infrastructure. Prior to 2007, stormwater drainage infrastructure in the Cedar Creek (Upper) and Chelatchie Creek subwatersheds included 102 objects. In 2007-2009, an additional 2,408 previously unmapped objects were added to the StormwaterClk database.

Since there were no mapped public stormwater facilities found in the Cedar Creek (Upper) and Chelatchie Creek subwatersheds, retrofit and inspection and maintenance evaluations were not conducted. Education and public outreach efforts focusing on private stormwater facility owners are needed to help maintain stormwater facility maintenance standards in Clark County's Stormwater Facility Maintenance Manual.

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

Illicit Discharge Detection and Elimination Screening

Illicit discharge screening was not conducted.

Source Control

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

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

Methods
Under the County's 2007 NPDES municipal stormwater permit, each year staff is required to visit 20 percent of businesses that perform one of many potential pollution-generating activities listed in the

permit. Additionally, the permit requires visits to any business with a paved parking area. To simplify project planning and tracking, the CWP plans to visit 20 percent of all county businesses each year.

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

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

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

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

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

Results

In 2010, staff visited all the businesses required under the NPDES permit in the Cedar Creek (Upper)/Chelatchie Creek subwatershed. Table 10 summarizes source control activities.

Table 10: Source Control Project Summary, Cedar Creek (Upper)/Chelatchie Creek subwatershed

Metric	Number
Number of sites visited	31
Number of sites with source control issues	7
Number of repeat visits	0
Number of sites with issues successfully resolved	7
Number of sites referred to other agencies	0

Overview
The Cedar Creek (Upper)/ Chelatchie Creek subwatershed is located in northeastern Clark County. This subwatershed lies north of the Town of Yacolt and contains the rural business centers of Amboy and Chelatchie Prairie.

Type 4 parcels include a school and the businesses around Amboy and Chelatchie Prairie. This subwatershed should remain a priority for future Type 4 (business) source control site visits.

Stream Reconnaissance and Feature Inventory

A stream reconnaissance and feature inventory was not conducted.

Physical Habitat Assessment

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

Methods
Physical habitat measurements were made for one reach of Cedar Creek (Cedar Creek 6, RM 11.1 to RM 17.9) and one reach of Chelatchie Creek (Chelatchie Creek 2, RM 0.5 to RM 5.1) by R2 Resource Consultants, Inc. (December 2004) for the Lower Columbia Fish Recovery Board. The project followed modified USFS Level II Stream Reach Inventory protocols.

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

The Cedar Creek 6 survey reach is classified as a moderate gradient mixed control channel type. The reach has a map gradient of 1-2 percent. The channel is forced pool-riffle and plane bed, and confinement is moderate to high. Habitat consists primarily of small riffles and pools (35 percent and 57 percent of the survey reach habitat by length, respectively). The maximum depth of pools averages 0.7 m.

R2 noted that the dominate and subdominant substrate classes of streambed riffles are comprised of gravel (48 percent) and sand (32 percent). Embeddedness is rated in each habitat unit according to four categories (0-25%, 25-50%, 50-75% and 75-100%). The overall mean embeddedness level is 42 percent.

Table 11 summarizes habitat evaluations based on Washington Conservation Commission and NOAA Fisheries Properly Functioning Condition standards.

Table 11 Summary of Habitat Evaluations of Upper Cedar Creek (Cedar Creek 6 Survey Reach) Based on Washington Conservation Commission and NOAA Fisheries Properly-Functioning Condition Standards

Parameter	WCC[1]	PFC[2]
% Pool by Surface Area	Poor	
Pool Frequency		Not properly functioning
Pool Quality	Fair	At risk
LWD	Poor	Not properly functioning
Substrate	Poor	Not properly functioning
Streambank Stability	Good	Properly functioning
Water temperature	Poor	Not properly functioning
[1] Available Ratings: Good; Fair; Poor		
[2] Available Ratings: Properly Functioning; At Risk; Not Properly Functioning		

The Chelatchie Creek 2 survey reach is classified as a very low gradient, unconfined Palustrine channel. The reach has a map gradient of 0.5 percent. This channel type is typically dune-ripple sequences formed of sand and small gravel. Habitat consists primarily of pools, which represent 52 percent of the survey reach habitat by length, followed by glides (35 percent) and small riffles (13 percent). The maximum depth of pools averages 0.7 meter.

R2 noted that the dominate and subdominant substrate classes of streambed riffles are comprised of gravel (50 percent) and sand (44 percent). The overall mean embeddedness level is 66 percent. Table 12 summarizes habitat evaluations based on Washington Conservation Commission and NOAA Fisheries Properly Functioning Condition standards.

Table 12: Summary of Habitat Evaluations of Chelatchie Creek (Chelatchie 2 Survey Reach) Based on Washington Conservation Commission and NOAA Fisheries Properly-Functioning Condition Standards

Parameter	WCC[1]	PFC[2]
% Pool by Surface Area	Fair	
Pool Frequency		Not properly functioning
Pool Quality	Fair	At risk
LWD	poor	Not properly functioning
Substrate	poor	Not properly functioning
Streambank Stability	good	Properly functioning
Water temperature		
[1] Available Ratings: Good; Fair; Poor		
[2] Available Ratings: Properly Functioning; At Risk; Not Properly Functioning		

Geomorphology Assessment

A geomorphology assessment was not conducted.

Riparian Assessment

Purpose

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

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

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

Method

Where possible, the assessment is based on GIS data from existing reports, primarily the Habitat Assessment reports prepared for the Lower Columbia Fish Recovery Board (R2 Resource Consultants, Inc., 2004). Summary information from the Draft Shoreline Inventory and Characterization also is reviewed (ESA Adolfson, June 2010). 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 exist from the LCFRB characterization, an examination of current orthophotographs is used to make a general assessment of riparian condition and identify areas where restoration or preservation projects may be appropriate.

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

The 2004 LCFRB Habitat Assessment report, 2010 Draft Shoreline Inventory and Characterization Report and aerial photographs also were reviewed for specific project opportunities in each subwatershed. Potential project sites have been reviewed and verified through field reconnaissance and are detailed in the results.

Results

Results are based primarily on the 2004 LCFRB Habitat Assessment for the Cedar Creek (Upper) and Chelatchie Creek subwatersheds contained within the Kalama, Washougal and Lewis River Habitat Assessments Chapter 3: The North Fork Lewis River Basin. The full characterization report is available on the Clark County website at:
http://www.clark.wa.gov/water-resources/documents.html#mon

For areas in the subwatersheds not included in the habitat assessment (several unnamed tributaries to Chelatchie Creek and Cedar Creek), LWD recruitment potential and shade rating analyses were based on a qualitative review of 2010 orthophotographs available through Google Earth.

At the subwatershed scale, the LCFRB rated the riparian conditions in the Cedar Creek (Upper) subwatershed as "Moderately Impaired" and Chelatchie Creek subwatershed as "Impaired."

Riparian (Large Woody Debris (LWD) Delivery)

Figure 5 shows the Cedar Creek (Upper) and Chelatchie Creek subwatersheds LWD delivery potential. In the Cedar Creek (Upper) subwatershed, the survey includes the mainstem of Cedar Creek. The mainstem is shown as having a mix of High (47% of length) and Moderate (53% of length) LWD recruitment along the appx 6.8 mi distance surveyed (EDT reach "Cedar Creek 6").

Review of non-surveyed areas of the mainstem of Cedar Creek indicates that areas upstream of the surveyed reach are likely to have moderate and low LWD recruitment. The lower LWD recruitment would be within areas where the south bank of the creek contains relatively narrow (<100') zones of woody vegetation. Such low-recruitment areas are located generally between (45.899633, -122.36535) and (45.89217, -122.33603), although some portions of that stretch appear to have been recently planted with trees and will improve their capacity to provide LWD over time. The headwaters of Cedar Creek (above appx (45.88714, -122.30895)) also appear to have relatively low LWD recruitment potential.

Review of non-surveyed tributaries to Cedar Creek indicates a similar mix of likely high and moderate LWD recruitment, with some areas that appear to have been recently planted with trees and will improve their capacity to provide LWD over time. An unnamed tributary that discharges into Cedar Creek from the northeast at appx (45.90661, -122.38141) represents about 2 miles of likely high LWD recruitment.

Within the Chelatchie Creek subwatershed, the survey included the mainstem of Chelatchie Creek. Review of the surveyed area of Chelatchie Creek indicated primarily low LWD recruitment levels (70% of length), with some areas of medium recruitment (28% of length) and an area of high recruitment (2% of length) within the appx 5 mile distance surveyed (EDT reaches "Chelatchie Cr 1" and "Chelatchie Cr 2").

Review of a surveyed tributary to Chelatchie Creek indicates primarily medium recruitment (82% of length) with an area of low recruitment (18% of length) along the appx 1.3 mile distance surveyed (EDT reach "NF Chelatchie Cr"). The low recruitment area is centered around the location where the creek crosses SR 503 (appx 45.917161, -122.43492).

Review of unsurveyed (upstream) reaches of the same tributary to Chelatchie Creek estimated LWD recruitment potential ranging from low to none, with the lowest levels of recruitment in fields near NE 256th Ave (appx 45.93256, -122.41087).

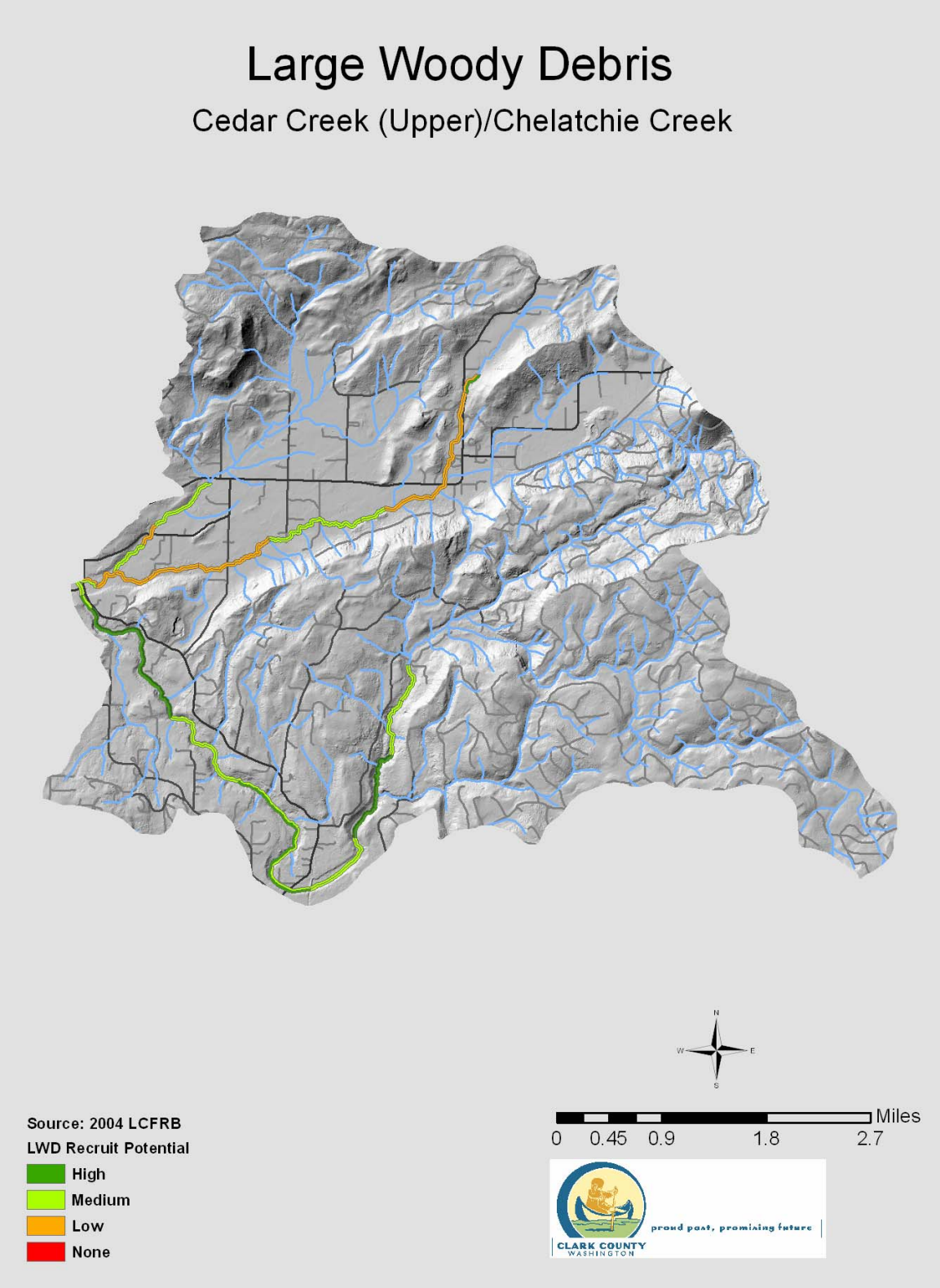

Figure 5: Cedar Creek (Upper) and Chelatchie Creek LWD Recruitment Potential (adapted from R2 Resource Consultants, Inc., 2004)

Shade

The Cedar Creek (Upper) and Chelatchie Creek subwatersheds shade ratings from the 2004 LCFRB Habitat Assessment are illustrated on Figure 6. In the Cedar Creek (Upper) subwatershed, the survey covered the mainstem of Cedar Creek for appx 6.8 miles (EDT each "Cedar Creek 6"). The mainstem of Cedar Creek in the Cedar Creek (Upper) watershed has shade levels ranging from 10 percent to 55 percent. Percent shade levels were distributed as follows:

% Shade	% of Reach Length
10	13
30	59
55	27

Review of unsurveyed areas of Cedar Creek indicated low to moderate levels of shading where the forested riparian zone is 100 feet or less.

In the Chelatchie Creek subwatershed, the survey covered the mainstem of Chelatchie Creek and a tributary to Chelatchie Creek. The mainstem of Chelatchie Creek in the Chelatchie Creek subwatershed (EDT reaches "Chelatchie Cr 1" and "Chelatchie Cr 2") has shade levels ranging from 10 percent to 55 percent. Percent shade levels were distributed as follows:

% Shade	% of Reach Length
10	66
30	30
55	5

The LCFRB habitat assessment for the Cedar Creek (Upper) and Chelatchie Creek subwatersheds indicated that all reaches surveyed are currently off-target with respect to the State Forest Practices shade/elevation screen standards.

Management Recommendations

Overall recommended management activities for the Cedar Creek (Upper) and Chelatchie Creek subwatersheds include preservation and enhancement of spawning habitat, fine sediment control, livestock control, riparian revegetation and removal of invasive species.

Potential Projects

Potential riparian restoration projects for the Cedar Creek (Upper) and Chelatchie Creek subwatersheds were identified from review of the 2004 LCFRB Habitat Assessment report, along with orthophotography analysis in areas not formally surveyed. Recommended restoration projects in both watersheds include riparian plantings in areas where the forested riparian zone is relatively narrow (see discussions under LWD and Shade, above).

Reforestation of such areas would provide both improved riparian LWD recruitment and stream channel shading. However, these two subwatersheds contain little publicly owned land, and so

specific potential projects are difficult to identify. Existing culvert replacement projects on public land described in Table 13 may provide limited potential for small-scale restoration on adjacent banks.

Table 13: Tax Exempt Parcels Overlapping Potential Riparian Restoration Areas

ASSR_SN	ASSR_AC	OWNER	PT1DESC	Description
300015-000	4.5	Clark County	Railroad right-of-way	Site of existing PW Mitigation Project #3: Cedar Creek Railroad Culvert Replacement
NE Amboy Rd ROW	N/A			Site of existing PW Mitigation Project #8: Clark County Fish Passage Replacement Culverts (on Cedar Creek)

Figure 6: Cedar Creek (Upper) and Chelatchie Creek Shade Values (adapted from R2 Resource Consultants, Inc, 2004)

Floodplain Assessment

A floodplain assessment was not conducted.

Wetland Assessment

Purpose

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

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

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

Methods

The assessment includes review of existing GIS data for wetlands. Primary information sources are the county wetlands atlas, Watershed Characterization and Analysis of Clark County (Ecology Publication # 09-06-019, 2009), and personal communication with other county programs.

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

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

Results

Figure 7 shows potential wetland areas within the Cedar Creek (Upper)/Chelatchie Creek subwatersheds based on data from the county wetlands atlas, including the Clark County wetland model and National Wetlands Inventory.

The Cedar Creek (Upper) and Chelatchie Creek subwatersheds have wetlands associated with the main channels of Cedar and Chelatchie Creeks and their tributaries, including: natural depressions and man-made impoundments; flood influenced riverine wetlands; sloped seep wetlands dominated by groundwater discharge. Chelatchie Prairie (Chelatchie Creek

subwatershed) also has large complexes of nearly flat slope wetlands that are predominantly pastures and hay fields.

Table 14: Distribution of Wetlands by Hydrogeomorphic Class

HGM Class	Area (ac.)	% of Sub-basin*	% of total wetland
Slope Wetlands	729	4.3	44.4
Depressional Wetlands	151	0.9	9.2
Riverine Wetlands	763	4.5	46.4
All Wetlands	1,643	9.7	

*Subwatershed area 16,891 ac.

The majority of wetlands is located in landscape positions (along stream channels or on broad, nearly flat slopes) where there are limited opportunities to improve water quality or hydrologic functions in these subwatersheds. Review of the wetland inventories and studies did not identify any significant project opportunities in publicly held or tax-exempt land.

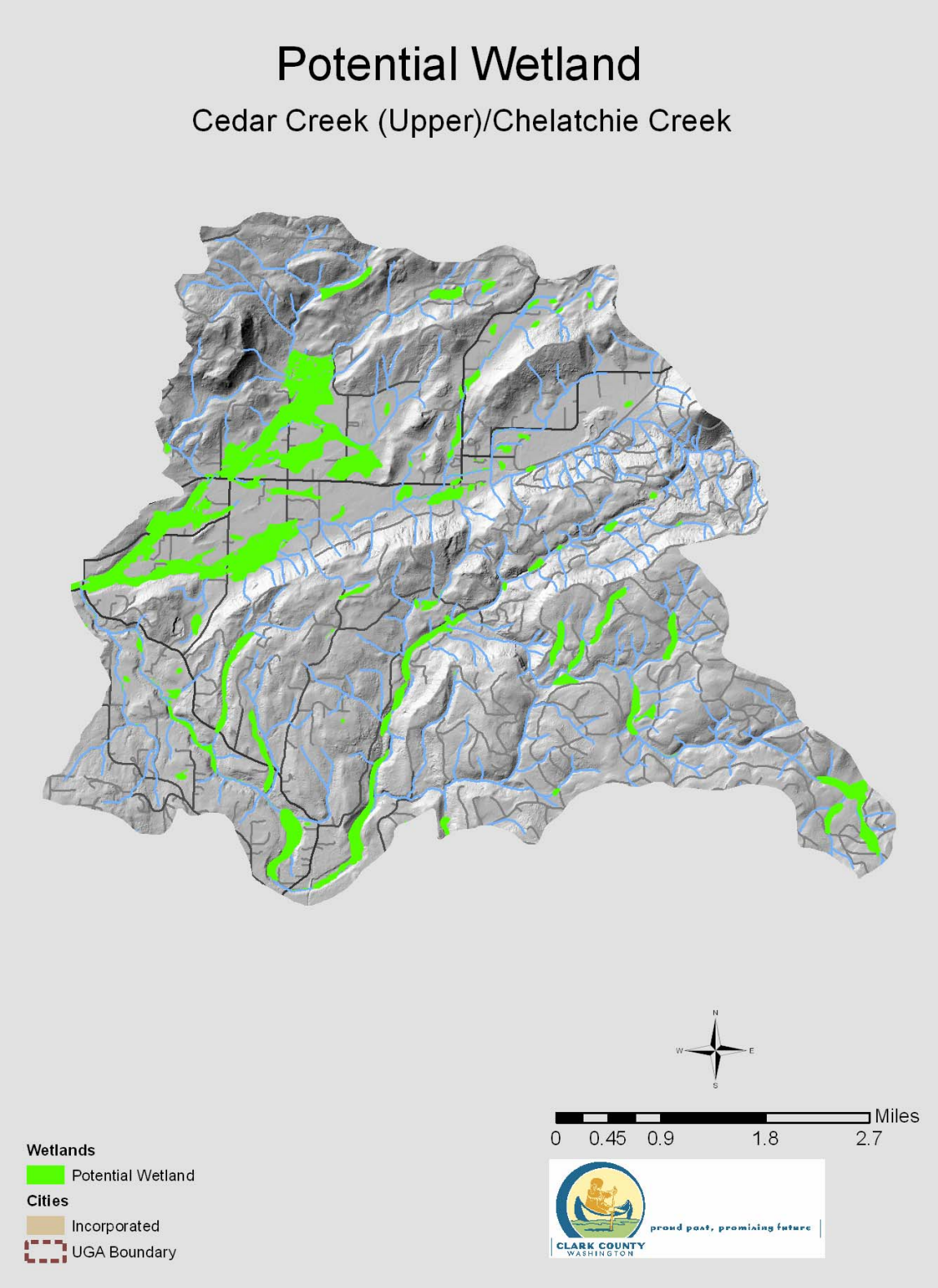

Figure 7: Cedar Creek (Upper) and Chelatchie Creek Potential Wetlands

Watershed Characterization

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

Results pertaining to the Cedar Creek (Upper)/Chelatchie Creek subwatersheds are summarized below.

The Cedar Creek (Upper) and Chelatchie Creek subwatersheds are part of the "Lewis" Rain Dominated Mountainous hydrogeologic unit. It is characterized by rain dominated precipitation, shallow and deep patterns of groundwater flow, and glacial till over consolidated formations, as well as more permeable sedimentary formations (e.g. river alluvium and Troutdale formation) and moderate to steep topography (Ecology, 2009).

Figure 8 depicts priority areas for protection and restoration of hydrologic and denitrification processes countywide based on an analysis of the relative importance and level of alteration in each subwatershed.

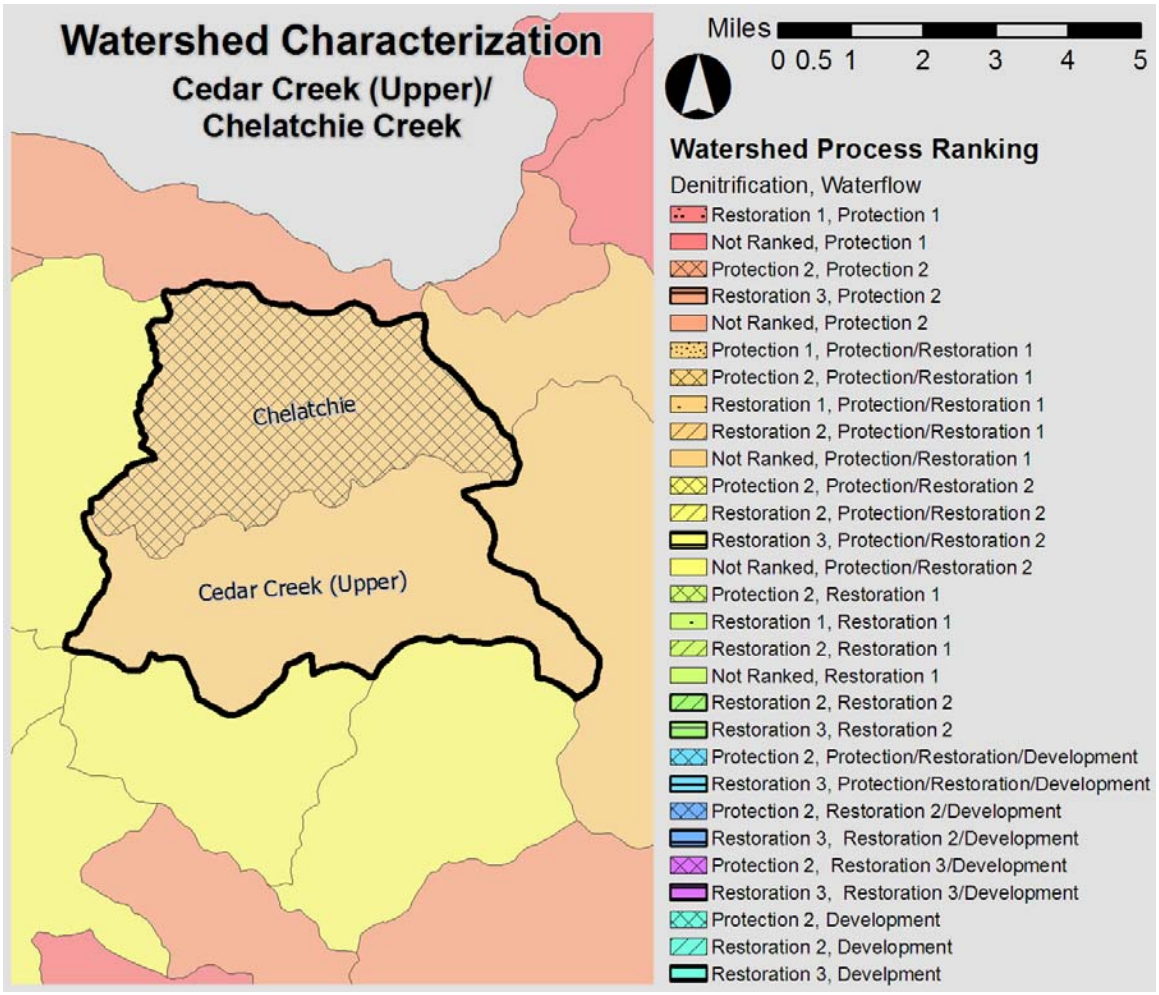

Figure 8: Priorities for suitability of areas for protection and restoration for the hydrogeologic process (from Watershed Characterization and Analysis of Clark County (Ecology, 2009))

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

Protection and restoration of hydrologic (waterflow) processes are recommended for the Cedar Creek (Upper) and Chelatchie Creek subwatersheds (orange). The Chelatchie Creek subwatershed also is ranked for restoration of denitrification processes (cross-hatched) in the wetlands of Chelatchie Prairie. Cedar Creek (Upper) is not ranked for denitrification processes.

Macroinvertebrate Assessment

Purpose

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

The B-IBI score is an index of 10 metrics describing characteristics of stream biology, including: tolerance and intolerance to pollution; taxonomic richness; feeding ecology; reproductive strategy; population structure. Each metric was selected because it has a predictable response to stream degradation. For example, stonefly species often are the most sensitive and first to disappear as human-caused disturbances increase, resulting in lower values for the metric "Number of Stonefly taxa."

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

Methods

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

Raw data values for each metric are converted to a score of one, three or five, and the10 individual metrics are added to produce an overall B-IBI score ranging from 10 to 50. Scores 10 to 24 indicate low biological integrity, 25 to 39 indicate moderate integrity, and greater than 39 indicate high biological integrity.

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

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

- CHL010 (Chelatchie Creek at SR503)
- CHL030 (Chelatchie Creek upstream of north fork confluence)
- CED080 (Cedar Creek upstream of Clark County RR culvert)

In the Chelatchie Creek subwatershed, samples were collected annually by CWP staff from 2001-2009 (no sample in 2003) at Station CHL010 and in 2004 at Station CHL030. Station CED080 in the Cedar Creek (Upper) subwatershed was sampled by CWP staff in 2004 and by CPU volunteer monitors in 2005.

Results

The average of eight samples at CHL010 places this station in the category of moderate biological integrity. Individual annual scores ranged fairly widely, from 26 to 38, in this time period. At CHL030, the single sample collected in 2004 falls at the low end of the moderate category, while the sample from CED080 is at the upper margin of the moderate category.

Table 15 shows somewhat different results for the two Chelatchie Creek stations. There are three high, five moderate and two low scores among the average results for individual metrics at Station CHL010, compared with one high, six moderate and three low at Station CHL030. Low scoring metrics for Number of Intolerant taxa and Percent Predator taxa at both stations suggest human disturbance. Intolerant taxa are typically the first to disappear as human disturbance increases, while predator taxa are a measure of food web complexity which decreases as human disturbance increases. A poor score for Percent Tolerant taxa at CHL030 further indicates human impact as tolerant taxa begin to make up a larger percentage of the population (Fore, 1999).

Table 16 indicates more consistent submetric scores at CED080, with eight moderate and two high scores. However, the overall scores for the two samples were quite different, with a B-IBI of 48 in 2004 and only 30 in 2005. A one-year difference of this magnitude is uncommon, and sampling error may have accounted for the low score in 2005.

Table 15: Station CHL010 and Station CHL030 Average Annual Macroinvertebrate Community Metrics and Total Scores from 2001 through 2009

B-IBI Metrics	CHL010 8-Year Averages			CHL030 2004		
	Value	Score	Category	Value	Score	Category
Total number of taxa	47.8	5	high	39	3	moderate
Number of Mayfly taxa	8.0	3	moderate	6	3	moderate
Number of Stonefly taxa	8.3	5	high	7	3	moderate
Number of Caddisfly taxa	7.8	3	moderate	9	3	moderate
Number of long-lived taxa	4.9	3	Moderate	7	5	high
Number of intolerant taxa	2.0	1	low	0	1	low
Percent tolerant taxa	41.4	3	moderate	60.4	1	low
Percent predator taxa	6.7	1	low	8.4	1	low
Number of clinger taxa	28.9	5	high	19	3	moderate
Percent dominance (3 taxa)	49.7	3	moderate	64.9	3	moderate

B-IBI Metrics	CHL010 8-Year Averages			CHL030 2004		
	Value	Score	Category	Value	Score	Category
Average annual B-IBI Score		34	moderate		26	moderate

Table 16: Station CED080 Average Annual Macroinvertebrate Community Metrics and Total Score from Within the Period 2007

B-IBI Metrics	CED080 2-Year Averages		
	Value	Score	Category
Total number of taxa	40.0	3	moderate
Number of Mayfly taxa	8.0	3	moderate
Number of Stonefly taxa	7.5	3	moderate
Number of Caddisfly taxa	9.0	3	moderate
Number of long-lived taxa	6.0	5	high
Number of intolerant taxa	3.0	3	moderate
Percent tolerant taxa	20.8	3	moderate
Percent predator taxa	14.2	3	moderate
Number of clinger taxa	27.0	5	high
Percent dominance (3 taxa)	52.0	3	moderate
Average annual B-IBI Score		39	moderate

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

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

Figure 9 indicates that scores for Station CHL010 are widely spread but always in the middle portion of the range of expected scores for subwatersheds with relatively low amounts of impervious area (estimated 2000 Total Impervious Area from Wierenga, 2005). These results suggest that factors other than impervious area may be contributing to less than optimal biological integrity, implying at least a moderate opportunity to increase the level of biological health by improving habitat and stream conditions.

The score for CHL030 is quite low for an area with low impervious area. A significant opportunity should exist here to improve biological health through habitat enhancement. Management strategies that limit further degradation and promote stewardship are important in both subwatersheds.

Figure 10 indicates that based on the 2004 score, little improvement could be expected in Cedar Creek (Upper). Instead, management should focus on protecting the existing biological integrity.

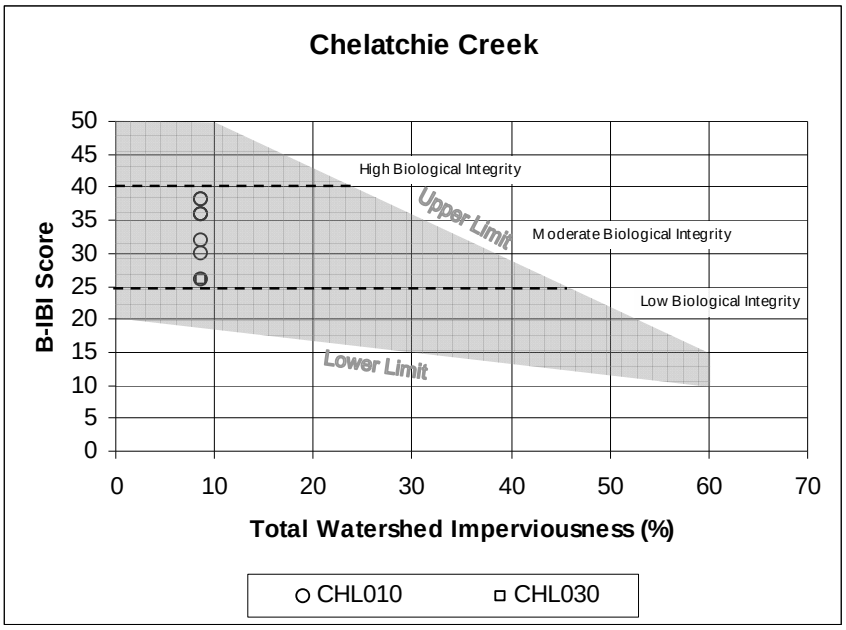

Figure 9: Approximate range of B-IBI in Puget Lowland watersheds, showing progressive decline with increasing imperviousness in the upstream watershed. Adapted from Booth et. al, 2004. Markers indicate B-IBI scores at Station CHL010 and Station CHL030 for particular years, versus estimated 2000 subwatersheds TIA.

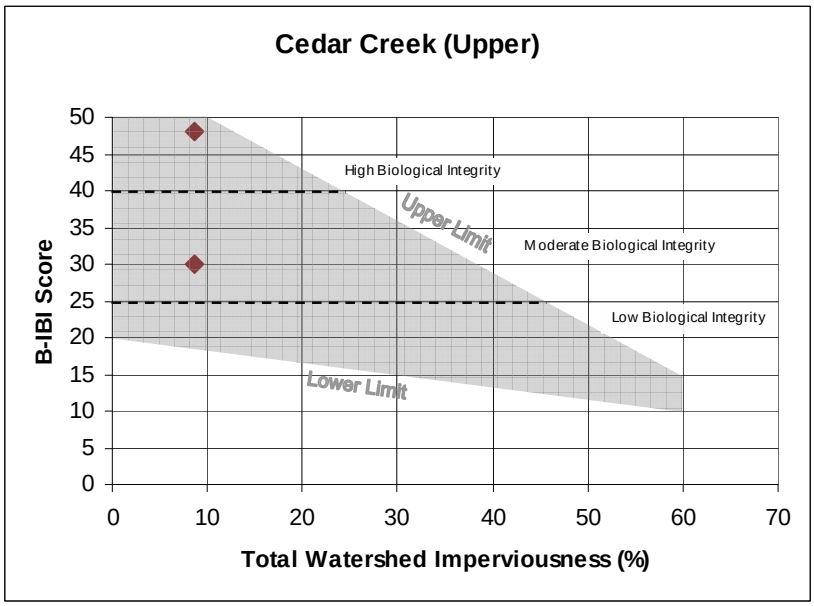

Figure 10: Approximate range of B-IBI in Puget Lowland watersheds, showing progressive decline with increasing imperviousness in the upstream watershed. Adapted from Booth et. al., 2004.

Markers indicate B-IBI scores at Station CED080 for particular years, versus estimated 2000 subwatershed TIA.

Fish Use and Distribution

Purpose

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

Methods

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

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

- WDFW passage barrier database
- SalmonScape (http://wdfw.wa.gov/mapping/salmonscape/)
- Clark County 1997 passage barrier data
- Clark Conservation District/LCFRB passage barrier dataset

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

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

Results/Summary

Distribution

The available evidence suggests that anadromous fish use in the Cedar Creek (Upper) subwatershed could potentially include chum salmon in the mainstem of Cedar Creek and a few of its tributaries, including Boody Creek (Figure 11). The fish distribution data also identified the known presence of coho salmon (Figure 12), fall Chinook (Figure 13), spring Chinook (Figure 14) and winter steelhead (Figure 15) in the mainstem of Cedar Creek. Winter steelhead is presumed present in several tributaries of Cedar Creek, including Boody Creek (Figure 15).

In the Chelatchie Creek subwatershed, fish distribution data suggest anadromous fish use could potentially include chum salmon in the mainstem of Chelatchie Creek and two of its tributaries (Figure 11). Fish distribution data also identified the known presence of coho salmon (Figure 12), fall Chinook (in a relatively small area, see Figure 13) and winter steelhead (Figure 15). Spring Chinook is presumed present in the lower reaches of Chelatchie Creek and a tributary (Figure 14).

In addition to the known distribution of coho salmon and winter steelhead, both are presumed present in tributaries discharging to Chelatchie Creek from the north and east, and could potentially be present in the upper reaches of the tributary discharging to Chelatchie Creek from the east (Figure 12 and Figure 15). Fall Chinook is presumed present in the lower reaches of Chelatchie Creek (Figure 13).

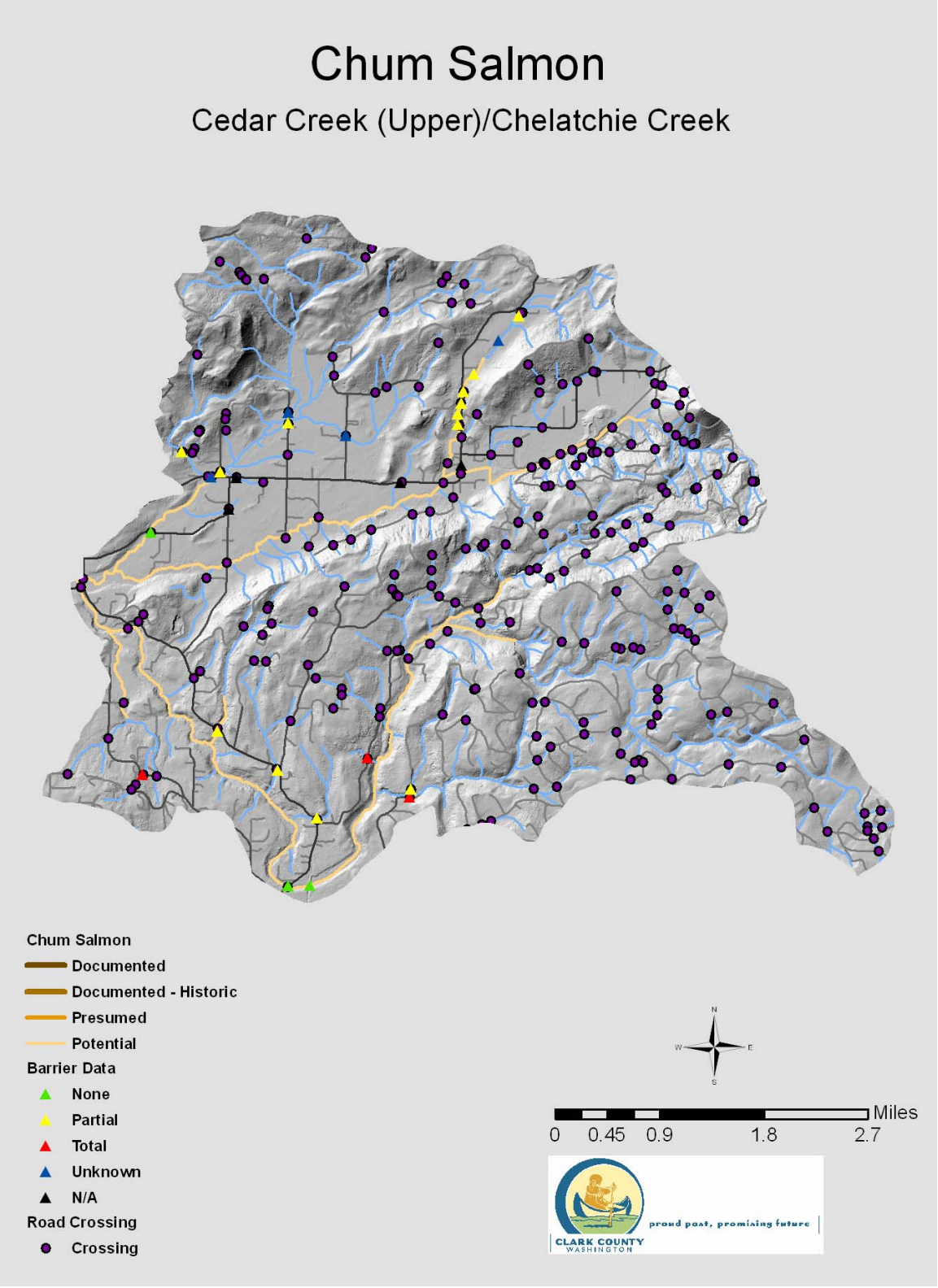

Figure 11: Cedar Creek (Upper) and Chelatchie Creek Chum Salmon Distribution and Barriers

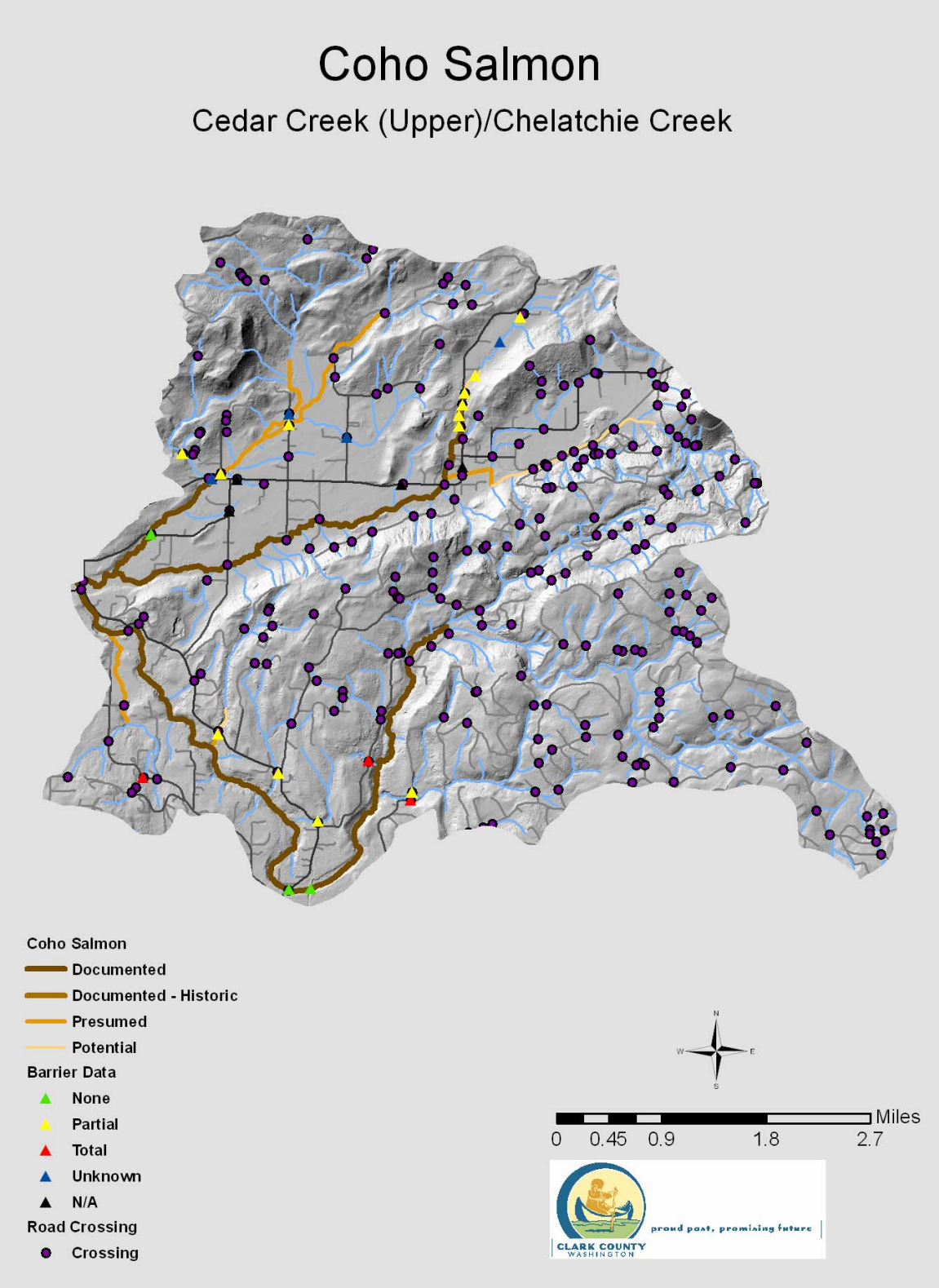

Figure 12: Cedar Creek (Upper) and Chelatchie Creek Coho Salmon Distribution and Barriers

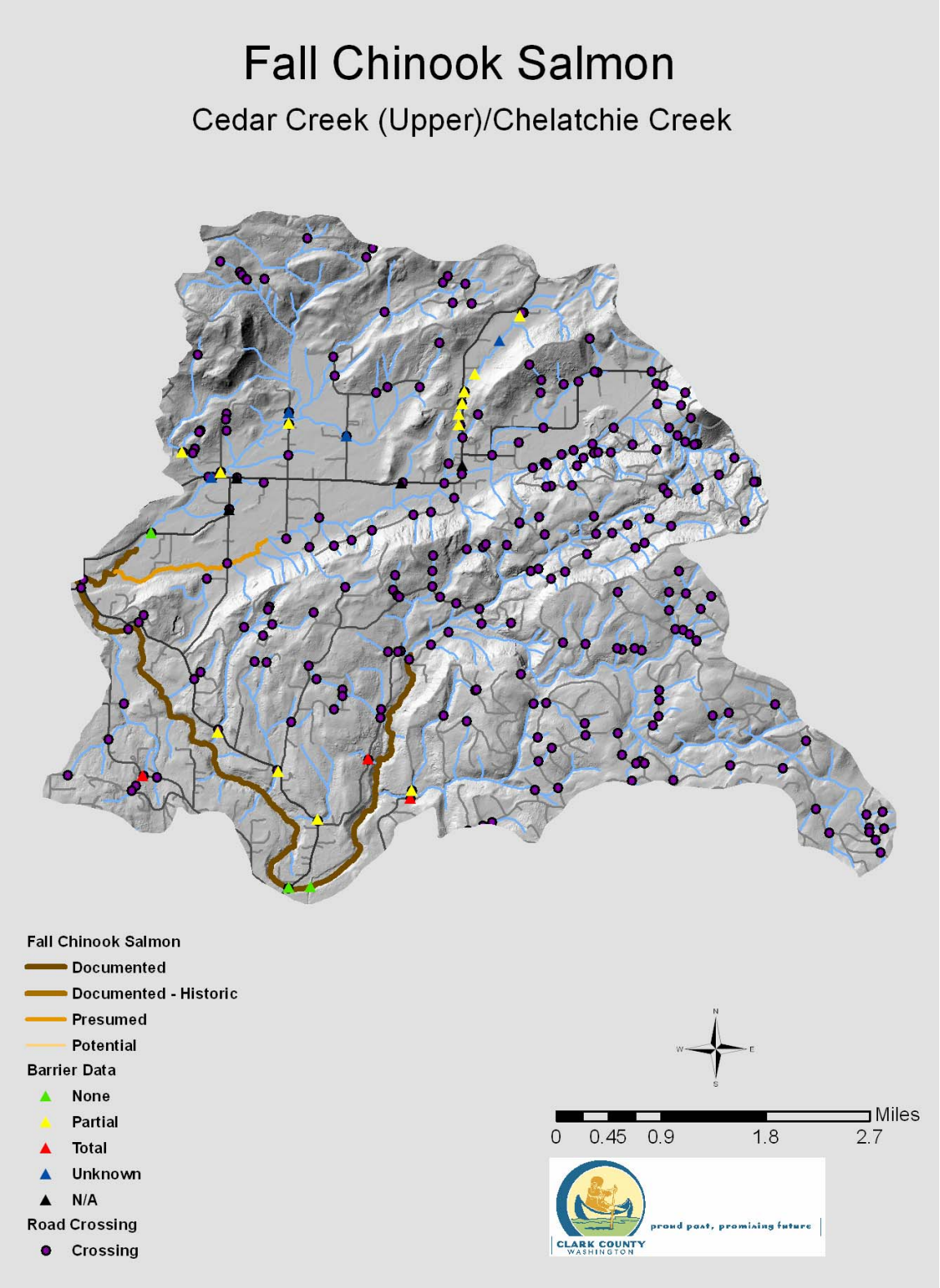

Figure 13: Cedar Creek (Upper) and Chelatchie Creek Fall Chinook Salmon Distribution and Barriers

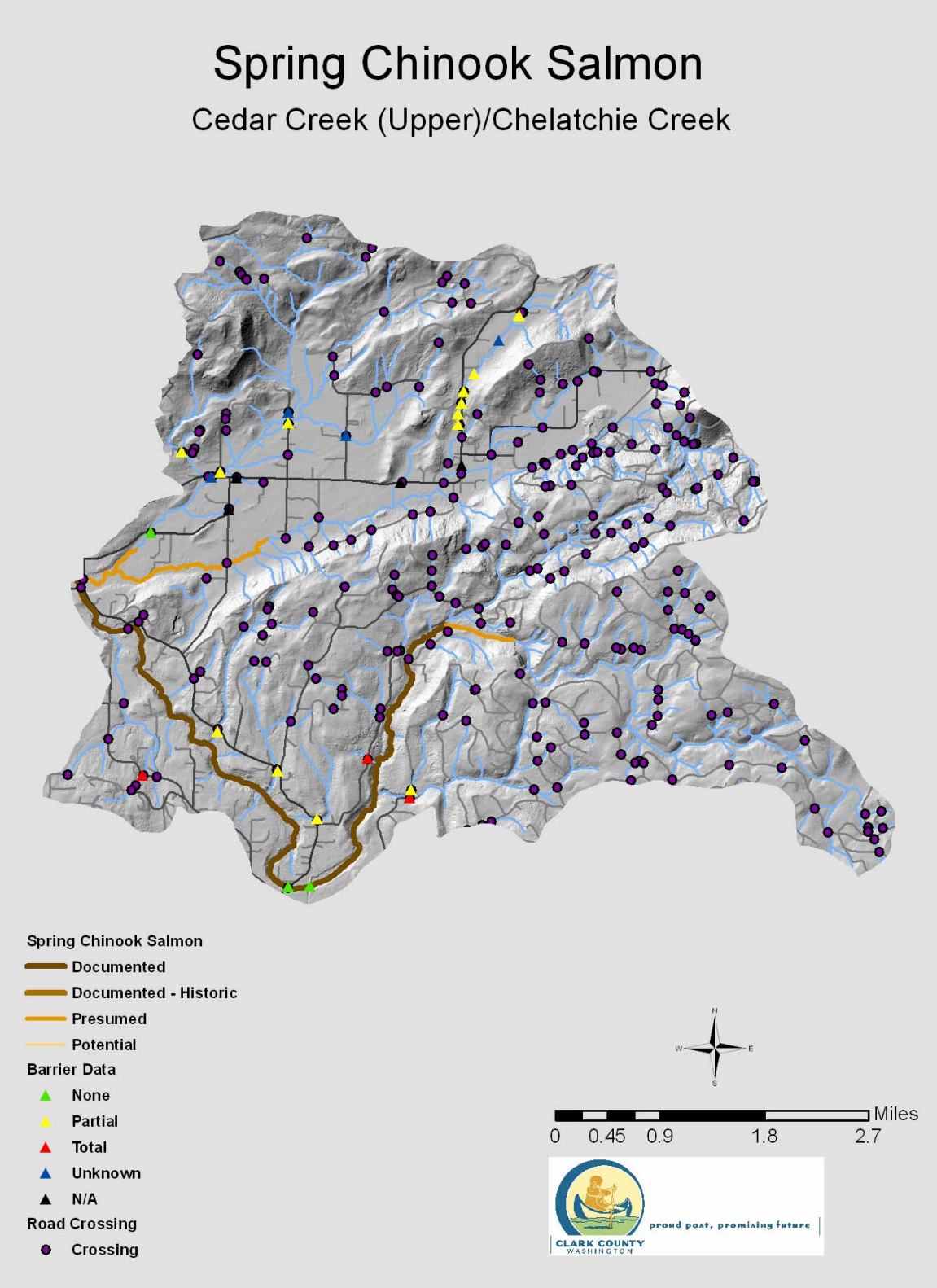

Figure 14: Cedar Creek (Upper) and Chelatchie Creek Spring Chinook Salmon Distribution and Barriers

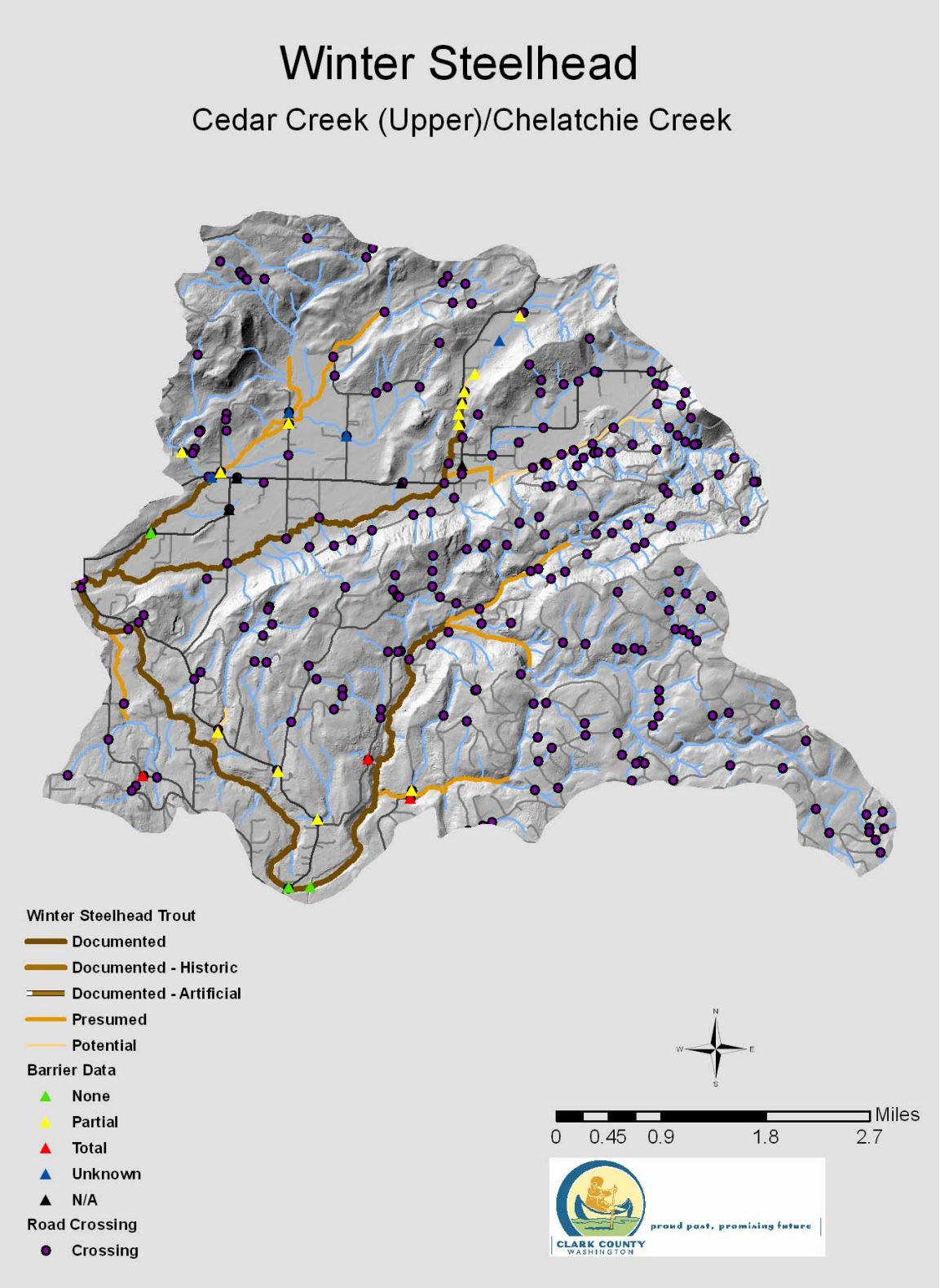

Figure 15: Cedar Creek (Upper) and Chelatchie Creek Winter Steelhead Distribution and Barriers

Barriers

The WDFW barrier database provides the most complete assessment of barriers in the study area subwatersheds (Figure 11, Figure 12, Figure 13, Figure 14, and Figure 15). There are no total fish barriers mapped on the mainstem of Cedar Creek or Chelatchie Creek in these subwatersheds. In the Chelatchie Creek subwatershed, several "Unknown" and "Partial" barriers are mapped on a tributary entering Chelatchie Creek from the north. Also, several partial barriers are mapped on Chelatchie Creek in the vicinity of NE Yale Bridge Rd (SR 503).

In the Cedar Creek (Upper) subwatershed, several tributaries are shown as having partial fish barriers. Three total barriers are mapped on tributaries at (45.886766, -122.435318), (45.889556, -122.395058) and (45.884826, -122.387435).

Recommendations

None of the mapped fish barriers is located on publicly owned lands, so private landowner cooperation would be required. The LCFRB report identifies an unmapped barrier on Cedar Creek at Amboy-Yacolt Road which may benefit from a passage enhancement project, stating that "The rock weir appears to make passage difficult over low- to mid-range flows. Minor rearrangement of the rock structure could be done to enhance passage while still providing grade control." (LCFRB 2004).

The 2009 LCFRB report suggests that reconnecting some in-channel and off-channel habitats could have significant positive benefits for all species using the system. However, "The blocked habitat is believed to be marginal in the majority of cases and no individual barriers in themselves account for a significant portion of blocked miles." Therefore, projects should be carefully selected to optimize the cost-benefit ratio (LCFRB 2009).

Hydrologic and Hydraulic Models

Hydrologic and hydraulic modeling were not conducted.

Analysis of Potential Projects

The analysis of potential projects:

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

Projects or activities are placed in one of several categories.

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

Summary of Conditions, Problems, and Opportunities

Conditions and Problems

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

Coordination with Other Programs

The DES coordinates with the Washington Department of Ecology, Lower Columbia Fish Recovery Board and Vancouver-Clark Parks and Recreation in efforts to improve stream health. Fish First is active in fish recovery efforts in the Cedar Creek watershed.

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

Broad-Scale Characterization

The study area is primarily forest and agriculture, with little development. Non-forested areas tend to be flatter sections cleared many years ago for agriculture. The topography is alluvial and terraced valleys bordered by bedrock hills, with slopes primarily 8-20 percent and some portions sloping up to 70 percent. Chelatchie Prairie is a notable feature, sloping from Tukes Mountain down to the town of Amboy. Geology consists of volcanic and intrusive rock underlying glacial alluvial deposits. Glacial till covers much of the area outside of Chelatchie Praire. Soils are primarily well-drained Cinebar silt loam. Stream hydrology is at or close to natural forested conditions.

Standard subwatershed scale metrics such as percent forest, percent total impervious area, road density and effective impervious area, when compared with NOAA fisheries standards, suggest

stream habitat is partially functioning. Road density is in the Not Properly Functioning category, while impervious area and forest cover are between the thresholds for Properly and Not Properly Functioning systems. Stream crossing density is in the Properly Functioning category.

Water Quality Assessment
Chelatchie Creek is a water of concern for stream temperature on the 2008 303(d) Ecology list of impaired water bodies. There are no listings for the Cedar Creek (Upper) subwatershed.

A relatively large water quality dataset is available for this area, as Clark County maintains a long-term station on Chelatchie Creek and several temperature studies have been conducted.

Overall data indicates that water quality is good in both subwatersheds. As of 2007, Chelatchie Creek ranked third best among 15 long-term stations in Clark County for general water quality, and there were no significant trends. Phosphorus, turbidity and fecal coliform data collected in 2009 indicated Chelatchie Creek met available criteria. Temperatures routinely exceeded state standards in Cedar Creek during 2004 monitoring, while Chelatchie Creek was significantly cooler and met standards in effect at that time.

Drainage System Inventory and Condition
Stormwater infrastructure is limited in this area, consisting primarily of roadside ditches. Overall drainage mapping is complete. There are 4 stormwater facilities, none of which is publicly owned and operated.

Off-site evaluations were conducted at 22 outfalls discharging to critical areas. All were in compliance and no referrals were necessary.

Source Control
There were 31 businesses qualifying for source control visits in this study area. All sites were inspected; source control issues were identified at seven sites. All site issues were successfully resolved.

Illicit Discharge Screening
Illicit discharge screening was not conducted.

Stream Reconnaissance Feature Inventory
A feature inventory was not conducted.

Physical Habitat
Physical habitat measurements in this assessment area were made in 2004 (R2 Resource Consultants, Inc., 2004) for one reach in the Cedar Creek (Upper) subwatershed and one reach in Chelatchie Creek.

The Cedar Creek survey reach is classified as a moderate gradient mixed control channel type, with a map gradient of 1-2 percent. Habitat in this reach consists mainly of small riffles and pools. Habitat parameters including pool frequency, pool quality, LWD, substrate and water

temperature were classified as at risk or not properly functioning. Streambanks were classified as stable and properly functioning.

The Chelatchie Creek survey reach is a very low gradient, unconfined Palustrine channel with a map gradient of 0.5 percent. Habitat is primarily pools and glides. Habitat parameters were impaired and classified the same as the Cedar Creek reach.

Embededdness in the Cedar Creek reach was estimated at 42 percent, compared with 66 percent in Chelatchie Creek.

Geomorphology Assessment
A geomorphology assessment was not conducted.

Riparian Assessment
In the 2004 LCFRB Habitat Assessment, overall riparian conditions in the Cedar Creek reach were rated 'moderately impaired' and the Chelatchie Creek reach was rated 'impaired.' Large woody debris recruitment potential was variable and ranged from poor to good throughout the mainstems and tributaries. Shade levels were below state targets in both subwatersheds.

Wetland Assessment
Wetlands comprise 10 percent of the watershed in this study area. Both subwatersheds have wetlands primarily associated with the main channels of creeks and tributaries. Chelatchie Creek also has large complexes of nearly flat slope wetlands that are predominantly pastures and hay fields.

The majority of wetlands is located in landscape positions where opportunities to improve water quality or hydrologic functions are limited. Protection and restoration of hydrologic processes are recommended for both subwatersheds, while Chelatchie Creek also is ranked for restoration of denitrification processes.

Macroinvertebrate Assessment
Data are available from three locations, collected at various times between 2001- 2009. Based on these samples, Chelatchie Creek near the mouth (8 samples) has moderate biological integrity. Chelatchie Creek above the north fork confluence and Cedar Creek upstream of the county RR culvert also score in the moderate range. However, the Chelatchie station is near the bottom of the category while Cedar Creek is near the top. Submetric scores indicate human disturbance at all three sites, with a higher level of disturbance evident in the upstream Chelatchie Creek site.

Overall B-IBI scores near the mouth of Chelatchie Creek are in the middle of the predicted range for areas with similar levels of total impervious area, while the upstream Chelatchie Creek site scores near the low end. A relatively small loss of integrity could degrade both sites into the low category, particularly the upstream site. There is an opportunity to increase biological integrity by improving habitat and stream conditions at both locations.

The Cedar Creek scores are inconsistent; a low score in 2005 may be due to sampling error. A 2004 sample was at the top of the expected range, indicating high biological integrity and a need for protection rather than improvement.

Fish Use and Distribution
The available information suggests that anadramous fish use in the Cedar Creek (Upper) subwatershed includes Coho, fall and spring Chinook, winter steelhead and potentially Chum. Chelatchie Creek is thought to support the same species, with the exception of spring Chinook.

There are no total fish barriers mapped on mainstem creeks in this assessment area, but several 'unknown' and 'partial' barriers are mapped on tributaries. Clark County removed a significant barrier culvert in Cedar Creek at Amboy-Yacolt Road several years ago. There are no high priority removal projects at this time.

Recently Completed or Current Projects

There are no recently completed or current County projects in this assessment area.

Analysis Approach

Purpose
The Analysis of Potential Projects narrows the initial list of possible opportunities to a subset of higher priority items. Listed opportunities in sections of the SNAP report include sites requiring immediate follow-up, possible stormwater capital improvement projects, internal followup by DES staff and, in some cases, information to be forwarded to other county departments or outside agencies.

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

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

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

Based on this review, lower priority opportunities are removed and higher priority opportunities are recommended for further consideration below.

There were no specific project opportunities identified in this study area.

Riparian restoration:
There are numerous locations in this study area where riparian areas are narrow or absent. Reforestation of these areas would provide improved LWD recruitment, and channel shading and should be encouraged. No specific projects were identified because Clark County owns little land in this area. In most cases, working with private landowners would be required.

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.

There were no NPDES permit-related management recommendations identified for this study area.

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

- Conserve existing agricultural and forest lands and promote healthy practices
- Restore stream channels
- Protect and/or enhance existing wetlands
- Encourage and support riparian planting efforts by private landowners

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