Lower East Fork Lewis River

Habitat Restoration Plan

Developed with oversight by the East Fork Lewis Working Group
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EXECUTIVE SUMMARY

The EF Lewis River has been identified as a critical component for successful recovery of Lower Columbia ESA-listed salmon and steelhead species (LCFRB 2004). The East Fork Working Group (Work Group) was convened to develop a consensus based plan of prioritized actions to recover and restore important salmon and steelhead habitat in the Lower East Fork Lewis River Basin. Development of this Plan was led and coordinated by the Lower Columbia River Fish Recovery Board (LCFRB).

It is the primary objective of the Work Group that this Plan balances the needs of fish and people. Its purpose is to identify the root causes of habitat degradation within the Lower East Fork Lewis Basin and develop goals, objectives, and specific restoration and preservation actions that will, as an aggregate, help recover salmon and steelhead habitat in the EF Lewis River. The specific objectives identified in the Plan include: working to develop strong local support for habitat restoration and preservation; preservation of existing quality habitat, protection and restoration of the channel migration zone, protection and enhancement of in-stream flows, monitoring and enhancing temperature conditions, enhancing in-stream and off-channel habitat, restoring native riparian forests, removing fish passage barriers, improving water quality, assisting with local land use planning, and implementing monitoring programs.

The Working Group identified a suite of restoration and assessment opportunities that accomplish reach-scale objectives and strategies. Project opportunities address the life stage limiting factors that have been identified through previous studies. A project ranking system was used to develop a final list of prioritized actions. This Plan identifies a total of 55 restoration/preservation actions for priority reaches in the Lower East Fork Lewis River Basin. These include 41 instream projects, 2 levee removal projects, 4 riparian restoration projects, 4 fish passage improvement projects, 3 assessment projects, and 1 land preservation project. Thirteen of the highest ranking projects were taken forward to the conceptual design stage; these projects are presented in Table 1.

Table 1. Summary of the highest ranking restoration, preservation, and assessment actions (identified by name and location) forwarded to the conceptual design stage.

Project ID	Project Name	Reach Name	River Mile
EF-A 02	Daybreak Pits avulsion risk assessment	EF Lewis 6A, 6B, 6C, 7, 8A	7.3 - 9.5
EF 28	Side-channel restoration	EF Lewis 8A	9.0 – 9.5
EF 41	Riparian restoration	EF Lewis 5A, 5B	5.7 - 7.3
MS 01	Lower Mason habitat enhancement	Mason Creek 1	0 - 1
EF 10	Side-channel habitat enhancement	EF Lewis 8B	13 - 13.5
MN 02	Manley Creek habitat enhancement (downstream of 259th)	Manley Creek 1B - 1C	0.2 - 0.75
EF 21	Side-channel habitat enhancement	EF Lewis 8A	10.5
EF 42	Levee and drainage ditch removal	EF Lewis 4B	5.1
EF 20	Side-channel and backwater habitat enhancement	EF Lewis 8B	10.7
EF 12	Instream habitat enhancement	EF Lewis 8B	11 - 11.3
EF-A 01	Ridgefield Pits alternatives assessment	EF Lewis 6B; Dyer Cr 1,2	7.3 - 8.3
EF-A 03	Temperature and groundwater assessment	EF Lewis 5A-8B	5.7 - 15
EF 05	Off-channel habitat enhancement	EF Lewis 8B	14

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CHAPTER 1 - INTRODUCTION

Background

The East Fork Lewis River Basin once supported significant populations of fall Chinook salmon, chum salmon, coho salmon, and winter steelhead. These populations have declined dramatically in the watershed, and beginning in 1998, were listed under the Endangered Species Act (ESA) as Threatened. In 2004, the Lower Columbia Fish Recovery Board (LCFRB) developed a Salmon Recovery Plan and Sub-basin Fish and Wildlife Plan (Recovery Plan) (LCFRB 2004). The Recovery Plan included an assessment of conditions in the East Fork Lewis River, identification of factors limiting fish population and recovery, and developed a suite of protection and restoration goals to aid recovery of these critical populations.

The decline of native anadromous fish populations in the Columbia Basin have been attributed to many factors which are commonly referred to as the "four H's:" harvest, hydropower development, hatchery impacts, and habitat loss. While the Recovery Plan addressed many of the factors associated with the "four H's, it did not identify specific restoration actions necessary to restore and protect aquatic habitat. This Habitat Restoration Plan (Plan), being undertaken by the East Fork Lewis River Work Group (Working Group), addresses the specific goals and measures needed to improve aquatic habitat in the Lower East Fork Lewis Basin.

The Plan's approach builds on the previous work of the Recovery Plan by developing reach specific restoration and preservation objectives and constraints, identifying project sites where it is appropriate to conduct restoration/preservation or monitoring projects, and prioritizing the projects based on biological benefits, cost, and other feasibility factors. These prioritized projects will be used as the basis for future grant applications and actions by the LCFRB and other entities in the watershed. A subset of projects deemed suitable for near-term implementation was further developed to the conceptual design stage.

Additional resources consulted during development of the Plan can be found in the attached annotated bibliography (Appendix C).

Geographic focus

The geographic extent of the Plan area begins at the confluence of the EF Lewis and Lewis River at RM 0.0 and extends up the East Fork to RM 15.0. All of the major tributaries that fall within this section are included. To assist in identifying existing conditions and habitat restoration and preservation objectives for a large number of reaches, the reaches have been grouped based on geomorphic similarities and the spatial extent of available information. Tributary reaches were segmented into two categories; the first segment includes reaches that lie within the mainstem EF Lewis River valley floor; the second segment includes tributary reaches that extend beyond the valley floor.

Collaborative process

The partners involved in the development of this plan include a variety of federal, state, tribal and private interests. Some of the partners have jurisdiction for improving habitat, some are responsible for land management activities, some are local landowners, and others represent various local or regional interests. In developing this Plan, the Working Group recognized the need for a comprehensive, collaborative approach to restoration in the Basin that builds upon existing partnerships and encourages new public and private relationships. By working together to develop reach level goals and objectives and then identifying the highest priority actions in the highest priority reaches, the Working Group hopes to ensure that restoration actions meet recovery goals.

The public is a key partner in restoration

This Plan is not a regulatory document. It relies on the willing cooperation of public landowners, private landowners, local interest groups, and the people of the basin. It also requires the support of federal, state, local and tribal governments. It is a goal of this Plan to engage the public as an active partner in implementing and sustaining restoration efforts. This goal will be achieved by building public awareness, understanding and support; and by providing opportunities for participation in all aspects of restoration implementation. The Working Group has guided the planning process, and public feedback has been incorporated into the Plan. No project that occurs on private land will be forwarded to conceptual design or funding without landowner consent. Projects that have support of the landowner will include all landowner concerns (such as erosion and flood control protection and recreation uses) and will be incorporated as explicit design criteria to guide project designs.

Two public meetings were held in March 2009 to introduce the Plan to landowners and to solicit input on aspects of the Plan. Invitations were sent to all landowners owning land adjacent to waterways in the lower East Fork Lewis River Basin. Attendees submitted verbal and written comments. In some cases, the Plan was amended based on comments, and in other cases, comments were addressed through clarification or explanation. The comments and responses are included as Appendix F. This appendix also includes the input received from members of the Lower Columbia Fish Recovery Board Technical Advisory Committee (TAC).

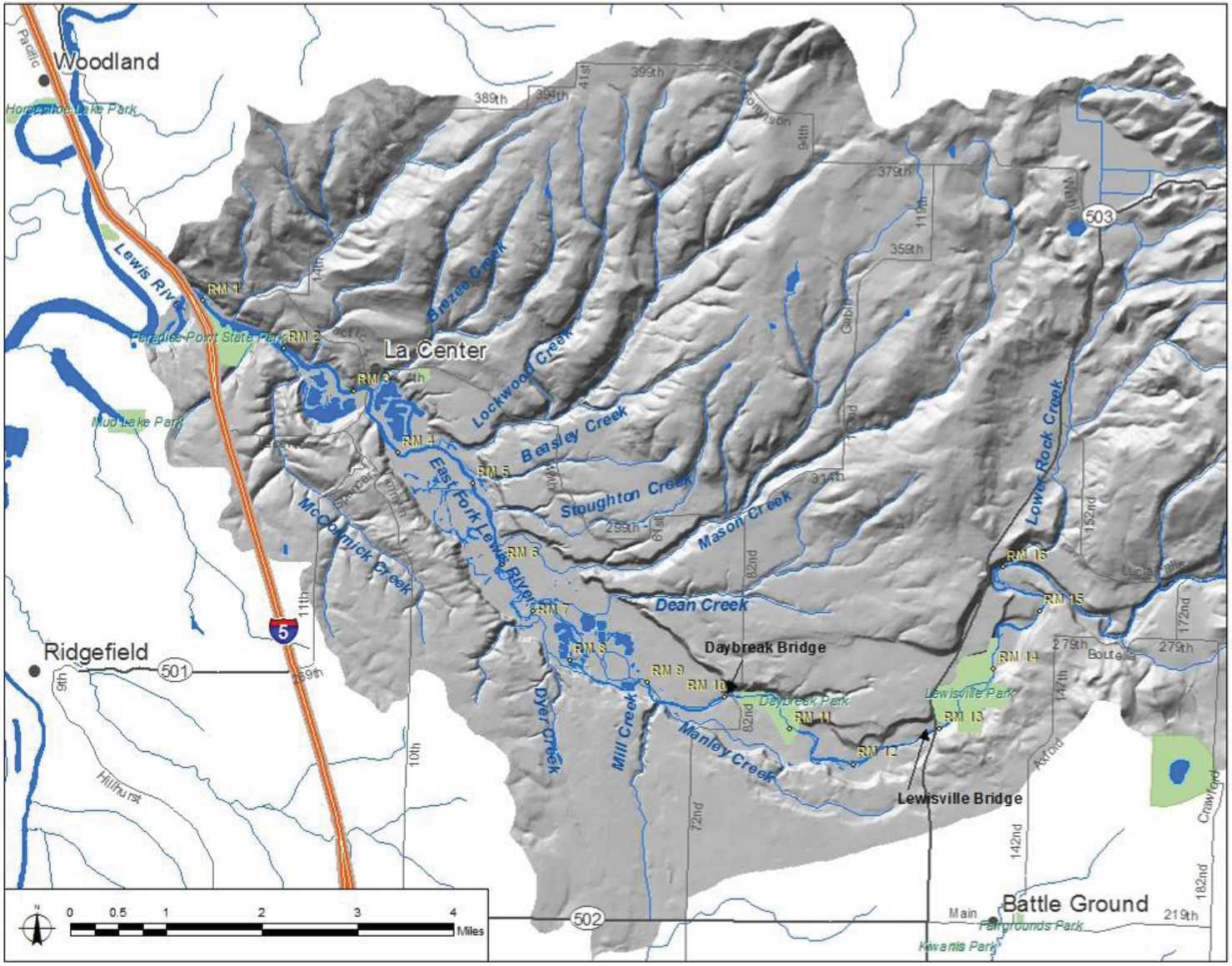


Figure 1. The project area encompasses the Lower East Fork Lewis River Basin (gray hillshade) up to river mile (RM) 15, just upstream of Lewisville Park.

CHAPTER 2 – GOALS AND OBJECTIVES

Vision

The EF Lewis River has been identified as a critical component for successful recovery of Lower Columbia ESA-listed salmon and steelhead (LCFRB 2004). All five populations of salmon and steelhead in the EF Lewis are considered "primary" populations for regional species recovery. The purpose of this Plan is to identify the root causes of habitat degradation within the Basin and develop goals, objectives, and specific restoration and preservation actions that will, as an aggregate, help recover salmon and steelhead habitat in the EF Lewis River.

This Plan builds upon the goals and objectives identified in the Salmon Recovery Plan and Sub-basin Fish and Wildlife Plan (LCFRB 2004), which stated vision is: *of a scientifically credible, socially and culturally acceptable, and economically and politically sustainable plan wherein: Washington lower Columbia salmon, steelhead, and bull trout are recovered to healthy, harvestable levels that will sustain productive sport, commercial, and tribal fisheries through the restoration and protection of the ecosystems upon which they depend and the implementation of supportive hatchery and harvest practices, and; The health of other native fish and wildlife species in the lower Columbia will be enhanced and sustained through the protection of the ecosystems upon which they depend, the control of non-native species, and the restoration of balanced predator/prey relationships (LCFRB 2004).*

Regional recovery plan goals and priorities

All five salmon and trout populations are considered primary to population recovery in the Lower Columbia Basin and are expected to achieve high levels of viability (LCFRB 2004). The current viability status and recovery goal for each of the East Fork populations is presented in Table 2.

The Recovery Plan concluded that contributions to recovery and mitigation in the Lower EF Lewis would come from a variety of actions, programs, and projects. The following list describes the most immediate priorities identified in the Recovery Plan and the 6 Year Habitat Work Schedule. This Plan focuses on four of the nine priorities (highlighted below) which can be specifically addressed by restoration /preservation actions. The remaining priority elements are being addressed via other state and local regulatory compliance means.

1. **Protect intact forests in headwater basins**
2. **Restore lowland floodplain function, riparian function and stream habitat diversity**
3. Manage growth and development to protect watershed processes and habitat conditions
4. Manage forest lands to protect and restore watershed processes
5. **Restore passage at culverts and other barriers**
6. **Address immediate risks with short-term habitat fixes**
7. Align hatchery priorities with conservation objectives
9. Reduce out-of-basin impacts so that the benefits of in-basin actions can be realized.

Table 2. Current viability status of East Fork Lewis populations and the biological objective that is necessary to meet the recovery goal for the Cascade strata and the lower Columbia ESU (source, LCFRB 2004a).

Focal Species	ESA	Hatchery Component[1]	Historical Numbers[2]	Recent Numbers[3]	Current Viability[4]	Recovery Goal
Fall Chinook	Threatened	No	4,000-30,000	100-700	V Low	900
Chum (a)	Threatened	No	120,000-300,000[5]	<100	V Low	not identified
Coho	Threatened	No	5,000-40,000	Unknown	V Low	2,000
Summer Steelhead	Threatened	Yes	1,000-9,000	100	V Low	500
Winter Steelhead	Threatened	Yes	3,000-10,000	100-300	Med	400

(a) Includes combined East Fork and North Fork Lewis populations
1 Significant numbers of hatchery fish are released in the sub-basin.
2 Historical population size inferred from presumed habitat conditions using Ecosystem Diagnosis and Treatment Model and NOAA back-of-envelope calculations..
3 Approximate current annual range in number of naturally-produced fish returning to the subbasin.
4 Prospects for long term persistence based on criteria developed by the NOAA Technical Recovery Team.
5 Historic production for the entire Lewis Basin.

Restoration plan goals and objectives

Central to this Plan are goals, objectives, and specific strategies that guide the development of preservation and restoration opportunities. The underlying intent of these goals is to ensure a holistic approach that addresses the root causes of aquatic habitat impairment. Rehabilitation measures that treat only the symptoms of habitat degradation, while disregarding the causes of impairment, may only provide short term benefits.

Presented below are eleven guiding goals and objectives that came out of Working Group discussions. **Reach specific objectives are presented in Appendix A.** The goals focus on addressing the root causes of habitat degradation to ensure that restoration actions result in long term benefits. The recommended timeline for sequencing and implementing these actions is included in Table 3.

Habitat preservation: Protect existing functioning upland and riparian forests, floodplain, and stream channel habitat and allow no further degradation in order to preserve existing habitat for Chinook, coho, steelhead, chum and other native aquatic species. Protect existing functioning headwater habitat in the tributaries.

Channel migration zone protection and restoration: Protect and restore the Lower East Fork Lewis channel migration zone where feasible to enhance long-term habitat forming processes needed to support multiple species and life-stages. Identify locations where restoration projects and/or acquisition could substantially enhance channel migration functions while considering downstream impacts of migration.

Protect and restore in-stream flows: Identify and correct sources of instream flow impairment. Identify and halt illegal withdrawals. Implement programmatic solutions to

instream flow issues. Supplement flows if necessary to enhance in-stream flows. Focus immediately on critical in-stream flow impairments in the tributaries (i.e. Manley Creek).

Temperature monitoring and enhancement: Take action to reduce elevated summer and fall stream temperatures (to TMDL standard) in order to benefit summer juvenile rearing (coho and steelhead) and prespawning holding and migration (fall Chinook, coho, and chum). Provide support to WDOE in TMDL assessment and help ensure a comprehensive and useful TMDL. Locate and monitor cold water refuge sources (i.e. groundwater). Evaluate innovative approaches for utilizing cold water sources. The Working Group determined that temperature was a critical limiting factor that must be corrected prior to the implementation of certain habitat restoration efforts. In light of temperature impairments, restoration planning should focus on projects that either help to reduce temperature impairment or that provide temperature refugia for fish during warm water periods.

Channel Stability and Sediment: Past gravel mining practices, hydromodifications and riparian degradation have altered channel stability, bank erosion rates, and sediment input and transport in the lower East Fork. Fine sediment deposition can impair spawning and egg incubation. Riparian restoration, placement of LWD, and the use of instream structures will improve sediment transport dynamics and reduce fine sediment input from upstream and local sources.

Habitat enhancement: Conduct habitat enhancement efforts including off-channel / side-channel reconnection and in-stream habitat enhancement using LWD. Preserve and enhance cold water refugia in the channel, floodplain, off-channel and side channel habitats for coho and steelhead rearing and adult migration and holding. Increase habitat complexity and access to thermal refuge areas. Increase abundance and quality of mainstem pool habitat.

Riparian restoration: Restore native riparian forest communities to increase long-term bank stability, shade, and LWD recruitment to benefit multiple species and life-stages. Reforest the lower East Fork Lewis valley bottom (historic floodplain and channel migration zone) from Lewisville Park to the mouth. Expand current efforts and provide annual funding for riparian restoration work. Support invasive species management.

Ridgefield pits restoration and daybreak pits avulsion risk assessment: The Ridgefield Pits avulsion area consists of severely degraded in-stream habitat conditions. Identify and evaluate potential alternatives for recovery of this reach, including active and passive restoration measures. The Daybreak Pits pose a potential avulsion/stream capture scenario that would be extremely detrimental to existing habitat quality and quantity. Assess the potential for stream channel avulsion through the pits and take measures to reduce or eliminate the risks.

Monitoring: Conduct monitoring to accomplish the following objectives: 1) measure progress towards accomplishing this Plan's objectives, 2) evaluate effectiveness of projects to accomplish species recovery goals, and 3) track long-term trends in habitat conditions. Monitoring will provide information that can be used to establish future restoration goals for the basin and will allow for an adaptive management approach to developing treatment strategies. Monitoring activities should occur in conjunction with the regional

monitoring strategy outlined in the Recovery Plan. In general, monitoring activities in the watershed should include:

a. Stream habitat quantity and quality, including the identification of existing and future potential spawning and rearing habitat capacity.
b. Sediment source and transport conditions.
c. Temperature monitoring in the main-stem and off-channel habitats. Establish an extensive temperature monitoring network. Consider an aerial thermal imaging study on the main-stem to identify cool water sources.
d. Invasive plant species monitoring
e. Juvenile and adult fish use patterns, survival, productivity, and abundance

Land use and public land management: Assist local governments and public agencies in developing land use policies and regulations and in managing public lands that will protect, restore and enhance salmon habitat in the Lower East Fork Lewis River.

Passage barriers: Remove barriers to fish passage and migration, such as culverts and dams, to expand access to historic habitat and ensure fish can seasonally migrate to preferred habitat. Specific fish passage barriers are discussed in Appendix B.

Water quality: Improve water quality conditions by restoring runoff processes and reducing fine sediment, farm waste, and storm-water inputs.

Table 3. Scheduling goals for implementation of restoration, preservation, and monitoring actions.

Task	2009	2010	2011	2012	2013	2014	2015
Riparian restoration							
	Have valley floor planted by 2012						
CMZ protection and restoration							
	Work to secure CMZ protection until complete						
Ridgefield and Daybreak Pits Assess							
	Assessment and designs by 2010						
Passage barriers							
	All significant barriers corrected by 2012						
Temperature assessment							
	Assessment and recommendations by 2011						
In-stream flow protection							
	Work to restore in-stream flows until complete						
Habitat preservation and enhancement							
	Enhancement each year based on assessment work						
Monitoring							
	Annually to measure progress and inform enhancement						

Project sequencing and grouping

Whenever feasible, restoration and preservation actions should be combined to maximize fish benefits and gain cost efficiencies. By combining projects and sequencing complimentary projects, impacts to public uses can be reduced, permitting and funding can be streamlined, and disruption to fragile environments minimized. Project sequencing requires cooperation and communication among the various interest groups and ensures that overall strategies and goals are being met.

Consideration of other wildlife and habitat values

The East Fork Lewis River Watershed supports a tremendous number of species of flora and fauna, all of which form relationships that constitute a vital ecosystem. Many of those species have been adversely affected by ecosystem changes. While this Plan focuses on recovery of important salmon and trout habitat, it is critical that preservation and restoration actions integrate other wildlife and habitat values. Projects which negatively impact other important wildlife habitat will not be considered.

CHAPTER 3 – EXISTING CONDITIONS & LIMITING FACTORS

Overview

Existing data and studies were compiled and reviewed. These studies provide baseline information that is used to identify and evaluate appropriate restoration and preservation actions at both the basin and reach scale. An in-office review of technical information included watershed assessment (LCFRB 2005), EDT modeling, and available information on habitat conditions, hydromodifications, passage barriers, riparian conditions, sediment sources, and geomorphology. The majority of the available information can be viewed in the annotated bibliography which accompanies the Plan (Appendix C) as well as the Recovery and Subbasin Plan.

Mainstem and tributary existing conditions are discussed in this section (narrative descriptions and plansheet maps). Additional detailed information of existing conditions on each of the major tributaries is included in Appendix B.

EDT and priority stream reaches

To identify the factors which limit fish population in the watershed, the Recovery Plan used the Ecosystem Diagnosis and Treatment (EDT) life cycle model to identify how different species and life stages were affected by habitat conditions in reaches throughout the Lower East Fork Lewis Basin (Lichatowich, *et al* 1995; Lestelle, *et al*. 2004). Reaches were assigned to tiers according to biological objectives, fish distribution, critical life history stages, current habitat conditions, and potential fish population performance.

This Plan uses the same reach tier designations used in the Recovery Plan. Reaches that are high priority for one or more primary populations are identified as Tier 1. Tier 2 reaches are medium priority reaches for one or more primary populations. Tier 4 reaches are low priority for primary populations (Table 4). Detailed information on the life stage limiting factors for each reach and species is located at the end of this section (for mainstem reaches), and in Appendix B (for tributary reaches).

Table 4. Recovery Plan reach tiers in the Lower EF Lewis Basin (source, LCFRB 2004a).

Tier 1	Tier 2	Tier 4
EF Lewis Reach 4A-8B	Dean Cr 3	EF Lewis 1-3, tidal
Brezee Cr 2	Dyer Cr 2, 4	Brezee Cr 1, 3-5, tribs
Dean Cr 1A	Lockwood Cr 1	Beasely Cr
Dyer Cr 1	McCormick Cr 1A,C,I	Dean Cr 2
Jenny Cr	Mill Cr 1 A	Dyer Cr 3,5,dam
Mason Cr Trib 1	Mason Cr 1,3,8	Lockwood Cr 2,3,4, trib
Manley Cr 1 A	Mason Cr RB Trib 1 A	Manly Cr 2, culverts
Manley Cr 1 D	Manley Cr 1 B,C	Mason Cr 2,4-7, tribs/culverts
Manley Cr 1 E		McCormick 1B

Tier 1	Tier 2	Tier 4
Manley Cr 1 F		Mill Cr 1B-D, culvert, fishway
Manley Cr 1 G		Riley Cr 1-5, culvert, tribs
McCormick Cr D-H		Stoughton Cr 1-3, culvert, dam
Mill Cr 1C		Unnamed Tributary 1

*Note: The absence of Tier 3 reaches results from all of the EF Lewis populations being designated as 'primary' populations with respect to regional recovery objectives.

Key limiting factors

The following are the primary aquatic habitat limiting factors identified as part of Recovery Planning which were used to inform the restoration planning process.

- Water Temperature
- Habitat Diversity
- Key Habitat Quantity
- Channel Stability
- Sediment
- Passage Barriers
- Predation
- Oxygen
- Pathogens
- Lack of Nutrients

The above limiting factors, as well as additional limiting factors identified by the Working Group, were discussed in detail with respect to scientific uncertainty, significance to the watershed, and strategies needed to address underlying causes. The primary limiting factors are presented and discussed below.

Elevated stream temperature

Elevated water temperatures during the summer and early fall are of primary concern to recovery efforts in the Lower East Fork Lewis Basin. Juvenile salmon and steelhead use both the mainstem East Fork and its tributaries as critical rearing habitat during the summer months. Stream temperatures in the mainstem commonly exceed the 64°F (18°C) State standard, and occasionally exceed 73.4ºF (23ºC) at locations from Lewisville Park and downstream (Table 5). Temperatures in excess of 22 ºC are considered lethal to rearing salmon and trout. In the Ridgefield gravel pits (RM 8), temperatures may be warming as a result of large water surface areas within the former gravel pits. Temperature monitoring has found water warmer below the Ridgefield Pits compared to above the Ridgefield Pits (Fish First, unpublished data). Stream temperatures are also a concern in McCormick Creek, Manley Creek, Lockwood Creek, and lower Dean Creek. Temperatures in excess of 77 ºF (25ºC) in lower Dean Creek have been recorded near the mouth.

There are a variety of human caused impacts that result in increased water temperatures. These include: 1) removal of trees and other shade-producing vegetation from stream banks, 2) reduction of summertime stream flows, 3) channel modifications and widening that increases the stream surface exposed to solar radiation, 4) loss of floodplain and groundwater (hyporheic) connectivity due to development, channel simplification, and channel incision, and 5) discharges of warm water from point sources, such as residential ponds adjacent to tributary reaches.

There is evidence that isolated areas of cool water are present both within the mainstem and off-channel habitats (Fish First, Inter-Fluve, unpublished data). In healthy alluvial systems where there is regular aquifer recharge, off-channel and side-channel habitat can be cooler than the mainstem river. Isolated pockets of cold water exist in places where the surface water is in contact with groundwater recharge. Side channels have been found to be resistant to warming and cooling through a buffering effect that occurs when water flows from the main channel, or from groundwater, to side channels via intra-gravel seepage (Poole and Berman 2002). The diversity of surface and subsurface flow allows for stratification, storage, insulation, and re-mixing of water of different temperatures, which can moderate daily temperatures during summer months and provide colder water than the mainstem (Pool et al 2002, Melchior et al 2005).

Table 5. Summary of average 7 day maximum temperatures observed in the mainstem East Fork Lewis River from 2001 to 2007 (source, WDOE 2005).

Mainstem Lewis (7DAM)	2001	2002	2003	2004	2005	2006	2007	Agency
Schultz residence					22.7			WDOE for TMDL
Lewisville Park					23.2			WDOE for TMDL
Daybreak Park/Dollar Corner	24.4	23.9	25.9	25.1	23.2	25.4	23.3	WDOE ambient monitoring
Above Ridgefield Pits					23.5			WDOE for TMDL
Below Dean Cr					23.3			WDOE for TMDL
Above Lockwood Cr					30.9			WDOE for TMDL
Mouth					27.2			WDOE for TMDL

Table 6. Summary of average 7 day maximum temperatures observed in the Lower East Fork Lewis River tributaries from 2002 to 2007 (source: WDOE 2005,Clark County unpublished data).

Tributaries (7DAM)	2002	2003	2004	2005	2006	2007	Agency	Location
Brezee Creek	18.8	19	20.5	19.5	19.4	20.5	Clark Cty	At La Center Road
Brezee Creek				19.5			WDOE	At mouth
Jenny Creek		19.6		19.9			Clark Cty	Pacific Highway
McCormick Creek			20.3				Clark Cty	La Center Road
Manly Creek				21.9	25.2		Clark Cty	Lower Daybreak
Manly Creek				21.5	22.8		Clark Cty	Downstream of culvert
Mason Creek			21.7				Clark Cty	JA Moore Road
Mason Creek				17.7			WDOE	Below Heitmann Cr
Mill Creek			16.3				Clark Cty	NE 259th St
Dean Creek				25.3			WDOE	At mouth
Dean Creek				22.6			WDOE	At JA Moore Road
Lockwood				22.1			WDOE	At mouth

Habitat diversity & key habitat quantity

Habitat diversity & key habitat quantity are low in the Lower East Fork Lewis (LCFRB 2004a). Habitat diversity is related to the complexity of available habitat and is influenced by such factors as gradient, channel confinement, riparian function, and the presence of large woody debris. Channel confinement is related to levees and past incision and has resulted in the loss of connectivity to important off-channel and side-channel habitat. Riparian function has been substantially impacted below RM 10 due to residential, agricultural, and mining development (LCFRB 2005). Complex galleries of

willow, alder, ash, cottonwood, and conifers that covered the valley floodplain have been replaced with remnant stands of those species intermixed with abundant Himalayan blackberry, scotch broom, and reed canary grass (LCFRB 2005). The loss of connected floodplains and healthy streamside forests has resulted in a steep decline in large woody debris inputs to the stream channel and floodplain. LWD density and habitat complexity are low throughout the lower river (LCFRB 2005).

Key habitat is defined as the primary habitat type(s) utilized by a species during a particular life stage; thus key habitat is different for each life stage. In the lower mainstem, main channel pool abundance and quality are poor, as is the quantity of available off-channel and side-channel habitat. Critical spawning habitat has been reduced as a result of channel confinement projects and the river's avulsion into the Ridgefield Pits, which eliminated approximately 3,200 lineal feet of riffle habitat (LCFRB 2005). It is estimated that over 50% of the off-channel habitat and wetlands in the historical lower river floodplain are no longer accessible (Wade 2000).

Channel migration zone

The following paragraphs describe the effects of past land-uses on channel migration and floodplain processes and the potential impacts on habitat quantity and quality. It should be recognized that there exists incomplete information regarding specific cause and effect relationships. It is the hope of the Working Group that additional studies and monitoring will advance our understanding of how land use alterations impact instream habitat and other beneficial uses. Over time, this information will continue to help guide the selection of appropriate enhancement strategies.

In the Lower East Fork Lewis, levees, rip-rap, gravel mining, historical dredging, riparian land clearing, reduction in large woody debris, and development have led to channel confinement and loss of river meander processes (LCFRB 2005). Past incision has been documented in several areas (e.g. Norman 1998) and is likely related to historical instream gravel mining (bar scalping), gravel pit avulsions, and historical dredging. In recent years, secondary aggradation has been observed (Fish First, unpublished data) and is likely a result of channel re-adjustment through bank erosion as the modified stream attempts to establish a new equilibrium. This is a common scenario that has been observed on many alluvial streams that have been subjected to river channelization/incision (Knighton 1998).

In an undisturbed free-formed alluvial river system, new channels are constantly being abandoned, re-shaped, and created anew by long-term geomorphic processes and channel migration. They are formed as the river evolves and migrates across its floodplain and channel migration zone, resulting in full or partial abandonment of meander channels, which can be seasonally or perennially inundated. These secondary channels provide critical habitat for juvenile salmonids by providing refuge from temperature and velocity fluctuations, cover from predation, and large areas of preferred edge habitat (Groot and Margolis 1991, Roni et al 2002). Off-channel habitats are often temporary features, which are created or lost depending on the frequency of channel adjustment. When natural processes such as river meandering, input of large wood, and sediment supply are disrupted by human actions, the channel responds through simplification, floodplain disconnection, loss of secondary habitats (i.e. off-channels and side-channels), and persistent instability (Roni et al 2002).

Channel simplification, incision, and lack of channel migration not only result in loss of habitat but also result in a loss of connection between groundwater and surface flow, which can lead to decreased dry season stream flows and increased summertime stream temperatures. At the habitat unit scale, the presence of connected side-channel and off-channel complexes, especially at low flows, increases the amount of surface water and groundwater connectivity. This hyporheic flow is important for moderating stream temperatures, a benefit that is lost as a result of channel simplification. At the valley and reach scale, the interaction between groundwater and surface flow is equally important. In undisturbed alluvial floodplain systems, water stored in the alluvial aquifer, such as the one that exists throughout the valley floor of the East Fork Lewis, slowly contributes cool water to the stream channel during dry periods. This process is disrupted by channel incision that reduces the ability of wet-season flows to adequately access floodplains and recharge the aquifer and that prematurely drains the stored aquifer water. Aquifer storage is further reduced by agricultural drainage ditches excavated into the floodplain. In disrupted systems where alluvial aquifers are not adequately recharged, instead of receiving water from the surrounding aquifer, rivers may "lose" water to the alluvial aquifer more readily as the dry season progresses, thus compounding temperature problems.

In-stream flow

Low flows in the summer and early fall are of concern in the East Fork Lewis Basin, particularly in the tributaries and as it relates to warm summer temperatures. Stream-flow is a driving force with regards to channel form and aquatic habitat connectivity. It provides the energy needed to transport water, sediment, organic material, nutrients, and thermal energy within the stream corridor. Stream-flow influences the water level of nearby groundwater and surface water bodies (such as wetlands, lakes, and ponds) and dictates the frequency, extent, and duration of floodplain inundation. Human-caused reductions in summer flows in the East Fork can lead to warmer water temperatures, reduced oxygen levels, fish stranding, increased competition for food and quality habitat, vulnerability to predation, and increase in disease.

The WRIA 27/28 Watershed Management Plan, adopted in 2006, sets forth goals, strategies, measures, and actions for managing water resources in the East Fork Lewis. The plan, developed pursuant to the state Watershed Management Act (RCW 90.82), recognizes that stream flows are an important determinant of habitat conditions for fish and other aquatic life in streams, and can be adversely affected by withdrawals for water supply and other human activities. To protect stream flows, the plan:

- Proposed minimum stream flows;
- Recommended that sub-basins be closed to further withdrawals;
- Established water reserves to meet future community needs;
- Developed flow and habitat mitigation measures as conditions for accessing water reserves;
- Called for the curtailment of unauthorized water withdrawals; and
- Identified watershed enhancements needed to improve stream flows over the long-term.

In 2008 the WA Department of Ecology adopted a water management rule (Chapter 173-527 Washington Administrative Code) for the Lewis River Basin that was consistent with the Watershed Plan and formally establishes minimum stream flows, water reservations, and mitigation requirements.

Channel stability & sediment

Bank stability is a concern in both the tributaries and the Lower East Fork. Between RM 7 and RM 10 channel avulsions into gravel mining pits (i.e. Ridgefield Pits and Mile 9 Pit), hydromodifications, and riparian degradation have altered the channel stability and rates of sediment supply in the lower river (LCFRB 2005). Channel avulsions and resulting incision has induced bank failures; and floodplain terraces have been cleared of forest vegetation that provides root strength and large wood recruitment. In some areas, bank retreat exceeds what would be expected if riparian forests were intact. Bank retreat recruits a mix of substrate/sediment depending on location. Some of the material is coarse-grained and contributes spawning-sized gravels, whereas other material is fine-grained and may impair spawning. Bank stability problems in the tributaries include segments of Mason Creek, cattle impacts on Rock Creek, and mass wasting sites in upper Lockwood Creek (Wade 2000, in LCFRB 2005). There are also believed to be many other undocumented bank erosion areas in the tributaries.

Passage barriers

No physical barriers exist on the mainstem of the Lower East Fork Lewis River. However, there are significant passage barriers (both natural and artificial) that exist on the tributaries (Appendix B). Jenny Creek has a natural waterfall barrier at RM 0.13 and Riley Creek has a series of cascades which may limit passage. McCormick, Brezee, Dyer, and Riley Creeks all have reservoirs that act as full or partial barriers. All the tributaries have passage problems at road crossings, where some culverts limit or completely block passage. The WDFW SSHIAP database and Clark County records helped identify and rate passage obstructions in the tributaries (Appendix B). Since Chinook and chum are primarily mainstem river spawners, they are less impacted by the tributary barriers. Coho, and to a lesser extent steelhead, are the species most impacted by the tributary barriers.

Predation

Reduced juvenile mortality due to increases in top predator species is of concern in the Lower East Fork. The ponded, slow water habitat in the avulsed section of the Ridgefield Pits reach provides preferred native and non-native predator habitat. Increased summer water temperature provide habitat for non-native warm water species which were not historically present and which prey on native salmonids. The presence of hatchery steelhead (which are released below Lewisville Park) may also increase predation of smaller native salmonids.

Water quality: pollutants, oxygen, pathogens

The Lower East Fork mainstem was listed on the 1998 WA state 303(d) list of impaired water bodies due to exceedances of temperature and fecal coliform standards (WDOE 1998). Elevated summer water temperatures combined with reduced stream flow can create conditions where dissolved oxygen falls below the preferred range. The primary concern regarding fish pathogens is related to the release of summer steelhead hatchery fish into the basin.

Reach-scale fish use and physical habitat conditions – plan-sheet maps

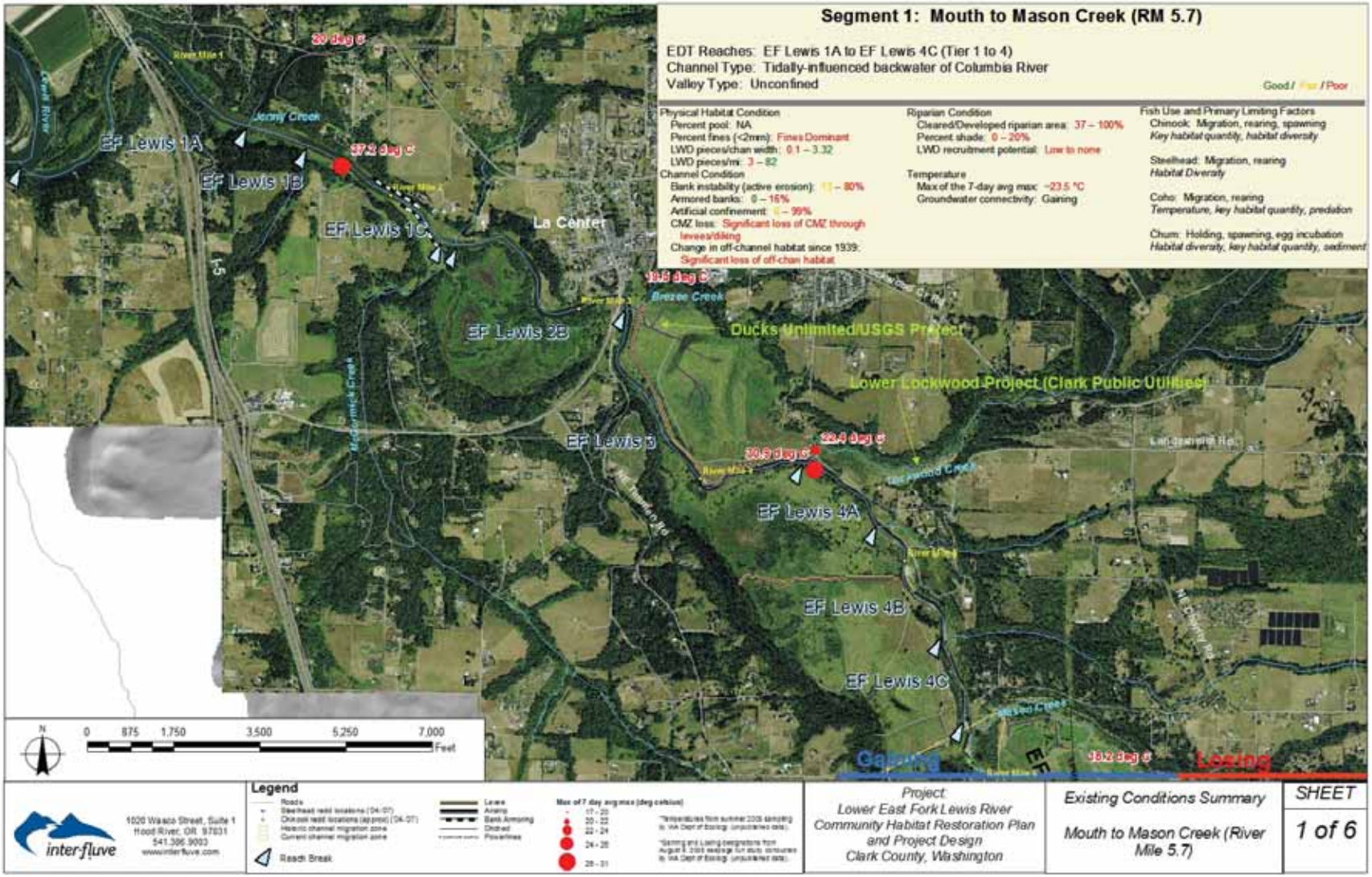
These maps present a summary of the known fish use and physical habitat data that is available for reaches within the Lower East Fork Lewis Basin. Maps are provided for groups of adjacent reaches with similar geomorphic settings. The data summarized on these maps includes results of WDFW spawner surveys (Chinook and steelhead), physical habitat data, stream temperature data, and past or proposed restoration project locations. Tributary reaches were segmented into two categories; the first segment includes reaches that lie within the mainstem East Fork Lewis River valley floor; the second segment includes tributary reaches which extend beyond the valley floor. Information on existing conditions is presented for each of the tributaries in Appendix B**.** Those segments include:

Mainstem East Fork Lewis River Segments:

- Segment 1A-4C: RM 0.0-5.7 (Mouth to Mason Creek).
- Segment 5A-6A: RM 5.7-7.3 (Mason Creek to Ridgefield Pits).
- Segment 6B: RM 7.3-8.0 (Ridgefield Pits Avulsed Reach)
- Segment 6C- 8B: RM 8.0-13 (Ridgefield Pits to Lewisville Bridge)
- Segment 8B: RM 13-15 (Lewisville Bridge to RM 15).

Lower East Fork Lewis River Tributary Segments:

	(valley floor)	(outside valley floor):
• Brezee Creek:	RM 0.0-0.48	RM 0.48 – headwaters
• Beasley Creek:	RM 0.0-0.35	RM 0.35 – headwaters
• Dean Creek:	RM 0.0-0.87	RM 0.87 – headwaters
• Dyer Creek:	RM 0.0-0.53	RM 0.53 – headwaters
• Jenny Creek:	RM 0.0-0.13	RM 0.13 – headwaters
• Lockwood Creek:	RM 0.0-1.39	RM 1.39 – headwaters
• Manley Creek:	RM 0.0-1.52	RM 1.52 – headwaters
• Mill Creek:		RM 0.00 – headwaters
• McCormick Creek:	RM 0.0-0.95	RM 0.95 – headwaters
• Swanson Creek:	RM 0.0-0.60	
• Stoughton Creek:	RM 0.0-0.86	RM 0.86 - headwaters
• Riley Creek:	RM 0.0-headwaters	


Segment 1: Mouth to Mason Creek (RM 5.7)
EDT Reaches: EF Lewis 1A to EF Lewis 4C (Tier 1 to 4)
Channel Type: Tidally-influenced backwater of Columbia River
Valley Type: Unconfined
Good / Fair / Poor
Physical Habitat Condition
Percent pool: NA
Percent fines (<2mm): Fines Dominant
LWD pieces/chan width: 0.1 – 3.32
LWD pieces/mi: 3 – 82
Channel Condition
Bank instability (active erosion): 11 – 80%
Armored banks: 0 – 16%
Artificial confinement: 0 – 99%
CMZ loss: Significant loss of CMZ through levees/diking
Change in off-channel habitat since 1939: Significant loss of off-chan habitat
Riparian Condition
Cleared/Developed riparian area: 37 – 100%
Percent shade: 0 – 20%
LWD recruitment potential: Low to none
Temperature
Max of the 7-day avg max: ~23.5 °C
Groundwater connectivity: Gaining
Fish Use and Primary Limiting Factors
Chinook: Migration, rearing, spawning
Key habitat quantity, habitat diversity
Steelhead: Migration, rearing
Habitat Diversity
Coho: Migration, rearing
Temperature, key habitat quantity, predation
Chum: Holding, spawning, egg incubation
Habitat diversity, key habitat quantity, sediment
20 deg C
River Mile 1
Jenny Creek
EF Lewis 1A
EF Lewis 1B
37.2 deg C
River Mile 2
EF Lewis 1C
La Center
I-5
38.6 deg C
Breeze Creek
Ducks Unlimited/USGS Project
Lower Lockwood Project (Clark Public Utilities)
EF Lewis 2B
Mcdermick Creek
EF Lewis 3
22.4 deg C
30.9 deg C
River Mile 3
Lockwood Creek
EF Lewis 4A
River Mile 4
EF Lewis 4B
EF Lewis 4C
Mason Creek
Gaining
38.2 deg C
Losing
N
0
875
1,750
3,500
5,250
7,000
Feet
Legend
Roads
Steelhead redd locations (04-07)
Chinook redd locations (approx) (04-07)
Historic channel migration zone
Current channel migration zone
Reach Break
Levee
Armoring
Bank Armoring
Ditched
Pipelines
Max of 7 day avg max (deg celsius)
17 - 20
20 - 22
22 - 24
24 - 26
26 - 31
*Temperatures from summer 2005 sampling by WA Dept of Ecology (unpublished data)
*Gaining and Losing designations from August 5, 2005 readings for study consumers by WA Dept of Ecology (unpublished data)
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Mouth to Mason Creek (River Mile 5.7)
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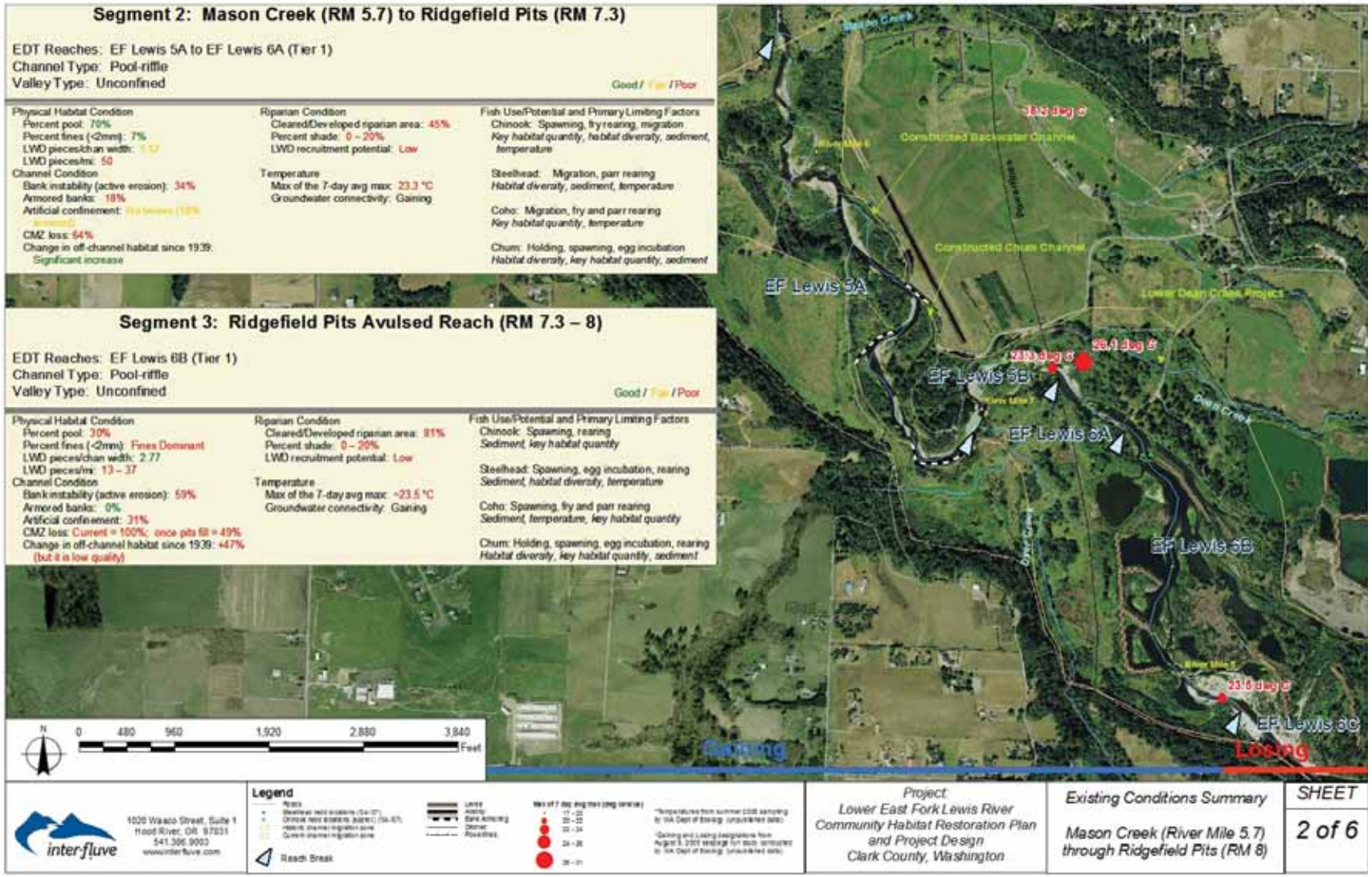
Segment 2: Mason Creek (RM 5.7) to Ridgefield Pits (RM 7.3)
EDT Reaches: EF Lewis 5A to EF Lewis 6A (Tier 1)
Channel Type: Pool-riffle
Valley Type: Unconfined
Good / Fair / Poor
Physical Habitat Condition
Percent pool: 70%
Percent fines (<2mm): 7%
LWD pieces/chan width: 1.12
LWD pieces/mi: 50
Channel Condition
Bank instability (active erosion): 34%
Armored banks: 18%
Artificial confinement: 0% levees (18% armored)
CMZ loss: 64%
Change in off-channel habitat since 1939:
Significant increase
Riparian Condition
Cleared/Developed riparian area: 45%
Percent shade: 0 – 20%
LWD recruitment potential: Low
Temperature
Max of the 7-day avg max: 23.3 °C
Groundwater connectivity: Gaining
Fish Use/Potential and Primary Limiting Factors
Chinook: Spawning, fry rearing, migration
Key habitat quantity, habitat diversity, sediment, temperature
Steelhead: Migration, parr rearing
Habitat diversity, sediment, temperature
Coho: Migration, fry and parr rearing
Key habitat quantity, temperature
Chum: Holding, spawning, egg incubation
Habitat diversity, key habitat quantity, sediment
Segment 3: Ridgefield Pits Avulsed Reach (RM 7.3 – 8)
EDT Reaches: EF Lewis 6B (Tier 1)
Channel Type: Pool-riffle
Valley Type: Unconfined
Good / Fair / Poor
Physical Habitat Condition
Percent pool: 30%
Percent fines (<2mm): Fines Dominant
LWD pieces/chan width: 2.77
LWD pieces/mi: 13 – 37
Channel Condition
Bank instability (active erosion): 59%
Armored banks: 0%
Artificial confinement: 31%
CMZ loss: Current = 100%; once pits fill = 49%
Change in off-channel habitat since 1939: +47%
(but it is low quality)
Riparian Condition
Cleared/Developed riparian area: 91%
Percent shade: 0 – 20%
LWD recruitment potential: Low
Temperature
Max of the 7-day avg max: ~23.5 °C
Groundwater connectivity: Gaining
Fish Use/Potential and Primary Limiting Factors
Chinook: Spawning, rearing
Sediment, key habitat quantity
Steelhead: Spawning, egg incubation, rearing
Sediment, habitat diversity, temperature
Coho: Spawning, fry and parr rearing
Sediment, temperature, key habitat quantity
Chum: Holding, spawning, egg incubation, rearing
Habitat diversity, key habitat quantity, sediment
Mason Creek
River Mile 6
18.3 deg C
Constructed Backwater Channel
Powerline
Constructed Chum Channel
EF Lewis 5A
Lower Chum Creek Project
23.3 deg C
26.1 deg C
EF Lewis 5B
River Mile 7
Chum Creek
EF Lewis 6A
Chum Creek
EF Lewis 6B
River Mile 8
23.5 deg C
EF Lewis 6C
Losing
Gaining
N
0
480
960
1,920
2,880
3,840
Feet
Legend
Reach Break
Levee
Bank Armoring
Stream
Roadway
Max of 7-day avg max (deg celsius)
17 - 20
20 - 22
22 - 24
24 - 26
26 - 31
*Temperatures from summer 2008 sampling by WA Dept of Ecology (unpublished data).
*Gaining and Losing designations from August 5, 2003 readings for study conducted by WA Dept of Ecology (unpublished data).
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Mason Creek (River Mile 5.7)
through Ridgefield Pits (RM 8)
SHEET
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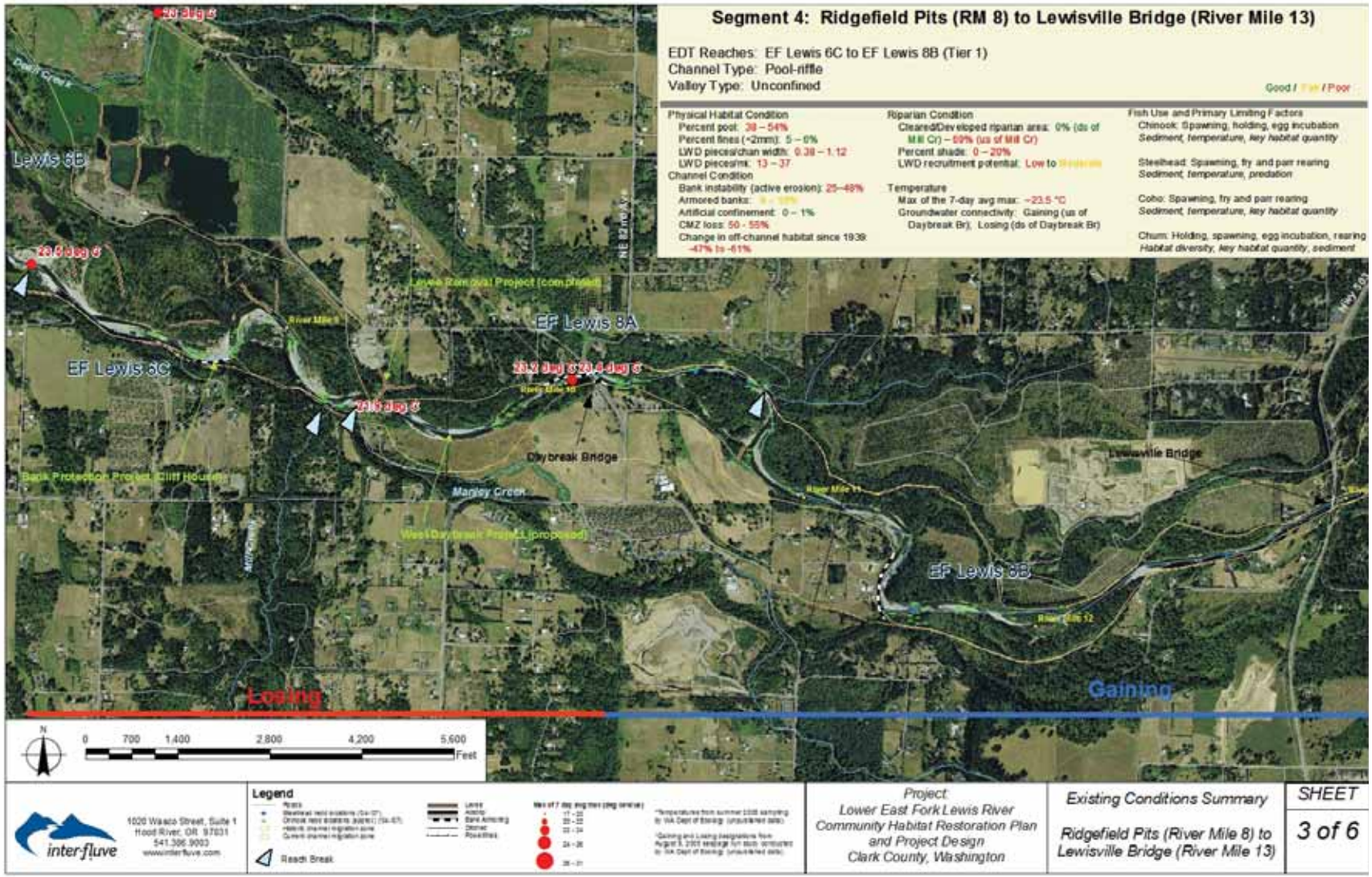
Segment 4: Ridgefield Pits (RM 8) to Lewisville Bridge (River Mile 13)
EDT Reaches: EF Lewis 6C to EF Lewis 8B (Tier 1)
Channel Type: Pool-riffle
Valley Type: Unconfined
Good / Fair / Poor
Physical Habitat Condition
Percent pool: 38 – 54%
Percent fines (<2mm): 5 – 6%
LWD pieces/chan width: 0.38 – 1.12
LWD pieces/mi: 13 – 37
Channel Condition
Bank instability (active erosion): 25–48%
Armored banks: 9 – 18%
Artificial confinement: 0 – 1%
CMZ loss: 50 - 55%
Change in off-channel habitat since 1939: -47% to -61%
Riparian Condition
Cleared/Developed riparian area: 0% (ds of Mill Cr) – 69% (us of Mill Cr)
Percent shade: 0 – 20%
LWD recruitment potential: Low to Moderate
Temperature
Max of the 7-day avg max: ~23.5 °C
Groundwater connectivity: Gaining (us of Daybreak Br); Losing (ds of Daybreak Br)
Fish Use and Primary Limiting Factors
Chinook: Spawning, holding, egg incubation
Sediment, temperature, key habitat quantity
Steelhead: Spawning, fry and parr rearing
Sediment, temperature, predation
Coho: Spawning, fry and parr rearing
Sediment, temperature, key habitat quantity
Chum: Holding, spawning, egg incubation, rearing
Habitat diversity, key habitat quantity, sediment
Lewis 6B
EF Lewis 6C
EF Lewis 8A
EF Lewis 8B
Daybreak Bridge
Lewisville Bridge
Marley Creek
Mill Creek
NE 82nd Ave
Lewis Restoration Project (completed)
Bank Protection Project, Cliff Houses
West Daybreak Project 1 (proposed)
River Mile 9
River Mile 10
River Mile 11
River Mile 12
Losing
Gaining
0 700 1,400 2,800 4,200 5,600 Feet
Legend
Reach Break
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Ridgefield Pits (River Mile 8) to Lewisville Bridge (River Mile 13)
SHEET
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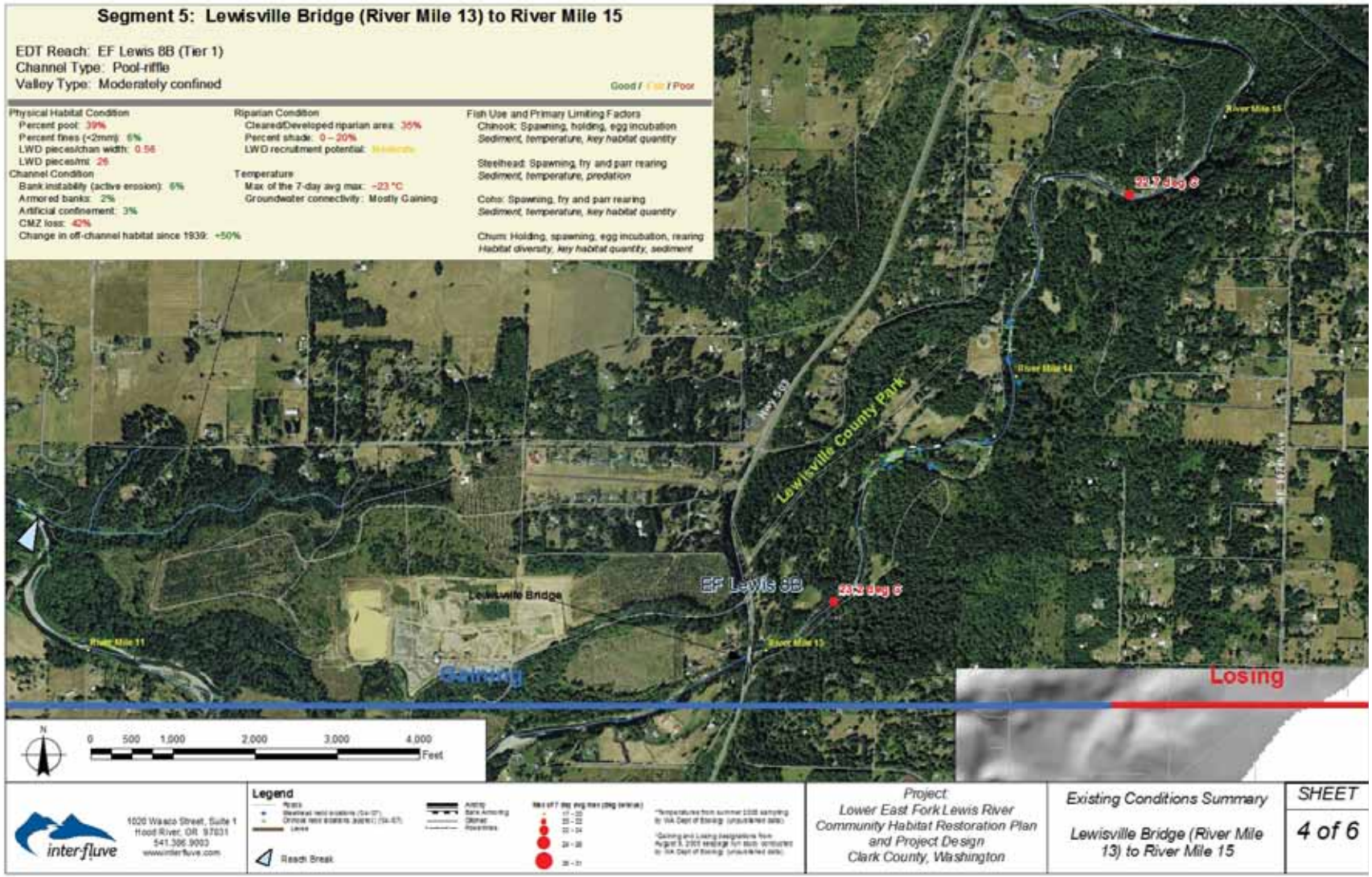
Segment 5: Lewisville Bridge (River Mile 13) to River Mile 15
EDT Reach: EF Lewis 8B (Tier 1)
Channel Type: Pool-riffle
Valley Type: Moderately confined
Good / Fair / Poor
Physical Habitat Condition
Percent pool: 39%
Percent fines (<2mm): 6%
LWD pieces/chan width: 0.56
LWD pieces/mi: 26
Channel Condition
Bank instability (active erosion): 6%
Armored banks: 2%
Artificial confinement: 3%
CMZ loss: 42%
Change in off-channel habitat since 1939: +50%
Riparian Condition
Cleared/Developed riparian area: 35%
Percent shade: 0 – 20%
LWD recruitment potential: Moderate
Temperature
Max of the 7-day avg max: ~23 °C
Groundwater connectivity: Mostly Gaining
Fish Use and Primary Limiting Factors
Chinook: Spawning, holding, egg incubation
Sediment, temperature, key habitat quantity
Steelhead: Spawning, fry and parr rearing
Sediment, temperature, predation
Coho: Spawning, fry and parr rearing
Sediment, temperature, key habitat quantity
Chum: Holding, spawning, egg incubation, rearing
Habitat diversity, key habitat quantity, sediment
River Mile 15
22.7 deg C
River Mile 14
Lewisville County Park
NW 13th Ave
EF Lewis 8B
23.2 deg C
Lewisville Bridge
River Mile 11
River Mile 13
Gaining
Losing
N
0 500 1,000 2,000 3,000 4,000
Feet
Legend
Reach Break
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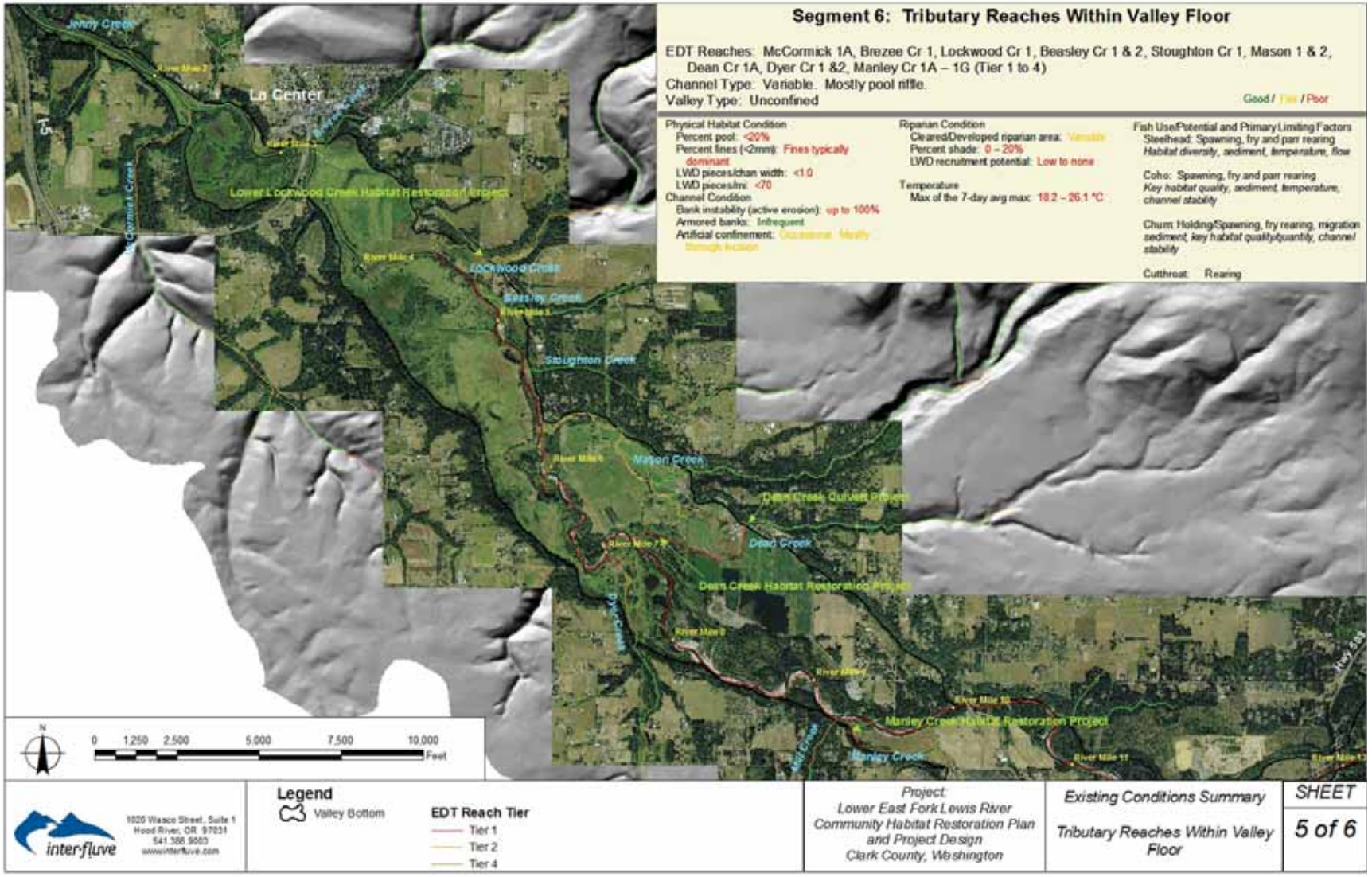
Segment 6: Tributary Reaches Within Valley Floor
EDT Reaches: McCormick 1A, Brezee Cr 1, Lockwood Cr 1, Beasley Cr 1 & 2, Stoughton Cr 1, Mason 1 & 2, Dean Cr 1A, Dyer Cr 1 &2, Manley Cr 1A – 1G (Tier 1 to 4)
Channel Type: Variable. Mostly pool riffle.
Valley Type: Unconfined
Good / Fair / Poor
Physical Habitat Condition
Percent pool: <20%
Percent fines (<2mm): Fines typically dominant
LWD pieces/chan width: <1.0
LWD pieces/mi: <70
Channel Condition
Bank instability (active erosion): up to 100%
Armored banks: Infrequent
Artificial confinement: Occasional. Mostly through incision
Riparian Condition
Cleared/Developed riparian area: Variable
Percent shade: 0 – 20%
LWD recruitment potential: Low to none
Temperature
Max of the 7-day avg max: 18.2 – 26.1 °C
Fish Use/Potential and Primary Limiting Factors
Steelhead: Spawning, fry and parr rearing
Habitat diversity, sediment, temperature, flow
Coho: Spawning, fry and parr rearing
Key habitat quality, sediment, temperature, channel stability
Chum: Holding/Spawning, fry rearing, migration
sediment, key habitat quality/quantity, channel stability
Cutthroat: Rearing
Jenny Creek
La Center
Lower Lockwood Creek Habitat Restoration Project
McCormick Creek
Lockwood Creek
Beasley Creek
Stoughton Creek
Mason Creek
Dean Creek Culvert Project
Dead Creek
Dean Creek Habitat Restoration Project
Dyer Creek
Manley Creek Habitat Restoration Project
Manley Creek
River Mile 2
River Mile 4
River Mile 6
River Mile 7
River Mile 8
River Mile 10
River Mile 11
N
0 1,250 2,500 5,000 7,500 10,000 Feet
Legend
Valley Bottom
EDT Reach Tier
Tier 1
Tier 2
Tier 4
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Tributary Reaches Within Valley Floor
SHEET
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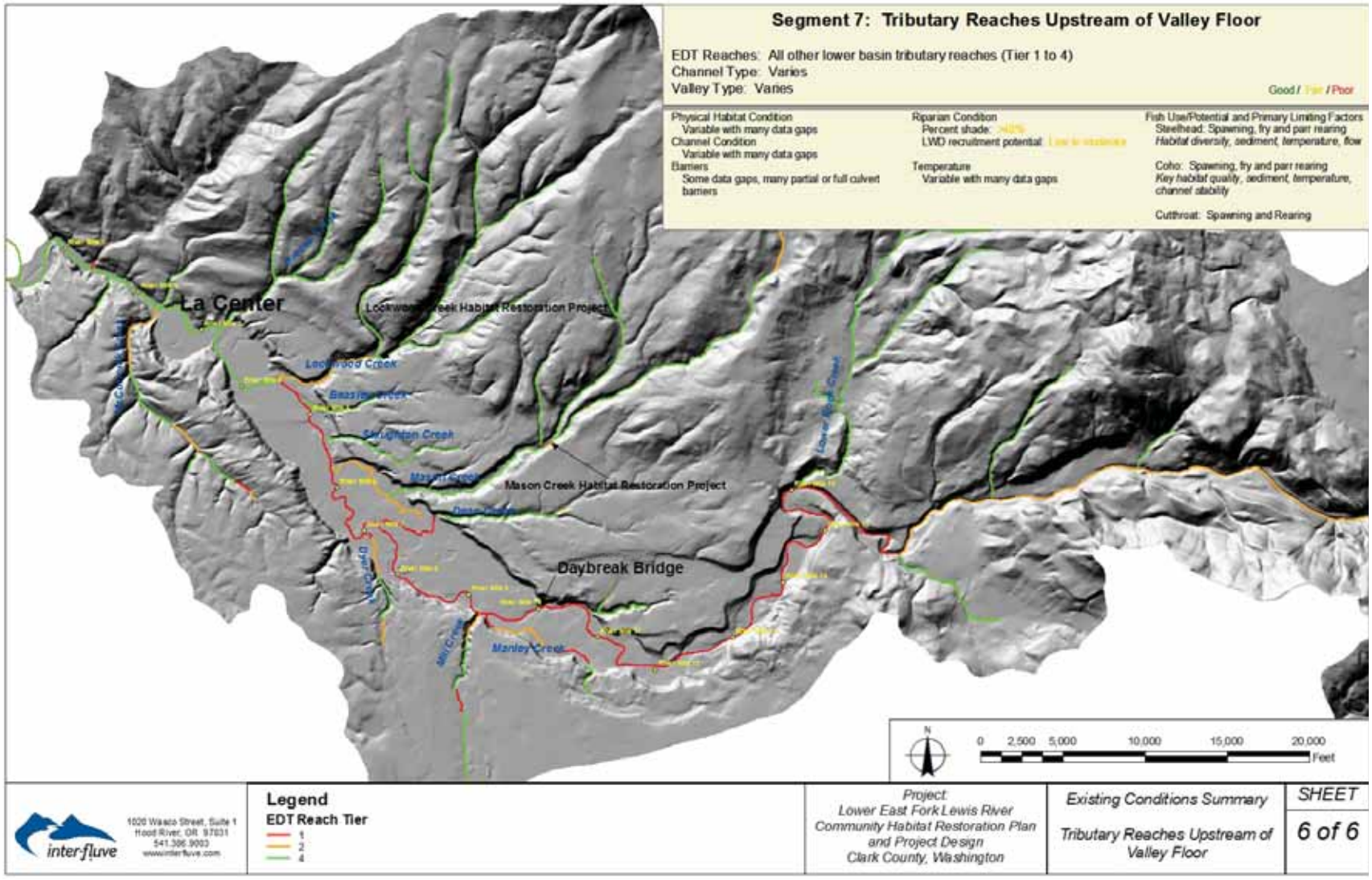
Segment 7: Tributary Reaches Upstream of Valley Floor
EDT Reaches: All other lower basin tributary reaches (Tier 1 to 4)
Channel Type: Varies
Valley Type: Varies
Good / Fair / Poor
Physical Habitat Condition
Variable with many data gaps
Channel Condition
Variable with many data gaps
Barriers
Some data gaps, many partial or full culvert barriers
Riparian Condition
Percent shade:
LWD recruitment potential:
Temperature
Variable with many data gaps
Fish Use/Potential and Primary Limiting Factors
Steelhead: Spawning, fry and parr rearing
Habitat diversity, sediment, temperature, flow
Coho: Spawning, fry and parr rearing
Key habitat quality, sediment, temperature, channel stability
Cutthroat: Spawning and Rearing
La Center
Lockwood Creek Habitat Restoration Project
Lockwood Creek
Grasslin Creek
Slaughter Creek
Mason Creek
Mason Creek Habitat Restoration Project
Daybreak Bridge
Manley Creek
N
0 2,500 5,000 10,000 15,000 20,000
Feet
Legend
EDT Reach Tier
1
2
4
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Tributary Reaches Upstream of Valley Floor
SHEET
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CHAPTER 4 – METHODS FOR PROJECT IDENTIFICATION

This section outlines the methodology for identifying and describing potential stream habitat enhancement opportunities in the Lower East Fork Lewis Basin. This effort resulted in a list of preliminary project opportunities and monitoring actions (projects). Projects on the list were subsequently put through a prioritization process (Chapter 5) in order to determine the sub-set of projects to carry forward for conceptual designs.

Project identification relied on office- and field-based approaches and was built off of past studies that identified habitat enhancement opportunities. Project identification focused on project opportunities in high priority reaches and on the primary life-stage limiting factors for the target fish species. Selection of project opportunities was guided by the reach-level strategies and goals developed in coordination with the Working Group.

Office-based identification of project opportunities

The office-based approach began by identifying projects that addressed the primary life-stage limiting factors for a particular reach and the reach-level strategies and goals developed in coordination with the Recovery Plan, Habitat Work Schedule, and Working Group input (Appendix A). Projects which met both the biologic and strategic criteria were added to the list of preliminary project opportunities. Information on project opportunities was compiled from:

1. previous studies
2. information received from EFWG and other community members
3. GIS-based aerial photo interpretation of potential project sites

Field-based identification of project opportunities

One week of field surveys was conducted for this effort. The field surveys were conducted during the first week of September 2008. Personnel conducting field surveys had expertise in fisheries biology and hydrology/geomorphology. Field surveys were first conducted in high priority (Tier 1) mainstem reaches and were followed by surveys of Tier 1 tributary reaches and then lower priority mainstem and tributary reaches as time and access allowed. Foot-based field surveys were conducted on the mainstem East Fork Lewis from Lewisville Park to backwater (approximately Mason Creek confluence). Surveys in tributaries were conducted on foot where access could be obtained. In areas without landowner permission for access, field surveys relied on what could be seen from road-stream crossings or other publicly-accessible points.

Field data collection was limited only to that needed for project conceptual designs and to ensure that projects could be adequately evaluated for the prioritization exercise. Data collection included some or all of the following measures (not all measures were taken at each site):

- Location information (GPS measurement and description)
- Extent of the problem/limiting factor (using range finder, tape measure, visual estimates, or aerial photo/GIS-based measures)

- Geomorphic site conditions, including channel processes and trends, substrate/sediment conditions, and hydrologic characteristics
- Vegetation conditions (including type and extent of invasive species)
- Stream temperature (i.e. spot measurements of temperature gradients between mainstem and off-channel sites)
- Occurrence and location of groundwater/spring inflow sources
- Sediment/substrate characterizations (visual observations)
- Channel conditions (e.g. streambank heights and slopes for conceptual designs using tape measure, hand-level, or clinometer)
- Habitat conditions (e.g. habitat unit types, presence of LWD)
- Access conditions for implementation
- Site photos and field sketches

Project descriptions

Information at each project opportunity area was compiled into the project list. Project information included some or all of the following elements depending on the site and the project type:

- Location information (location description and river mile)
- Species and life-stage use and potential use
- Problem/limiting factor present at site
- Contributing cause of limiting factor
- Recommended approaches to treat limiting factor(s) (with alternative approaches as appropriate)
- Benefit to fish and fish habitat that will be gained from the project alternatives
- Estimate of cost ranges for treatment types
- Logistical issues (constraints) including access and feasibility
- Data gaps / information needs

**preservation opportunities were also identified in areas with healthy, functioning habitat conditions that may be at risk of degradation.*

The project opportunity list was distributed to the Working Group and was discussed and refined at subsequent Working Group meetings.

Preliminary project cost estimates

Preliminary cost estimates were developed for each identified enhancement project in order to assist with project evaluation and prioritization. Construction costs were generated using per-unit values derived from a 25-year database of completed stream habitat restoration projects, and with reference to published heavy construction cost data (i.e. RS Means). All costs were escalated to 2009 values.

Per-unit costs were developed for a range of project type categories. Within each category, high, medium, and low values were established. These represent a range of costs that vary depending on a number of factors including stream size, bank height, machinery access, material source locations, and excavation extents. The project type categories and per-unit values are presented in Table 7. These values served as a guide for estimating construction costs.

A design and contingency multiplier was factored in at 35%. The cost estimates are provided as ranges in order to reflect the uncertainties associated with estimating costs at this preliminary project identification stage. Plus or minus 20% was used to calculate the range.

Cost estimates include the following assumptions:

- All materials and services are purchased outright. Costs may be considerably less than the ranges provided if materials or labor are donated.
- Costs include environmental permitting
- Costs do not include follow-up monitoring
- Costs do not include acquiring conservation easements

*Note: For projects carried forward to the conceptual design phase, more comprehensive cost estimates were developed.

Table 7. Guidelines used to generate project costs.

Project Type	Unit	Level of effort	Cost per unit	Definitions
Habitat enhancement (wood additions for habitat) ●includes adding single pieces and accumulations of wood for habitat and channel structure; and minor grading associated with installations	LF	Low	$100	small channel (<15 ft wide), minimal ballasting requirements, easy access
		Avg	$200	medium channel (15-30 ft wide), moderate ballasting requirements, moderate access
		High	$350	large channel (>30 ft wide), high ballasting requirements, difficult access
Mainstem bank structures ●includes meander-bend log jams with boulder and log ballast, grading, revegetation, erosion control	LF	Low	$150	easy access, bank height <3 ft, low ballasting requirements
		Avg	$300	moderate access, bank height 3-8 ft, moderate ballasting requirements, single soil lift or soil lift only in places
		High	$450	difficult access, bank height >8 ft, high ballasting requirements, soil lifts for bank stabilization, de-watering
Side-channel, groundwater channel ●includes excavation, grading, wood additions, planting, access road construction	SF	Low	$10	1-3 ft excavation depth, easy access
		Avg	$18	3-5 ft excavation depth, moderate access
		High	$26	>5 ft excavation depth, difficult access
Passage improvement ●large cost variation depending on site. These values are only used as a very general guide.	EA	Low	$30,000	small channel (<10 ft wide) culvert replacement or diversion structure removal
		Avg	$100,000	medium channel (10-20 ft wide) culvert replacement, small dam removal
		High	$300,000	large channel (>20 ft wide) culvert replacement, bridge construction, dam removal
Channel construction / re-configuration ●Includes excavation, re-grading, habitat enhancements using rock and wood, erosion control, bank stabilization, re-vegetation	LF	Low	$150	small channel (<10 ft wide, <2 ft deep), easy access, minimal soil lifts, on-site source for materials
		Avg	$400	medium channel (10-30 ft wide, 2-4 ft deep), moderate access, material source nearby, intermittent soil lifts
		High	$700	wide channel (>30 wide, >4 ft deep), difficult access, continuous soil lifts, imported gravels
Riparian ●includes clearing invasives, planting, watering, brush control, browse control	SF	Low	$0.50	bare root seedlings, live stakes, 10 ft spacing; minimal need for invasive control, brush control, browse control, or watering
		Avg	$1.50	intermediate between low and high
		High	$2.50	container stock, soil amendments, abundant invasives, high need for brush and browse control, intensive watering needs
Levee removal ●includes excavation and hauling material to a nearby off-site location. Includes erosion control	LF	Low	$50	easy access, on-site disposal, small levee
		Avg	$100	moderate access, nearby disposal, medium levee
		High	$150	difficult access, off-site disposal, large levee

CHAPTER 5 – METHODS FOR PROJECT PRIORITIZATION

Overview

This section outlines the methodology for prioritizing potential stream habitat enhancement opportunities in the Lower East Fork Lewis Basin. This effort takes the list of preliminary project opportunities identified from the in-office and field evaluation efforts and scores them according to how well they meet a number of stream habitat restoration objectives. All projects submitted for scoring meet the following criteria:

- The approach meets the goals and objectives of the Recovery Plan, Habitat Work Schedule, and EFWG,
- The approach is technically appropriate, and
- The project is coordinated with other habitat protection and restoration efforts in the watershed.

Project scoring results help determine appropriate project sequencing in the lower basin and are used to determine which projects are carried forward for conceptual designs.

The prioritization system focuses on evaluating projects according to the potential fish benefits. Fish benefits can be generally defined as the degree to which projects address key life-stage limiting factors for the populations of interest. Each project is assigned fish benefit ratings of High, Medium, or Low as well as a numerical score. This prioritization method is very similar and compatible with the LCFRB Habitat Work Schedule Evaluation Criteria for evaluating "benefits to fish"; and is expected to yield similar results.

In addition to the fish benefit score and H, M, L rating, projects are given a cost/benefit score. Projects also include discussions of special considerations associated with the project. Fish benefit scores, cost/benefit scores, and special considerations are used as tools to determine which projects are carried forward to the conceptual design phase. Final selection of projects to carry forward is determined through discussions with the EFWG.

Benefits to fish

Benefit ratings are high, medium, and low and the maximum benefit score is 200 points. Benefit to fish ratings and scores are the sum of:

- A population/reach rating and score, and
- A benefit rating and score (including protection/access/restoration rating and score).

Population/reach ratings and score: Population/reach ratings and scores reflect the degree to which a project targets priority populations and reaches.

Population/reach rating: A project's Population/Reach Rating is based on the Tier of the targeted reach or reaches. Tier ratings are assigned in the Recovery Plan based on the following rules.

Table 8. Reach tier designation rules (source, LCFRB 2004).

Reaches	Rule
Tier 1	All high priority reaches (based on EDT) for one or more primary populations.
Tier 2	All reaches not included in Tier 1 and which are medium priority reaches for one or more primary population and/or all high priority reaches for one or more contributing populations.
Tier 3	All reaches not included in Tiers 1 and 2 and which are medium priority reaches for contributing populations and/or high priority reaches for stabilizing populations.
Tier 4	Reaches not included in Tiers 1, 2, and 3 and which are medium priority reaches for stabilizing populations and/or low priority reaches for all populations.

If a project targets a Tier 1 reach or Tier 1 reaches, it received a "High" rating. If it targets no Tier 1 reach or reaches, but targets one or more Tier 2 reaches, it received a "Medium" rating. If it targets only Tier 3 or 4 reaches, it received a "Low" rating.

Population/reach score: In addition to its Population/Reach Rating, each project received a Population/ Reach Score. This score reflects that reaches within a given Tier may be utilized by a varying number of populations of varying recovery classifications and that the targeted reach or reaches may be of varying importance to the populations. The score is the cumulative total of the Population Classification (Primary = 3, Contributing = 2, Stabilizing =1) plus the Species Reach Potential (High=3, Medium=2, Low=1) for each population using the targeted reach or reaches. The definitions of population classifications are provided in Table 3. For multiple reach assessments and habitat projects, Population/ Reach Score is the average of the Population/ Reach scores for the individual reaches. The Population Classifications and Species Reach Potential ratings were taken from the Recovery plan. The maximum Population/ Reach Score is 100 points.

Table 9. Salmon and trout population classifications (source, LCFRB 2004a)

Population Classification	Viability Goal	Description	Persistence Probability[1]
Primary (P)	High (H) or High+ (H+)	Low (negligible) risk of extinction (represents a "viable" level)	95-99%
Contributing (C)	Medium (M)	Medium risk of extinction	75-94%
Stabilizing (S)	Low (L)	Stable, but relatively high risk of extinction	40-74%

[1]100-year persistence probabilities (LCFRB 2004)

Benefit ratings and scores (protection/access/restoration – PAR): Benefit ratings and scores reflect whether a project targets priority habitat project needs and the extent to which the project would address those needs. Benefit ratings are High, Medium, and Low and the maximum score is 100 points. The benefit ratings and scores reflect the degree to which the project affects the following elements: 1) habitat protection, 2) Access to blocked habitats, and 3) habitat restoration. The methods for scoring habitat assessments are also described.

**Note: The benefit rating and score differs from the LCFRB TAC scoring methodology in that the TAC scoring also factors in project cost. Because costs can vary dramatically depending on how conceptual project opportunities are configured (e.g. grouping multiple*

activities into one project vs. splitting them out) costs for East Fork Lewis project opportunities are not included in the scoring. Instead, a cost benefit score is calculated separately and is used as an independent consideration for evaluating project benefits.

1. **Protection**
   a. Rating: the protection benefit rating is based on the EDT protection value for the targeted reach or reaches using the flowing scale. EDT reach protection values can be found in the Recovery Plan.

Table 10. Protection benefit rating

EDT Reach Protection Value	Protection Rating
>50%	High
25 to 49%	Medium
<25%	Low

   b. Score: the protection score is the product of the Protection Rating times the number of habitat units. For protection elements, one habitat unit equals 500 feet of stream length on both sides or 1,000 feet of stream length on one side of the stream.

2. **Access**
   a. Rating: The access rating is based on the following two elements:

Habitat quality – Habitat quality is the quality of the habitat that would be made available. It is calculated as the average of upstream Tier reach ratings, where Tier 1 = 4 points, Tier 2 = 3 points, and Tier 4 = 1 point (there are no Tier 3 reaches in the East Fork Lewis Basin; nevertheless, the score values are kept consistent with the LCFRB TAC scoring methods). An average Tier score of 3 or greater is "high", 2 but less than 3 is "medium", and less than 2 is "low".

Passage improvement factor – The passage improvement factor is the degree to which passage will be restored at the barrier. It is calculated as 100% less the current passability percentage of the barrier. A score of 60 to 100% is "high", 30 to 59% is "medium" and <30% is "low".

The overall Access rating is derived using the following matrix.

Table 11. Access rating matrix

		Habitat Quality		
		High	Medium	Low
Passage Improvement	High	High	High	Medium
	Medium	High	Medium	Low
	Low	Medium	Low	Low

b. Score: The access score is the product of the passage improvement percentage (see Passage Improvement Factor above) times the habitat quality factor times the habitat quantity factor. The habitat quality factor and habitat quantity factor are determined from the following table.

Table 12. Habitat quality and habitat quantity factors

Habitat Quantity (miles of accessible upstream habitat that will be restored)	Quantity Factor	Habitat Quality Rating (see description above)	Quality Factor
5+ miles	10	High	10
2 to 4.9 miles	6	Medium	6
1 to 1.9 miles	4	Low/Unknown	2
0.5 to 0.9 miles	2		
<0.5 miles	1		

3. Restoration

a. Rating: The restoration rating is based on the EDT-derived multiple species restoration type ratings (High, Medium, Low) provided in the 6-Year Habitat Work Schedule for the reaches targeted by a project. For each reach, the ratings for the restoration types covered by the project are averaged and rounded up to the next highest rating.

b. Score: The restoration Score is the sum of the benefit score for each restoration type covered by the project. The benefit score of each restoration type is the product of the restoration type rating (High = 3, Medium = 2, Low = 1) times the number of habitat units times an effectiveness factor. A habitat unit equals:

(1) 500 feet on both sides of the stream or 1000 feet on one side of the stream for riparian, floodplain, and hillslope process project types; or
(2) 500 feet of stream length for instream project types.

The effectiveness factor reflects a percentage estimate of the extent to which the project would address the project type within the targeted habitat unit. For example, if the project were deemed to be fully effective in creating instream habitat structure it would receive an effectiveness factor of 100%.

4. Assessment

Assessment projects are important in identifying site-specific restoration opportunities and developing project designs. However, since they do not result in tangible on-the ground benefits the scoring process was amended to allow these projects to be ranked along with on-the-ground projects. The assessment score is based on the restoration score or the protection score, whichever is most applicable to the assessment effort. Since assessments often involve multiple reaches, an average, rather than the sum, of their restoration

or preservation benefits is used. When the restoration score is used, an effectiveness factor of 10 percent is used for all restoration project types being addressed in the assessment. Finally, the average restoration or protection benefit score is weighted to give a higher priority to assessment focusing on comprehensive prescriptions for multiple reaches. This is done by multiplying the average restoration or protection benefit score for an assessment covering 5 or more reaches by a factor of 1.25. An assessment covering 1 or 2 reaches is multiplied by 0.75.

5. **Total benefit ratings and scores (PAR)**
   a. Rating: A project is given an overall PAR rating of High, Medium, or Low based on the rating of the project's predominate type and reach or if the project is felt to address several project types to an equal or similar degree an average of the project type ratings was used.

   b. Score: A project's overall PAR score is the sum of its protection, access, restoration and assessment scores. Protection, access, restoration and assessment scores are normalized so that they carry equal weight. The score range for the PAR component is 0 to 100 points.

Final fish benefit ratings and scores

Rating: A project's overall benefit rating is a combination of the Population/Reach and PAR ratings and is determined using the following matrix.

Score: A project's overall Benefit Score is the sum of its Population/Reach Score and its PAR score. The numerical score is used to rank projects.

Table 13. Overall benefit rating matrix

		Protection/Access/Restoration Rating		
		High	Medium	Low
Population/Reach Rating	High	High	Medium	Low
	Medium	Medium	Medium	Low
	Low	Low	Low	Low

Cost benefit score

Each project is given a cost benefit score. The cost benefit score is calculated separately from the Fish Benefit Score. In this regard, this scoring differs from the LCFRB TAC scoring method, which factors cost benefit into the Fish Benefit Score. The cost benefit score is actually a benefit/cost score. It is calculated by taking the project Fish Benefit Score and dividing it by the estimated project cost. These values are then normalized to a maximum of 100 points.

Special considerations

If a project has special considerations, or constraints or opportunities that may affect the ability to implement the project successfully, these are discussed in the project descriptions (see Chapter 6). Special considerations may reflect landowner issues, sequencing issues, relationships to other projects, and physical, legal, social, or cultural considerations.

CHAPTER 6- PROJECT OPPORTUNITIES, PRIORITIZATION, AND CONCEPTUAL DESIGNS

Overview

Project opportunities and prioritization

A total of 55 project opportunities were identified on the lower East Fork Lewis River and tributaries. Projects were identified and scored according to the methods described in Chapters 4 and 5. In some cases, projects were amended based on input from the East Fork Working Group. Final ranking of projects occurred by first ranking projects according to their reach tier and then ranking projects according to their final benefit score. The cost-benefit score was not used to rank projects, but was included as a reference for determining which projects were carried forward to the conceptual design phase. Final project ranking was modified slightly by the Working Group. The final ranked project list can be found below in Table 14, followed by a table including the project cost estimates (Table 15). Project locator maps are included as well as descriptions of each of the 55 projects.

Conceptual Designs

A total of 13 projects were selected for development of conceptual designs. Selection of these projects was based on project scores, special considerations, and discussions/input of the Working Group. Table 14 indicates the projects that were carried forward to the conceptual design phase. In some cases, high ranking projects were not carried forward and lower ranking projects were carried forward. Considerations for making these determinations included whether or not landowners were amenable to developing conceptual designs and whether projects were already planned or underway for the site.

The conceptual designs are included as Attachment 1.

Prioritized project list

Table 14. Ranked project list.

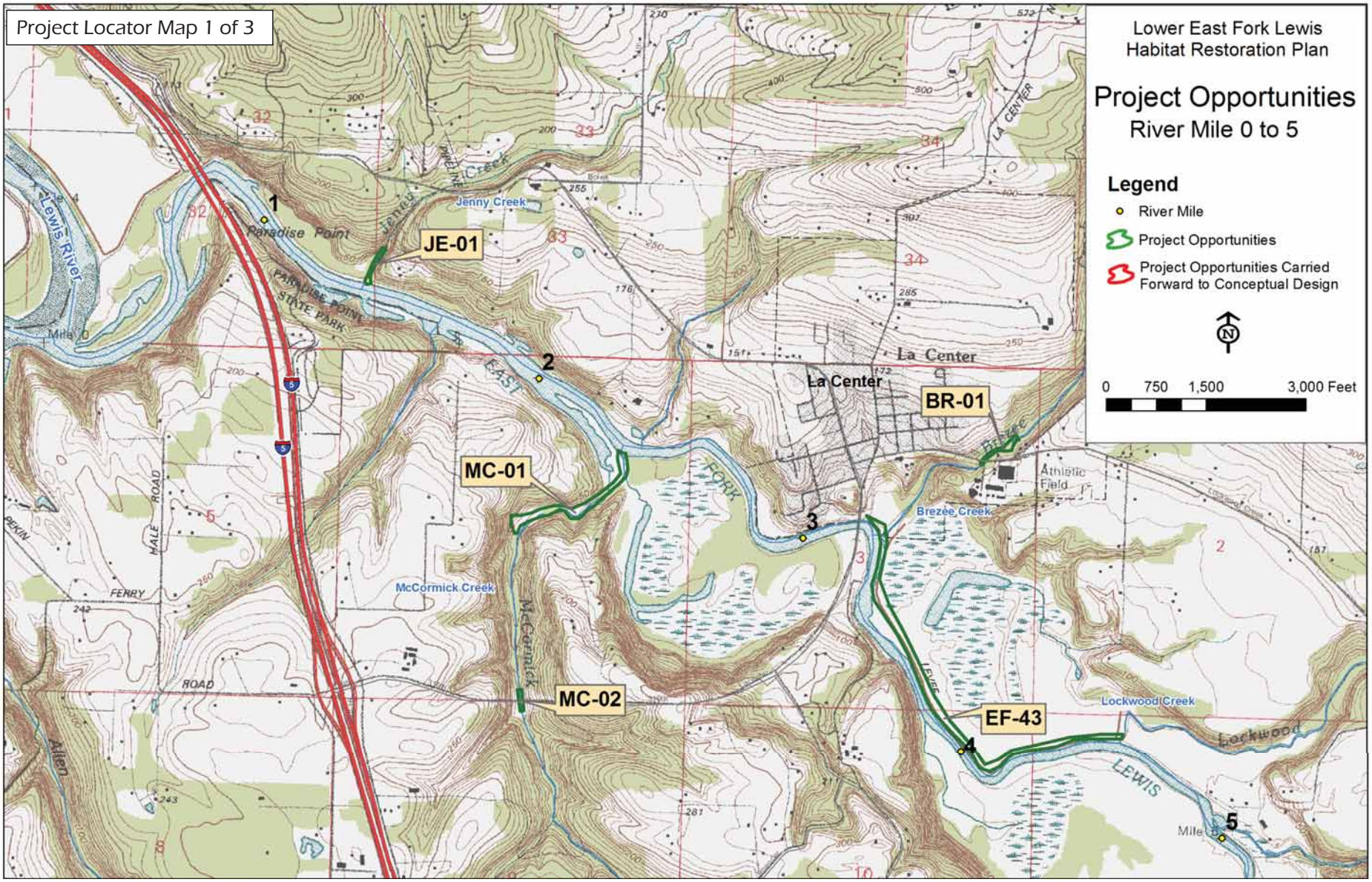
Project ID#	Project Name	River Mile	Rch Tier	Final Benefit Score	Cost Benefit Score	Selection for Concept Design	Comment
EF-A 02	Daybreak Pits avulsion risk assessment	7.3 - 9.5	1	123	--	Yes (study concept)	High scoring project (moved to top of list per EFWG decision)
EF 28	Side-channel habitat enhancement	9 - 9.5	1	140	9	Yes	
EF 13	Side/off-channel restoration	11.7 - 12.3	1	139	7		Private land (permission not granted)
EF 41	Riparian restoration	5.7 - 7.3	1	127	29	Yes	
EF 26	Streambank / in-channel habitat enhancement	9.5	1	126	10		Design funding pending
MS 01	Lower Mason habitat enhancement	0 - 1	2*	126	12	Yes	
EF 10	Side-channel habitat enhancement	13 - 13.5	1	123	10	Yes	
EF 21	Side-channel habitat enhancement	10.5	1	119	18	Yes	
MN 02	Manley Creek habitat enhancement (downstream of 259th)	0.2 - 0.75	2*	117	19	Yes	
EF 42	Levee and drainage ditch removal	5.1	1	117	55	Yes	
EF 14	Side/off-channel restoration	11.6	1	116	12		Private land (permission not granted)
DE 02	Lower Dean Creek channel enhancement (upstream portion)	0.4 - 0.9	1	115	20		Private land (permission not granted)
EF 20	Side-channel and backwater habitat enhancement	10.7	1	114	13	Yes	
EF 12	Instream habitat enhancement	11 - 11.3	1	111	17	Yes	
EF 24	Side-channel / off-channel restoration	10	1	111	26		Design funding pending
EF 16	Side/off-channel restoration	11.3	1	110	12		
EF 07	Side-channel / in-channel enhancement	13.7	1	109	14		
EF-A 01	Ridgefield Pits alternatives assessment	7.3 - 8.3	1	108	--	Yes (study concept)	EFWG decision to move forward to Conceptual Design
EF 02	Side/off-channel restoration	14.5	1	107	9		
EF 25	Side-channel restoration	9.7	1	106	22		Design funding pending
EF 22	Chum channel	10.2	1	105	24		Private land (permission not granted)
DE 01	Lower Dean Creek channel enhancement (downstream portion)	0 - 0.4	1	104	21		Project underway at this site
EF 27	Off-channel restoration	9.5	1	104	43		Design funding pending
EF 18	Streambank / in-channel habitat enhancement	10.9	1	103	21		
EF 09	Side-channel restoration	13.3	1	102	27		
EF 34	Streambank restoration; channel structure	7.2	1	102	42		
EF 17 (A)	Riparian restoration	11 - 11.7	1	101	100		
EF 17 (B)	Riparian restoration	12.2 - 12.8	1	101	100		
EF 08	Riparian restoration / Streambank enhancement	13.6 - 13.9	1	101	43		
EF 11	Side/off-channel restoration	12.5	1	101	13		
EF-A 03	Temperature and groundwater assessment	5.7 - 15	1	101	--	Yes (study concept)	EFWG decision to move forward to Conceptual Design
EF 01	Side-channel restoration	14.6	1	101	30		
EF 15	Streambank (rip-rap) enhancement	11.5	1	100	31		
EF 35	Remove rip-rap / in-channel enhancement	6.8	1	99	12		
MN 03	Manley Creek passage restoration and habitat enhancement (upstream of 259th)	0.75 - 1.5	1	99	7		
EF 04	Streambank / in-channel enhancement	14.1	1	98	29		
EF 03	Side-channel restoration	14.4	1	96	50		
EF 05	Off-channel habitat enhancement	14	1	96	31	Yes	Unique temperature refuge opportunity
EF 06	Streambank enhancement	13.9	1	93	--		
EF 39	Off-channel enhancement	6.1	1	93	34		
EF 36	Remove rip-rap / in-channel enhancement	6.6	1	90	22		
EF 38	Off-channel enhancement	6.3	1	90	47		
EF 40	Streambank restoration; channel structure	6.1	1	85	52		
EF 37	Enhance rip-rap	6.5	1	83	68		
BR 01	Brezee Creek Dam		1	74	7		
DE-P 01	Dean Creek land acquisition	0.4-0.9	1	63	--		
MC 04	Residential pond reach 1G and 1H		1	61	10		
MC 03	Residential pond reach 1 D		1	53	49		
MI 01	Mill Creek 1 C habitat enhancement	1 - 1.3	1	46	9		
JE 01	Lower Jenny Cr channel enhancement and off-channel creation	0 - 0.13	1	46	9		
MC 01	Lower McCormick channel enhancement	0 - 0.6	2	127	13		
MC 02	Restore passage at La Center Road Crossing	1	2	67	5		
MS 02	Mason channel enhancement reach 3-4	3.2 - 3.6	2	46	8		
DY 02	Dyer reach 4 channel and passage enhancement	1.3 - 1.6	2	44	5		
EF 43	Levee removal/set-back	3.2 - 4.4	4	112	13		

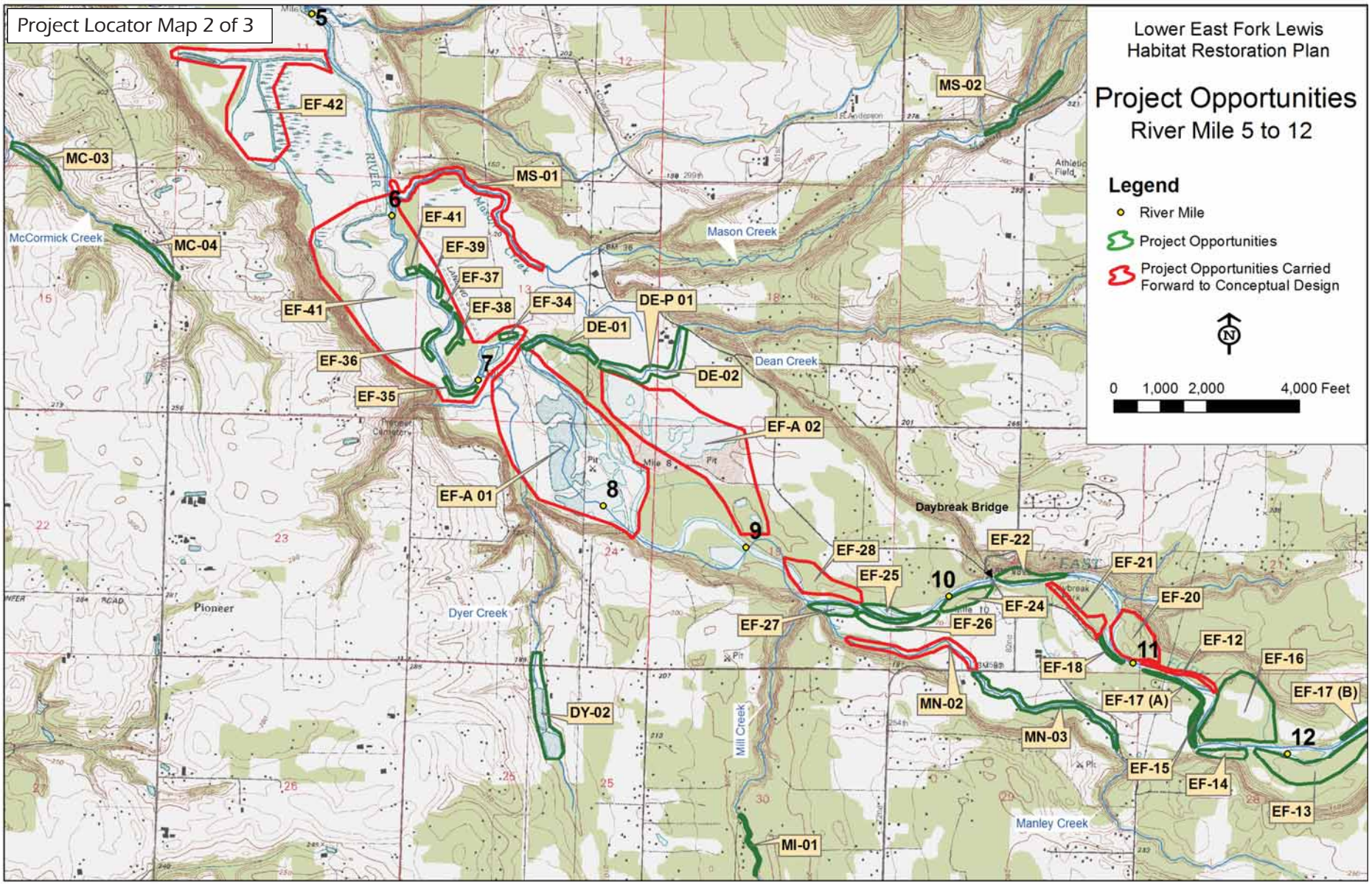
**These projects are located in Tier 2 reaches but were ranked as Tier 1 due to the habitat benefits accrued to fish originating in adjacent downstream Tier 1 reaches*

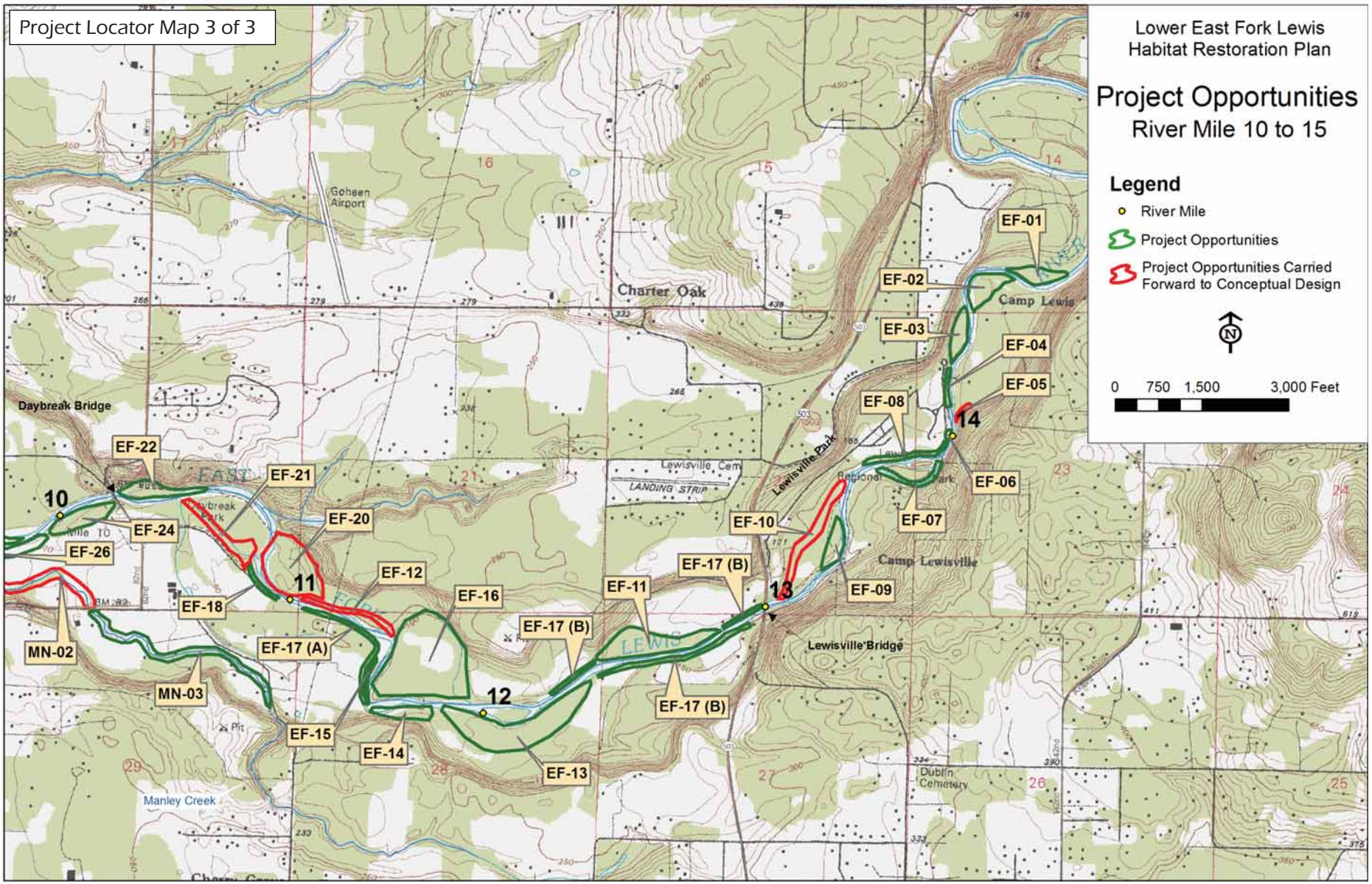
Project cost estimates

Table 15. Preliminary project cost estimates.

Project ID#	Project Name	Construction Cost Range Estimate	Cost Range Estimate (includes A& E and contingency)	Comment
EF-A 02	Daybreak Pits avulsion risk assessment			See conceptual design for cost detail
EF 28	Side-channel habitat enhancement			See conceptual design for cost detail
EF 13	Side/off-channel restoration	$563,000 - $845,000	$760,000 - $1,140,000	
EF 41	Riparian restoration			See conceptual design for cost detail
EF 26	Streambank / in-channel habitat enhancement	$360,000 - $540,000	$486,000 - $729,000	
MS 01	Lower Mason habitat enhancement			See conceptual design for cost detail
EF 10	Side-channel habitat enhancement			See conceptual design for cost detail
EF 21	Side-channel habitat enhancement			See conceptual design for cost detail
MN 02	Manley Creek habitat enhancement (downstream of 259th)			See conceptual design for cost detail
EF 42	Levee and drainage ditch removal			See conceptual design for cost detail
EF 14	Side/off-channel restoration	$282,000 - $422,000	$380,000 - $570,000	
DE 02	Lower Dean Creek channel enhancement (upstream portion)	$173,000 - $259,000	$233,000 - $350,000	
EF 20	Side-channel and backwater habitat enhancement			See conceptual design for cost detail
EF 12	Instream habitat enhancement			See conceptual design for cost detail
EF 24	Side-channel / off-channel restoration	$127,000 - $190,000	$171,000 - $257,000	
EF 16	Side/off-channel restoration	$264,000 - $396,000	$356,000 - $535,000	
EF 07	Side-channel / in-channel enhancement	$224,000 - $336,000	$302,000 - $454,000	
EF-A 01	Ridgefield Pits alternatives assessment			See conceptual design for cost detail
EF 02	Side/off-channel restoration	$365,000 - $547,000	$492,000 - $739,000	
EF 25	Side-channel restoration	$141,000 - $211,000	$190,000 - $285,000	
EF 22	Chum channel	$128,000 - $192,000	$173,000 - $259,000	
DE 01	Lower Dean Creek channel enhancement (downstream portion)	$144,000 - $216,000	$194,000 - $292,000	
EF 27	Off-channel restoration	$72,000 - $108,000	$97,000 - $146,000	
EF 18	Streambank / in-channel habitat enhancement	$144,000 - $216,000	$194,000 - $292,000	
EF 09	Side-channel restoration	$113,000 - $169,000	$152,000 - $228,000	
EF 34	Streambank restoration; channel structure	$72,000 - $108,000	$97,000 - $146,000	
EF 17 (A)	Riparian restoration	$30,000 - $45,000	$41,000 - $61,000	
EF 17 (B)	Riparian restoration	$30,000 - $45,000	$41,000 - $61,000	
EF 08	Riparian restoration / Streambank enhancement	$70,000 - $105,000	$95,000 - $142,000	
EF 11	Side/off-channel restoration	$229,000 - $343,000	$309,000 - $463,000	
EF-A 03	Temperature and groundwater assessment			See conceptual design for cost detail
EF 01	Side-channel restoration	$99,000 - $148,000	$133,000 - $200,000	
EF 15	Streambank (rip-rap) enhancement	$96,000 - $144,000	$130,000 - $194,000	
EF 35	Remove rip-rap / in-channel enhancement	$240,000 - $360,000	$324,000 - $486,000	
MN 03	Manley Creek passage restoration and habitat enhancement (upstream of 259th)	$406,000 - $609,000	$548,000 - $822,000	
EF 04	Streambank / in-channel enhancement	$100,000 - $150,000	$135,000 - $203,000	
EF 03	Side-channel restoration	$56,000 - $84,000	$76,000 - $114,000	
EF 05	Off-channel habitat enhancement			See conceptual design for cost detail
EF 06	Streambank enhancement	$5,000 - $7,000	$6,000 - $10,000	
EF 39	Off-channel enhancement	$80,000 - $120,000	$108,000 - $162,000	
EF 36	Remove rip-rap / in-channel enhancement	$120,000 - $180,000	$162,000 - $243,000	
EF 38	Off-channel enhancement	$56,000 - $84,000	$76,000 - $113,000	
EF 40	Streambank restoration; channel structure	$48,000 - $72,000	$65,000 - $97,000	
EF 37	Enhance rip-rap	$36,000 - $54,000	$49,000 - $73,000	
BR 01	Brezee Creek Dam	$320,000 - $480,000	$432,000 - $648,000	
DE-P 01	Dean Creek land acquisition	NA	NA	
MC 04	Residential pond reach 1G and 1H	$176,000 - $264,000	$238,000 - $356,000	
MC 03	Residential pond reach 1 D	$32,000 - $48,000	$43,000 - $65,000	
MI 01	Mill Creek 1 C habitat enhancement	$144,000 - $216,000	$194,000 - $292,000	
JE 01	Lower Jenny Cr channel enhancement and off-channel creation	$150,000 - $226,000	$203,000 - $305,000	
MC 01	Lower McCormick channel enhancement	$288,000 - $432,000	$389,000 - $583,000	
MC 02	Restore passage at La Center Road Crossing	$400,000 - $600,000	$540,000 - $810,000	
MS 02	Mason channel enhancement reach 3-4	$168,000 - $252,000	$227,000 - $340,000	
DY 02	Dyer reach 4 channel and passage enhancement	$248,000 - $372,000	$335,000 - $502,000	
EF 43	Levee removal/set-back	$260,000 - $390,000	$351,000 - $527,000	


Project Locator Map 1 of 3
Lower East Fork Lewis
Habitat Restoration Plan
Project Opportunities
River Mile 0 to 5
Legend
River Mile
Project Opportunities
Project Opportunities Carried Forward to Conceptual Design
0 750 1,500 3,000 Feet
JE-01
MC-01
MC-02
BR-01
EF-43
1
2
3
4
5
Paradise Point
Jenny Creek
Lewis River
La Center
McCormick Creek
Brezee Creek
Lockwood Creek
Athletic Field
LEWIS
EAST FORK
Mile 0
Mile 5


Project Locator Map 2 of 3
Lower East Fork Lewis
Habitat Restoration Plan
Project Opportunities
River Mile 5 to 12
Legend
River Mile
Project Opportunities
Project Opportunities Carried Forward to Conceptual Design
N
0 1,000 2,000 4,000 Feet
5
6
7
8
9
10
11
12
MC-03
MC-04
EF-42
EF-41
EF-39
EF-37
EF-38
EF-34
EF-36
EF-35
MS-01
MS-02
DE-P 01
DE-01
DE-02
EF-A 02
EF-A 01
EF-28
EF-25
EF-27
EF-22
EF-21
EF-20
EF-24
EF-26
EF-12
EF-16
EF-18
EF-17 (A)
EF-17 (B)
MN-02
MN-03
EF-15
EF-14
EF-13
DY-02
MI-01
McCormick Creek
Mason Creek
Dean Creek
Dyer Creek
Mill Creek
Manley Creek
Daybreak Bridge
Pioneer
Pioneer Cemetery
Mile 8
Mile 10
Pit
RIVER
MIDDLE FORK LANCASTER CREEK


Project Locator Map 3 of 3
Lower East Fork Lewis
Habitat Restoration Plan
Project Opportunities
River Mile 10 to 15
Legend
River Mile
Project Opportunities
Project Opportunities Carried Forward to Conceptual Design
N
0 750 1,500 3,000 Feet
EF-01
EF-02
EF-03
EF-04
EF-05
EF-06
EF-07
EF-08
EF-09
EF-10
EF-11
EF-12
EF-13
EF-14
EF-15
EF-16
EF-17 (A)
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Project descriptions

Project Name: Side-channel restoration **Project ID#:** EF 01

Reach Name: EF Lewis 8B

River Mile: 14.6

Location Description:
River right 0.4 miles upstream of upper Lewisville Park boat access

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
This is an old channel location and is within 100 feet of the existing channel. It is likely active at moderate winter flow levels but it is not active at low summer flows. This is an active channel adjustment, which needs to be considered during design.

Project Objective:
Enhance connectivity of side-channel to be active at low summer flows. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Need to evaluate in context of active lateral adjustment area. As part of this objective, it will be important to evaluate and address the effects of flow reduction that would occur in the mainstem.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project. There may be possible access from adjacent private lands, if landowner permission can be obtained.

Major Life Stages Addressed:
Coho - spawning, egg incubation, fry colonization, juvenile rearing
Fall Chinook - spawning, egg incubation, fry colonization, early rearing
Chum - spawning, egg incubation
Steelhead - spawning, egg incubation, juvenile rearing

Limiting Factors Addressed:
Habitat diversity, key habitat quantity, channel stability, temperature

Data Gaps / Needs:
Total length not surveyed. ID source for sand deposits in channel.

Project Name: Side/off-channel restoration **Project ID#:** EF 02

Reach Name: EF Lewis 8B

River Mile: 14.5

Location Description:
River left bank upstream of Lewisville Park

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Potentially available side-channel habitat is only accessible during flood flows. Temperatures taken

during the survey show that isolated pools in the channel are 2 deg F cooler than mainstem, suggesting good hyporheic flow. There are abundant invasive plant species.

Project Objective:
Increase the availability of year round active side-channel and off-channel habitat. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. At least one low-flow season of groundwater monitoring is recommended to support final designs. Reforest riparian and floodplain areas with native and locally-adapted species. As part of this objective, it will be important to evaluate and address the effects of flow reduction that would occur in the mainstem.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project. There may be difficult access. There is possible access from Lewisville Park across the river. The access conditions via the south bank are unknown.

Major Life Stages Addressed:
Coho - spawning, egg incubation, fry colonization, juvenile rearing
Fall Chinook - spawning, egg incubation, fry colonization, early rearing
Chum - spawning, egg incubation
Steelhead - spawning, egg incubation, juvenile rearing

Limiting Factors Addressed:
Habitat diversity, key habitat quantity, channel stability

Data Gaps / Needs:
Seasonality of hyporheic flow

Project Name: Side-channel restoration **Project ID#:** EF 03

Reach Name: EF Lewis 8B

River Mile: 14.4

Location Description:
River right just downstream of upper Lewisville Park boat access

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
This is a side-channel/flood overflow channel that is within 100 feet of the existing channel. It is just downstream of the upper boat ramp in Lewisville Park. It is not active at summer flow levels. The inlet is perched several feet above the low summer water level, possibly as a result of grading of the boat ramp/parking lot area.

Project Objective:
Ensure consistency with Clark County objectives for boat ramp area. Enhance connectivity of side-channel to be active at low summer flows. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Need to evaluate in context of boat ramp area. As part of this objective, it will be important to evaluate and address the effects of flow reduction that would occur in the mainstem.

Special Considerations:
This project is located on Clark County property (Lewisville Regional Park). Designs should be coordinated with Clark County Parks Department staff. County concerns include bank protection, flood control, maintenance, and interface with park facilities.

Major Life Stages Addressed:
Coho - spawning, egg incubation, fry colonization, juvenile rearing
Fall Chinook - spawning, egg incubation, fry colonization, early rearing
Chum - spawning, egg incubation
Steelhead - spawning, egg incubation, juvenile rearing

Limiting Factors Addressed:
Habitat diversity, key habitat quantity, channel stability

Data Gaps / Needs:
See Objectives above

Project Name: Streambank / in-channel enhancement **Project ID#:** EF 04

Reach Name: EF Lewis 8B

River Mile: 14.1

Location Description:
River right along ball field at Lewisville Park

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Steep eroding bank (15 ft tall) along park with failing bio-engineered bank treatments, bike path on top, and narrow or non-existent riparian buffer. Lack of instream cover.

Project Objective:
Enhance channel structure and habitat while also providing bank stability and protection of Lewisville Park property. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Reforest the streambank and riparian area with native and locally-adapted species.

Special Considerations:
This project is located on Clark County property (Lewisville Regional Park). Designs should be coordinated with Clark County Parks Department staff. County concerns include bank protection, flood control, maintenance, and interface with park facilities.

Major Life Stages Addressed:
Coho - egg incubation, fry colonization, juvenile rearing
Fall Chinook - egg incubation, fry colonization, early rearing
Steelhead - egg incubation, juvenile rearing

Limiting Factors Addressed:
Habitat diversity, channel stability, sediment load

Data Gaps / Needs:
Detailed site investigation, including topographic survey, geomorphic analysis, and development of potential alternatives

Project Name: Off-channel restoration **Project ID#:** EF 05

Reach Name: EF Lewis 8B

River Mile: 14

Location Description:
River left near Boy Scout camp. Across the river and just upstream from Lewisville Park swim beach.

Species Use:
Coho, steelhead

Site Description:
This site is located on Boy Scouts property. There is a small trib that enters the mainstem on the river left bank that contains cool water input during the summer. Temperatures in the tributary were 10 deg F cooler than the mainstem at the time of the survey. There is good adjacent spawning in the mainstem. Site observations and temperatures suggest suitable groundwater connectivity for an off-channel project.

Project Objective:
Create an off-channel area connected to the mainstem at low summer flows that is sourced by hyporheic flow and flow from the small perennial tributary. Enhance the quantity and quality of habitat features including bank complexity and cover and instream woody debris. At least one low-flow season of groundwater monitoring is recommended as part of design. Dissolved oxygen and mineral content should be monitored.

Special Considerations:
Private land (Boy Scouts of America). No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho - fry colonization, juvenile rearing
Fall Chinook - fry colonization
Steelhead - juvenile rearing

Limiting Factors Addressed:
Habitat diversity, key habitat quantity, temperature

Data Gaps / Needs:
Should measure dissolved oxygen

Project Name: Streambank enhancement **Project ID#:** EF 06

Reach Name: EF Lewis 8B

River Mile: 13.9

Location Description:
River right at Lewisville Park swim beach

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
This is the swim beach at Lewisville Park. Fine material has been imported for the beach. This fine

material enters the stream and has potential negative impact on adjacent spawning grounds.

Project Objective:
Work with Clark County to replace fine material with gravels. Investigate the potential for enhancing bank complexity, cover, and instream LWD along the opposite bank.

Special Considerations:
This project is located on Clark County property (Lewisville Regional Park). Designs should be coordinated with Clark County Parks Department staff. County concerns include bank protection, flood control, maintenance, and interface with park facilities.

Major Life Stages Addressed:
Coho - spawning, egg incubation
Fall Chinook - spawning, egg incubation
Steelhead - spawning, egg incubation

Limiting Factors Addressed:
Sediment load

Data Gaps / Needs:
None identified

Project Name: Side-channel / in-channel enhancement **Project ID#:** EF 07

Reach Name: EF Lewis 8B

River Mile: 13.7

Location Description:
River left at RM 13.7 across from Lewisville Park

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
This is an existing side-channel located across from Lewisville Park. There was flow in the channel at the time of the survey. There is a severe lack of channel structure, complexity, and spawning-sized gravels. This is a good opportunity to increase habitat diversity and pool quantity/quality.

Project Objective:
Enhance channel structure and habitat. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Consider adding spawning gravels. Maintain perennial flow into side-channel. As part of this objective, it will be important to evaluate and address the effects of flow reduction that would occur in the mainstem.

Special Considerations:
This project is located on Clark County property (Camp Lewisville). Designs should be coordinated with Clark County Parks Department staff. County concerns include bank protection, flood control, maintenance, and interface with park facilities.

Major Life Stages Addressed:
Coho - fry colonization, juvenile rearing
Fall Chinook - fry colonization, early rearing
Steelhead - juvenile rearing

Limiting Factors Addressed:
Habitat diversity, key habitat quantity, channel stability

Data Gaps / Needs:
See Objectives above

Project Name: Riparian restoration / Streambank enhancement **Project ID#:** EF 08

Reach Name: EF Lewis 8B

River Mile: 13.6 - 13.9

Location Description:
Lewisville Park

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
This area is along the river right bank at Lewisville Park. There is a lack of bank complexity, cover, and instream LWD. The riparian area has been cleared of forest vegetation along much of this segment. There is rip-rap and other bank armoring at several locations.

Project Objective:
Re-establish native riparian/floodplain vegetation to provide for natural channel stability, shade, and LWD recruitment. Work with the County (Lewisville Park). Remove rip-rap where feasible and enhance bank complexity, cover, and instream LWD.

Special Considerations:
This project is located on Clark County property (Lewisville Regional Park). Designs should be coordinated with Clark County Parks Department staff. County concerns include bank protection, flood control, maintenance, and interface with park facilities.

Major Life Stages Addressed:
All freshwater life-stages for coho, steelhead, fall Chinook, and chum

Limiting Factors Addressed:
Channel stability, habitat diversity, sediment load, temperature

Data Gaps / Needs:
Detailed site investigation

Project Name: Side-channel restoration **Project ID#:** EF 09

Reach Name: EF Lewis 8B

River Mile: 13.3

Location Description:
River right side channel

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Side-channel only flows as flood overflow channel. Numerous old channel scars in this area. Most appear perched high above mainstem.

Project Objective:
Enhance connectivity of side-channel to be active at

lower flows (i.e. summer). Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. At least one low-flow season of groundwater monitoring is recommended to support final designs. As part of this objective, it will be important to evaluate and address the effects of flow reduction that would occur in the mainstem.

Special Considerations:
This project is located on Clark County property (Lewisville Regional Park). Designs should be coordinated with Clark County Parks Department staff. County concerns include bank protection, flood control, maintenance, and interface with park facilities.

Major Life Stages Addressed:
Coho - spawning, egg incubation, fry colonization, juvenile rearing
Fall Chinook - fry colonization, early rearing
Chum - spawning, egg incubation (potential)
Steelhead - spawning, egg incubation, juvenile rearing

Limiting Factors Addressed:
Habitat diversity, key habitat quantity, channel stability

Data Gaps / Needs:
Topographic survey

Project Name: Side-channel restoration **Project ID#:** EF 10

Reach Name: EF Lewis 8B

River Mile: 13 - 13.5

Location Description:
River right through Lewisville Park

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Side-channel only flows as flood overflow channel. There were some isolated pools with water at the time of the survey (4 deg F cooler than mainstem). Total length = 2500 ft. Avg gradient = 0.8%. An excavated pond in the side-channel was the same temperature as the mainstem at the time of the survey.

Project Objective:
Enhance connectivity of side-channel to be active at lower flows (i.e. summer). Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. As part of this objective, it will be important to evaluate and address the effects of flow reduction that would occur in the mainstem.

Special Considerations:
This project is located on Clark County property (Lewisville Regional Park). Designs should be coordinated with Clark County Parks Department staff. County concerns include bank protection, flood control, maintenance, and interface with park facilities.

Major Life Stages Addressed:
Coho - spawning, egg incubation, fry colonization, juvenile rearing
Fall Chinook - fry colonization, early rearing
Chum - spawning, egg incubation (potential)
Steelhead - spawning, egg incubation, juvenile rearing

Limiting Factors Addressed:
Habitat diversity, temperature, key habitat quantity, channel stability

Data Gaps / Needs:
Detailed site investigation, including topographic survey, geomorphic analysis, and development of potential alternatives

Project Name: Side/off-channel restoration **Project ID#:** EF 11

Reach Name: EF Lewis 8B

River Mile: 12.5

Location Description:
River right off-channel

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
This is an old channel scar (backwater area) that is not connected with the mainstem at low flows. Temperature in the backwater area was 5 deg F warmer than the mainstem at the time of the survey (stagnant water). There may not be adequate hyporheic flow to provide summer high temperature refuge habitat.

Project Objective:
Increase the availability of connected backwater habitat for coho overwintering. An alternative objective is to create a side-channel that is active at low summer flows, but gradient is low (<0.5%). Groundwater monitoring is recommended before advancing this project forward.

Special Considerations:
This project is located on Clark County property (Lewis River Ranch). The project should be consistent with the county's master plan for the property and landowner sale agreements, and should consider the adjoining private property ownership. Public access and use is envisioned for this property, including development of a regional trail.

Major Life Stages Addressed:
Coho - fry colonization, juvenile rearing (winter)
Others potentially if re-connected as active side-channel

Limiting Factors Addressed:
Habitat diversity, key habitat quantity, channel stability

Data Gaps / Needs:
Topographic survey to investigate potential for side-channel

Project Name: In-channel habitat enhancement **Project ID#:** EF 12

Reach Name: EF Lewis 8B

River Mile: 11 - 11.3

Location Description:
River left and right banks

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Lack of channel habitat complexity (pools and bank cover) and in-stream wood structure to support juvenile rearing and adult holding.

Project Objective:
Increase the quality and complexity of mainstem pool habitat. Increase habitat complexity and cover along streambanks. Increase woody debris quantity.

Special Considerations:
This project is located on Clark County property (Lewis River Ranch). The project should be consistent with the county's master plan for the property and landowner sale agreements, and should consider the adjoining private property ownership. Public access and use is envisioned for this property, including development of a regional trail. Access for this project could potentially come from across the river, given landowner willingness.

Major Life Stages Addressed:
Fall Chinook - adult holding, fry colonization
Coho - adult holding, fry colonization, juvenile rearing
Steelhead - adult holding, fry colonization, juvenile rearing
Chum - adult holding, fry colonization

Limiting Factors Addressed:
Channel stability, habitat diversity, key habitat quantity, sediment load

Data Gaps / Needs:
Survey, hydraulic model

Project Name: Side/off-channel restoration **Project ID#:** EF 13

Reach Name: EF Lewis 8B

River Mile: 11.7 - 12.3

Location Description:
River left off-channel complex

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Large network of abandoned meander scars between RM 11.7 and 12.3. There are opportunities for creating connected side-channel and off-channel habitat in old channel scars. There is a small trib with temperatures 2 deg F cooler than the mainstem at time of survey that enters these channels. Site observations suggest suitable groundwater connectivity for off-channel project(s).

Project Objective:
Increase the availability of side-channel and backwater channel habitat that is connected to the mainstem during summer flow levels. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. At least one low-flow season of groundwater monitoring is recommended to support final design. As part of this objective, it will be important to evaluate and address the effects of flow reduction that would occur in the mainstem.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho - spawning, egg incubation, fry colonization, juvenile rearing
Fall Chinook - fry colonization, early rearing
Chum - spawning, egg incubation (potential)
Steelhead - spawning, egg incubation, juvenile rearing

Limiting Factors Addressed:
Habitat diversity, temperature, key habitat quantity, channel stability

Data Gaps / Needs:
Subsurface flow conditions. Detailed topographic survey.

Project Name: Side/off-channel restoration **Project ID#:** EF 14

Reach Name: EF Lewis 8B

River Mile: 11.6

Location Description:
River left back-channel

Species Use:
Coho, steelhead

Site Description:
Old channel scar. Did not investigate in detail due to private landownership. Aerial photo interpretation suggests the potential for creating connected off-channel habitat.

Project Objective:
Increase the availability of off-channel habitat that is connected to the mainstem during summer flow levels. Enhance the quantity and quality of habitat features including bank complexity and cover and instream woody debris. Needs further investigation. Groundwater monitoring is recommended before advancing this project forward.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho - fry colonization, juvenile rearing
Fall Chinook - fry colonization, early rearing
Steelhead - juvenile rearing

Limiting Factors Addressed:
Habitat diversity, temperature, key habitat quantity, channel stability

Data Gaps / Needs:
Was not able to survey because of private land. Needs further investigation for cold water sources, gradient, hyporheic flow, topography

Project Name: Streambank (rip-rap) enhancement **Project ID#:** EF 15

Reach Name: EF Lewis 8B

River Mile: 11.5

Location Description:
Rip-rap bank at residence on river left RM 11.5

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
There is rip-rap protecting residences on the river left bank (approximately 900 feet long). There is a lack of cover and complexity in the form of pools and instream LWD.

Project Objective:
Enhance channel structure and habitat while addressing landowners concerns with bank protection. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. To the extent possible, reforest the streambank and riparian area with native and locally-adapted species.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Fall Chinook - adult holding, fry colonization, early rearing
Coho - adult holding, fry colonization, juvenile rearing
Steelhead - adult holding, fry colonization, juvenile rearing
Chum - adult holding, fry colonization

Limiting Factors Addressed:
Habitat diversity

Data Gaps / Needs:
Detailed site investigation

Project Name: Side/off-channel restoration **Project ID#:** EF 16

Reach Name: EF Lewis 8B

River Mile: 11.3

Location Description:
River right off-channel / side-channel

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
This is an old meander scar/backwater channel. There is the potential for side-channel or off-channel habitat. Gradient is ~0.5%. Site observations and temperatures suggest suitable groundwater

connectivity. Beavers may dam channel if constructed as connected side-channel.

Project Objective:
Increase the availability of off-channel habitat that is connected to the mainstem during summer flow levels. Enhance the quantity and quality of habitat features including bank complexity and cover and instream woody debris. At least one low-flow season of groundwater monitoring is recommended to support final designs. As part of this objective, it will be important to evaluate and address the effects of flow reduction that would occur in the mainstem. This project could be conducted as a phased project in conjunction with EF 20; potentially connecting these as a single long side-channel.

Special Considerations:
This project is located on Clark County property (Lewis River Ranch). The project should be consistent with the county's master plan for the property and landowner sale agreements, and should consider the adjoining private property ownership. Public access and use is envisioned for this property, including development of a regional trail.

Major Life Stages Addressed:
Coho - fry colonization, juvenile rearing
Fall Chinook - fry colonization, early rearing
Steelhead - juvenile rearing

Limiting Factors Addressed:
Habitat diversity, key habitat quantity, temperature

Data Gaps / Needs:
Need to survey total extent of potential side-channel / off-channel. Investigate subsurface flow conditions

Project Name: Riparian restoration **Project ID#:** EF 17 (A)

Reach Name: EF Lewis 8B

River Mile: 11 - 11.7

Location Description:
Private residences in between RM 11 and 11.7

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Degraded riparian function (LWD recruitment, bank protection, shade). Invasive species. Residential use impacts.

Project Objective:
Re-establish native riparian/floodplain vegetation to provide for natural channel stability, shade, and LWD recruitment. Work with County and other landowners to continue and expand existing efforts.

Special Considerations:
This area consists primarily of private property. No project will be conducted without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
All freshwater life-stages for coho, steelhead, fall Chinook, and chum

Limiting Factors Addressed:
Channel stability, habitat diversity, sediment load, temperature, key habitat quantity

Data Gaps / Needs:
Level of potential landowner collaboration/willingness need to be explored

Project Name: Riparian restoration **Project ID#:** EF 17 (B)

Reach Name: EF Lewis 8B

River Mile: 12.2 - 12.8

Location Description:
Private residences in between RM 12.2 and Lewisville Bridge

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Degraded riparian function (LWD recruitment, bank protection, shade). Invasive species. Residential use impacts.

Project Objective:
Re-establish native riparian/floodplain vegetation to provide for natural channel stability, shade, and LWD recruitment. Work with private landowners.

Special Considerations:
This area consists primarily of private property. A narrow buffer of Clark County property is located on the north bank near RM 12.3. No project will be conducted without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project. Work on County land should be conducted in close coordination with the County.

Major Life Stages Addressed:
All freshwater life-stages for coho, steelhead, fall Chinook, and chum

Limiting Factors Addressed:
Channel stability, habitat diversity, sediment load, temperature, key habitat quantity

Data Gaps / Needs:
Level of potential landowner collaboration/willingness need to be explored

Project Name: Streambank / in-channel habitat enhancement **Project ID#:** EF 18

Reach Name: EF Lewis 8B

River Mile: 10.9

Location Description:
river left bank

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Long eroding cut-bank on left side (approx 200 meters long). Cleared riparian area. Lack of bank complexity and LWD.

Project Objective:
Slow or prevent accelerated erosion of unforested flood terrace until re-forested terrace can provide natural rates of stability. Increase the quality and complexity of mainstem pool habitat. Increase habitat complexity and cover along streambanks. Increase woody debris quantity. Reforest riparian and floodplain areas with native and locally-adapted species.

Special Considerations:
Private property. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Fall Chinook - adult holding, fry colonization
Coho - adult holding, fry colonization, juvenile rearing
Steelhead - adult holding, fry colonization, juvenile rearing
Chum - adult holding, fry colonization

Limiting Factors Addressed:
Channel stability, habitat diversity, sediment load, temperature, key habitat quantity

Data Gaps / Needs:
See Special Considerations

Project Name: Side/off-channel restoration **Project ID#:** EF 20

Reach Name: EF Lewis 8B

River Mile: 10.7

Location Description:
River right floodplain

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
This is an old meander scar/overflow channel. The channel is not connected at summer flow levels. The average gradient ~0.6%. There are good gravels and existing LWD present. Site observations and temperatures suggest suitable groundwater connectivity.

Project Objective:
Enhance connectivity of side-channel to be active at lower flows (i.e. summer). As part of this objective, it will be important to evaluate and address the effects of flow reduction that would occur in the mainstem. Increase availability of connected backwater channels. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. At least one low-flow season of groundwater monitoring is recommended to support final designs. Potential chum spawning channel near outlet (needs further investigation). This project could be conducted as a phased project in conjunction with EF 16; potentially connecting these as a single long side-channel.

Special Considerations:
This project is located on Clark County property (Lewis River Ranch). The project should be consistent with the county's master plan for the property and landowner sale agreements, and should consider the adjoining private property ownership. Public access and use is envisioned for this property, including development of a regional trail.

Major Life Stages Addressed:
Coho - spawning, egg incubation, fry colonization, juvenile rearing
Fall Chinook - fry colonization, early rearing
Chum - spawning, egg incubation (potential)
Steelhead - spawning, egg incubation, juvenile rearing

Limiting Factors Addressed:
Habitat diversity, temperature, key habitat quantity, channel stability

Data Gaps / Needs:
Engineering survey. Seasonality of subsurface flows.

Project Name: Side-channel enhancement plus small levee removal **Project ID#:** EF 21

Reach Name: EF Lewis 8A

River Mile: 10.5

Location Description:
River left active side-channel upstream of Daybreak Park

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Lack of channel structure in side-channel. Good opportunity to increase habitat diversity and pool quantity/quality. There is a small levee at the upstream end of the side-channel on the left bank that may be having an impact on channel location at the side-channel entrance.

Project Objective:
Enhance channel structure and habitat. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Provide anchoring and ballast to LWD structures according to stakeholder objectives. Maintain perennial flow into side-channel. Remove small levee at head of side-channel (RM 10.8).

Special Considerations:
This is Clark County property (undeveloped area of Daybreak Regional Park, upstream of the developed portion). Consideration should be given to issues such as: potential impact to existing uses, long-term maintenance and management, opportunities for future recreational uses, etc.

Major Life Stages Addressed:
Coho - spawning, egg incubation, fry colonization, juvenile rearing
Fall Chinook - spawning, egg incubation, fry colonization, early rearing
Steelhead - spawning, egg incubation, juvenile rearing
Chum - spawning, egg incubation, fry colonization

Limiting Factors Addressed:
Habitat diversity, key habitat quantity, channel stability

Data Gaps / Needs:
See Special Considerations

Project Name: Chum channel **Project ID#:** EF 22

Reach Name: EF Lewis 8A

River Mile: 10.2

Location Description:
River right immediately upstream of Daybreak Bridge

Species Use:
Chum, coho, steelhead

Site Description:
Potential chum channel location. Gradient is enough to create chum channel with sufficient flows. Temperatures was 4 deg F cooler than the mainstem at the time of the survey, suggesting hyporheic or spring flow into the area. There is existing grade control provided by the pool crest forming the pool under the bridge. The existing elevation of the outlet area is perched ~5 ft, possibly related to scour at the bridge location.

Project Objective:
Create a chum channel sourced by hyporheic flow. Add spawning gravels and complexity appropriate to support chum spawning. An alternative objective is to create and enhance off-channel juvenile rearing habitat for coho and steelhead. At least one low-flow season of monitoring is recommended as part of design.

Special Considerations:
Private property. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project. Project will require a detailed scour analysis sufficient to meet bridge program requirements, and must be approved by the Bridge Program Manager prior to starting work.

Major Life Stages Addressed:
Chum - spawning, egg incubation, fry colonization

Limiting Factors Addressed:
Key habitat quantity, channel stability, temperature

Data Gaps / Needs:
Need quantification of hyporheic flow conditions during chum spawning and egg incubation periods

Project Name: Side-channel / off-channel restoration **Project ID#:** EF 24

Reach Name: EF Lewis 8A

River Mile: 10

Location Description:
River left just downstream of Daybreak Park boat ramp

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
There is a side-channel that is only active as a flood-flow channel. There is a backwater area that is connected to the mainstem at the downstream end but this area has a lack of cover and instream wood complexity (80 ft of connected off-channel). Total average gradient of the overflow channel is ~0.5%. At the time of the survey, temperature in the existing backwater channel was 2-4 deg F cooler than the mainstem. There is good adjacent spawning in the mainstem.

Project Objective:
Enhance connectivity of side-channel to be active at lower flows (winter and summer). Enhance the quantity and quality of habitat features in the side-channel and the existing backwater area including bank complexity and cover and instream woody debris. Reforest riparian and floodplain areas with native and locally-adapted species. As part of this objective, it will be important to evaluate and address the effects of flow reduction that would occur in the mainstem.

Special Considerations:
Clark County property (Lower Daybreak). Project needs to be consistent with master planning process at this site. Project needs to take into consideration bank erosion, flood damage protection, and relationship with potential future recreation facilities. Mitigation credits should be pursued. Additional funding sources may be available. If there is any risk posed to Daybreak Bridge, this needs to be adequately evaluated.

Major Life Stages Addressed:
Coho -fry colonization, juvenile rearing
Steelhead - juvenile rearing
Fall Chinook - fry colonization, early rearing

Limiting Factors Addressed:
Habitat diversity, temperature, key habitat quantity, channel stability

Data Gaps / Needs:
Engineering survey. Hydraulic model

Project Name: Side-channel restoration **Project ID#:** EF 25

Reach Name: EF Lewis 8A

River Mile: 9.7

Location Description:
River right across from W Daybreak site

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
This is the old channel location and is within 100 feet of the existing channel. It is likely active at moderate winter flow levels but it is not active at low summer flows. This is an active channel adjustment, which needs to be considered during design.

Project Objective:
Enhance connectivity of side-channel to be active at low summer flows. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Need to evaluate in context of active lateral adjustment area. As part of this objective, it will be important to evaluate and address the effects of flow reduction that would occur in the mainstem.

Special Considerations:
No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project. Clark County Public Works expects to lead final design and construction (at least for portion on County land) and will pursue mitigation credit to the extent possible. Other parties pursuing work on County land will need to work in close coordination with the County.

Major Life Stages Addressed:
Coho - spawning, egg incubation, fry colonization, juvenile rearing
Fall Chinook - fry colonization, early rearing
Chum - spawning, egg incubation (potential)
Steelhead - spawning, egg incubation, juvenile rearing

Limiting Factors Addressed:
Habitat diversity, key habitat quantity

Data Gaps / Needs:
Actions here may depend on design at W Daybreak site. Actions here may be transient due to active lateral adjustment potential

Project Name: Streambank / in-channel habitat enhancement **Project ID#:** EF 26

Reach Name: EF Lewis 8A

River Mile: 9.5

Location Description:
River left bank

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Long eroding cut-bank on left side (approx 500 meters long). Cleared riparian area. Lack of bank complexity and LWD.

Project Objective:
Slow or prevent accelerated erosion of unforested flood terrace until re-forested terrace can provide natural rates of stability. Increase the quality and complexity of mainstem pool habitat. Increase habitat complexity and cover along streambanks. Increase woody debris quantity. Reforest riparian and floodplain areas with native and locally-adapted species. Reforest entire floodplain terrace from stream edge to valley wall.

Special Considerations:
Clark County property (Lower Daybreak). Projects need to be consistent with master planning process at this site. Projects need to take into consideration future of house, bank erosion, flood damage protection, and relationship with potential future recreation facilities. Mitigation credits should be pursued. Additional funding sources may be available.

Major Life Stages Addressed:
Fall Chinook - adult holding, fry colonization
Coho - adult holding, fry colonization, juvenile rearing
Steelhead - adult holding, fry colonization, juvenile rearing
Chum - adult holding, fry colonization

Limiting Factors Addressed:
Channel stability, habitat diversity, sediment load, key habitat quantity

Data Gaps / Needs:
Need to work our best approach with stakeholders

Project Name: Off-channel restoration **Project ID#:** EF 27

Reach Name: EF Lewis 7,8A

River Mile: 9.5

Location Description:
River left off-channel area at Manley Creek outlet

Species Use:
Coho, steelhead, Chinook

Site Description:
This is the backwater area on the river left bank that Manley Creek flows into. The backwater area is connected to the mainstem at the downstream end. There were beaver dams along this channel at the time of the survey. At the time of the survey, temperature in the off-channel area was 2 deg F warmer than the mainstem but 4 deg cooler than Manley Creek.

Project Objective:
Increase the availability of off-channel habitat that is connected to the mainstem during summer flow levels. Enhance the quantity and quality of habitat features including bank complexity and cover and instream woody debris.

Special Considerations:
Combination of private property and Clark County property (Lower Daybreak). No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project. Projects on County land need to be consistent with master planning process at this site. Projects need to take into consideration future of house, bank erosion, flood damage protection, and relationship with potential future recreation facilities. Mitigation credits should be pursued. Additional funding sources may be available.

Major Life Stages Addressed:
Coho - fry colonization, juvenile rearing
Fall Chinook - fry colonization, early rearing
Steelhead - juvenile rearing

Limiting Factors Addressed:
Habitat diversity, key habitat quantity

Data Gaps / Needs:
Current passability into off-channel area may be adequate

Project Name: Side-channel restoration **Project ID#:** EF 28

Reach Name: EF Lewis 8A

River Mile: 9.0 – 9.5

Location Description:
Across from W daybreak site. Runs along County maintenance yard

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Side-channel (~3,400 ft long) is only active during flood flows. Some of the channel may be from excavation for levee material for adjacent levee to the north. At the time of the survey, temperature was cooler in the upstream portion (52 deg F) compared to the mainstem (58 deg F) and in the channel downstream. Average gradient is 0.5%. Site observations suggest suitable groundwater connectivity for off-channel project.

Project Objective:
Enhance connectivity of side-channel to be active at summer flow levels. Increase hyporheic flow connectivity to the extent possible. Increase availability of connected backwater channels. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. At least one low-flow season of groundwater monitoring is recommended to support final designs. As part of this objective, it will be important to evaluate and address the effects of flow reduction that would occur in the mainstem.

Special Considerations:
There is private property at the upstream portion of this project area; the remainder is Clark County property. No project will be conducted at this site without full landowner willingness. Any potential

landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project. Clark County Public Works expects to lead final design and construction (at least for portion on County land) and will pursue mitigation credit to the extent possible. Other parties pursuing work on County land will need to work in close coordination with the County. It is possible to limit the project extent to County land if upstream landowners do not agree to participate.

Major Life Stages Addressed:
Coho - spawning, egg incubation, fry colonization, juvenile rearing
Fall Chinook - fry colonization, early rearing
Chum - spawning, egg incubation (potential)
Steelhead - spawning, egg incubation, juvenile rearing

Limiting Factors Addressed:
Habitat diversity, temperature, key habitat quantity, channel stability

Data Gaps / Needs:
Engineering survey. Hydraulic model. Seasonality of subsurface flows.

Project Name: Streambank restoration; channel structure **Project ID#:** EF 34

Reach Name: EF Lewis 5B

River Mile: 7.2

Location Description:
Right bank at powerline crossing ("Powerline Bend")

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
There is a lack of channel structure along banks for juvenile rearing and adult holding. The riparian area is cleared of forest vegetation. There is accelerated erosion of the flood terrace compared to what would be present under naturally forested conditions. There is a lack of bank complexity and instream LWD.

Project Objective:
Slow or prevent accelerated erosion of unforested flood terrace until re-forested terrace can provide natural rates of stability. Increase the quality and complexity of mainstem pool habitat. Increase habitat complexity and cover along streambanks. Increase woody debris quantity. Reforest riparian and floodplain areas with native and locally-adapted species.

Special Considerations:
Private property. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Fall Chinook - adult holding, fry colonization
Coho - adult holding, fry colonization, juvenile rearing
Steelhead - adult holding, fry colonization, juvenile rearing
Chum - adult holding, fry colonization

Limiting Factors Addressed:
Channel stability, habitat diversity, sediment load, key habitat quantity

Data Gaps / Needs: See Special Considerations

Project Name: Remove rip-rap / in-channel enhancement **Project ID#:** EF 35

Reach Name: EF Lewis 5A

River Mile: 6.8

Location Description:
River left bank (upstream site)

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
This is the left bank upstream of the airstrip (upstream site) that consists of a long rip-raped bank that lacks complex bank and in-channel habitat important for juvenile rearing. There is a lack of habitat structure and LWD.

Project Objective:
Remove the approximately 650 feet of rip-rap (in consultation with the landowner - Clark County). Increase the quality and complexity of mainstem pool habitat. Increase habitat complexity and cover along streambanks. Increase woody debris quantity. Reforest riparian and floodplain areas with native and locally-adapted species. Reforest entire floodplain terrace from stream edge to valley wall.

Special Considerations:
This project is located on Clark County property. This project must be consistent with a future greenway trail and should consider maintenance, management, and flood protection issues. Other parties pursuing work on County land will need to work in close coordination with the County.

Major Life Stages Addressed:
Fall Chinook - adult holding, fry colonization
Coho - adult holding, fry colonization, juvenile rearing
Steelhead - adult holding, fry colonization, juvenile rearing
Chum - adult holding, fry colonization

Limiting Factors Addressed:
Habitat diversity, key habitat quantity

Data Gaps / Needs:
Address the current benefit of the rip-rap

Project Name: Remove rip-rap / in-channel enhancement **Project ID#:** EF 36

Reach Name: EF Lewis 5A

River Mile: 6.6

Location Description:
River left bank (downstream site)

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
This is the left bank upstream of the airstrip (downstream site) that consists of a long rip-raped bank that lacks complex bank and in-channel habitat important for juvenile rearing. There is a lack of habitat structure and LWD.

Project Objective:
Remove the approximately 500 feet of rip-rap (in consultation with the landowner - Clark County). Increase the quality and complexity of mainstem pool habitat. Increase habitat complexity and cover along streambanks. Increase woody debris quantity. Reforest riparian and floodplain areas with native and locally-adapted species. Reforest entire floodplain terrace from stream edge to valley wall.

Special Considerations:
This project is located on Clark County property. This project must be consistent with a future greenway trail and should consider maintenance, management, and flood protection issues. Other parties pursuing work on County land will need to work in close coordination with the County.

Major Life Stages Addressed:
Fall Chinook - adult holding, fry colonization
Coho - adult holding, fry colonization, juvenile rearing
Steelhead - adult holding, fry colonization, juvenile rearing
Chum - adult holding, fry colonization

Limiting Factors Addressed:
Habitat diversity, key habitat quantity

Data Gaps / Needs:
Address the current benefit of the rip-rap

Project Name: Enhance rip-rap **Project ID#:** EF 37

Reach Name: EF Lewis 5A

River Mile: 6.5

Location Description:
River right bank at airstrip

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
This is the right bank at the airstrip. The bank is composed of rip-rap material. There is a lack of complex stream edge habitat important for juvenile rearing. There is a lack of habitat structure and LWD.

Project Objective:
Include any potential landowner concerns, such as erosion, flooding or safety considerations into design criteria for the project. Enhance channel structure and habitat while addressing landowners concerns with bank protection. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. To the extent possible, reforest the streambank and riparian area with native and locally-adapted species.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Fall Chinook - adult holding, fry colonization
Coho - adult holding, fry colonization, juvenile rearing
Steelhead - adult holding, fry colonization, juvenile rearing
Chum - adult holding, fry colonization

Limiting Factors Addressed:
Habitat diversity

Data Gaps / Needs:
Address the current benefit of the rip-rap

Project Name: Off-channel enhancement **Project ID#:** EF 38

Reach Name: EF Lewis 5A

River Mile: 6.3

Location Description:
Upstream back channel at airstrip

Species Use:
Coho, steelhead, chum (potential)

Site Description:
This is old chum channel. Now serves as a juvenile rearing channel (winter and summer). There was a large beaver dam at the downstream end at the time of the survey. There is good potential temperature refuge (the downstream end was 2 deg F cooler than the mainstem at the time of the survey).

Project Objective:
Enhance the quantity and quality of off-channel habitat features including bank complexity and cover and instream woody debris.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho -fry colonization, juvenile rearing
Steelhead - juvenile rearing
Fall Chinook - fry colonization, early rearing

Limiting Factors Addressed:
Habitat diversity, temperature, channel stability

Data Gaps / Needs:
More complete summer temperature profile needed

Project Name: Off-channel enhancement **Project ID#:** EF 39

Reach Name: EF Lewis 5A

River Mile: 6.1

Location Description:
Downstream back channel at airstrip

Species Use:
Coho, steelhead, chum (potential)

Site Description:
This channel is the downstream backwater channel that was constructed along the airstrip property. There is good temperature

refuge potential. The upstream end of the backwater channel was 8 deg F cooler than the mainstem at the time of the survey.

Project Objective:
Enhance the quantity and quality of off-channel habitat features including bank complexity and cover and instream woody debris.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho -fry colonization, juvenile rearing
Steelhead - juvenile rearing
Fall Chinook - fry colonization, early rearing

Limiting Factors Addressed:
Habitat diversity, temperature, channel stability

Data Gaps / Needs:
More complete summer temperature profile needed

Project Name: Streambank restoration; channel structure **Project ID#:** EF 40

Reach Name: EF Lewis 5A

River Mile: 6.1

Location Description:
Right bank across from "Car Body Hole"

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Lack of channel structure along banks for juvenile rearing and adult holding. Cleared riparian area. Lack of bank complexity and LWD.

Project Objective:
Slow or prevent accelerated erosion of unforested flood terrace until re-forested terrace can provide natural rates of stability. Increase the quality and complexity of mainstem pool habitat. Increase habitat complexity and cover along streambanks. Increase woody debris quantity. Reforest riparian and floodplain areas with native and locally-adapted species.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Fall Chinook - adult holding, fry colonization
Coho - adult holding, fry colonization, juvenile rearing
Steelhead - adult holding, fry colonization, juvenile rearing
Chum - adult holding, fry colonization

Limiting Factors Addressed:
Channel stability, habitat diversity, sediment load, key habitat quantity

Data Gaps / Needs:
None identified

Project Name: Riparian restoration **Project ID#:** EF 41

Reach Name: EF Lewis 5A, EF Lewis 5B

River Mile: 5.7 - 7.3

Location Description:
EF Lewis: Mason Creek to Ridgefield Pits

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Degraded riparian function (LWD recruitment, bank protection, shade). Effects from past grazing/ag. Abundant invasives.

Project Objective:
Re-establish native riparian/floodplain vegetation to provide for natural channel stability, shade, and LWD recruitment. Work with County to continue and expand existing efforts. Incorporate considerations for waterfowl habitat, wetlands, and habitat for terrestrial species.

Special Considerations:
This area has a combination of private and Clark County property. No project will be conducted without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project. This project must be consistent with a future greenway trail and should consider maintenance, management, and flood protection issues. Other parties pursuing work on County land will need to work in close coordination with the County.

Major Life Stages Addressed:
All freshwater life-stages for coho, steelhead, fall Chinook, and chum

Limiting Factors Addressed:
Channel stability, habitat diversity, sediment load, temperature, key habitat quantity

Data Gaps / Needs:
Identify where existing Clark County riparian restoration work has taken place

Project Name: Levee removal/set-back **Project ID#:** EF 42

Reach Name: EF Lewis 4B

River Mile: 5.1

Location Description:
River left levee near RM 5

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
Long levee perpendicular to valley across floodplain terrace.

Project Objective:
Remove levee to restore CMZ processes and connectivity of mainstem to adjacent floodplain wetlands. Take into consideration waterfowl habitat, wetlands, and habitat for terrestrial species.
Investigate presence of levee on south bank near RM 4.

Special Considerations:
This project is located on Clark County property (Schaeffer Property). This project must be consistent with a future greenway trail and should consider maintenance, management, and flood protection issues. Existing landowner sale agreements also need to be considered. Other parties pursuing work on County land will need to work in close coordination with the County.

Major Life Stages Addressed:
Coho - fry colonization, juvenile rearing
Fall Chinook - fry colonization, early juvenile rearing
Chum - fry colonization

Limiting Factors Addressed:
Key habitat quantity, habitat diversity

Data Gaps / Needs:
Evaluate flood protection benefit of levee

Project Name: Levee removal/set-back **Project ID#:** EF 43

Reach Name: EF Lewis 3

River Mile: 3.2 - 4.4

Location Description:
River right levee upstream of La Center

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
This is the long La Center levee on river right upstream of the La Center Bridge. The levee constrains the channel to its current location.

Project Objective:
In coordination with Clark County and other stakeholders, and as appropriate given the County's objectives for this area, restore/enhance channel migration and floodplain connectivity processes to the extent possible. This could include removing, setting-back, or selectively breaching the levee and conducting instream habitat enhancement along the bank margin.

Special Considerations:
Clark County ownership (La Center Bottoms). Projects need to take into consideration future establishment of a greenway trail through this area. Issues including maintenance, management, and flood protection need to be addressed. Existing agreements need to be considered. Any work should be conducted in close coordination with County staff.

Major Life Stages Addressed:
Coho - fry colonization, juvenile rearing
Fall Chinook - fry colonization, early juvenile rearing
Chum - fry colonization

Limiting Factors Addressed:
Key habitat quantity, habitat diversity

Data Gaps / Needs:
Evaluate flood protection benefit of levee

Project Name: Brezee Creek Dam **Project ID#:** BR 01

Reach Name: Brezee Creek 2

River Mile:

Location Description:
Upstream of Lockwood Road Crossing

Species Use:
Coho, steelhead

Site Description:
Fish passage is limited at the culvert under Lockwood Road. Passage is also limited by an earthen dam at the upstream end of reach 2. There is a lack of channel structure and habitat throughout this segment.

Project Objective:
Restore/enhance passage at the Lockwood Road crossing. Restore channel processes by removing the earthen dam. Restore the channel through the existing reservoir and enhance the existing channel between the culvert and the dam. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho - all freshwater life-stages
Steelhead - all freshwater life-stages

Limiting Factors Addressed:
Access, habitat diversity, key habitat quantity, temperature

Data Gaps / Needs:
Detailed site investigation, including topographic survey, geomorphic analysis, and development of potential alternatives

Project Name: Lower Dean Creek Channel Enhancement (downstream portion)
Project ID#: DE 01

Reach Name: Dean Cr 1 A

River Mile: 0 - 0.4

Location Description:
Mouth to Storedahl property

Species Use:
Coho, steelhead, chum (potential)

Site Description:
High temperature may create passage barrier in summer. There is water pollution (sediment, fecal coliform). There is channel incision, lack of floodplain connectivity, lack of channel structure and habitat components, degraded riparian zone, and abundant invasive riparian species. The stream has been impacted by agricultural uses, past channel re-locations, and adjacent mining operations.

Project Objective:
Enhance instream habitat conditions, increase floodplain connectivity, and reduce water temperatures. Temperature issues must be successfully addressed for this project to be successful. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Investigate the potential and need for isolating subsurface connections between the Daybreak gravel mine pit and the stream. Daybreak Pits avulsion risk assessment may impact the timing and specifics of design. Reforest riparian and floodplain areas with native and locally-adapted species.

Special Considerations:
Primarily in Clark County ownership. Any work here needs to be conducted in close coordination with the County and should take into consideration on-going restoration efforts, public use of the site, and maintenance and management issues.

Major Life Stages Addressed:
Coho - all freshwater life-stages
Steelhead - all freshwater life-stages
Chum (potential) - all freshwater life-stages

Limiting Factors Addressed:
Channel stability, habitat diversity, temperature, key habitat quantity, sediment load

Data Gaps / Needs:
Detailed site investigation, including topographic survey, geomorphic analysis, and development of potential alternatives

Project Name: Lower Dean Creek Channel Enhancement (upstream portion)
Project ID#: DE 02

Reach Name: Dean Cr 1 A

River Mile: 0.4 - 0.9

Location Description:
Storedahl property to J.A. Moore Road

Species Use:
Coho, steelhead, chum (potential)

Site Description:
High temperature may create passage barrier in summer. Water pollution concerns (sediment, fecal coliform). There is channel incision, lack of floodplain connectivity, lack of channel structure and habitat components, degraded riparian zone, and abundant invasive riparian species. The stream has been impacted by agricultural uses, past channel re-locations, and adjacent mining operations.

Project Objective:
Enhance instream habitat conditions, increase floodplain connectivity, and reduce water temperatures. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Investigate the potential and need for isolating subsurface connections between the Daybreak gravel mine pit and the stream. Daybreak Pits avulsion risk assessment may impact the timing and specifics of design. Reforest riparian and floodplain areas with native and locally-adapted species.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho - all freshwater life-stages
Steelhead - all freshwater life-stages
Chum (potential) - all freshwater life-stages

Limiting Factors Addressed:
Channel stability, habitat diversity, temperature, key habitat quantity, sediment load

Data Gaps / Needs:
Detailed site investigation, including topographic survey, geomorphic analysis, and development of potential alternatives

Project Name: Dyer reach 4 channel and passage enhancement **Project ID#:** DY 02

Reach Name: Dyer Cr 4

River Mile: 1.3 - 1.6

Location Description:
Near 259th Street crossing

Species Use:
Coho, steelhead

Site Description:
Fish passage is limited at 259th street (Clark County Conservation District study). The information provided is based on aerial photograph interpretation; a site visit in coordination with willing landowners will be required to develop designs. There are assumed to be water temperature concerns related to private residential ponds upstream. Cleared riparian areas and adjacent residential uses suggest impacts to riparian, streambank, and in-channel habitats.

Project Objective:
Address passage issues at the 259th Street crossing. In cooperation with willing landowners, enhance/restore fish passage and habitat in this area. Alternatives may include pond removal or disconnection from the mainstem. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Reforest riparian and floodplain areas with native and locally-adapted species.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho - all freshwater life-stages
Steelhead - all freshwater life-stages

Limiting Factors Addressed:
Passage, channel stability, habitat diversity, temperature, key habitat quantity, sediment load

Data Gaps / Needs:
Detailed site investigation, including topographic survey, geomorphic analysis, and development of potential alternatives

Project Name: Lower Jenny Cr channel enhancement and off-channel creation
Project ID#: JE 01

Reach Name: Jenny 1

River Mile: 0 - 0.13

Location Description:
Mouth to barrier falls

Species Use:
Coho, steelhead

Site Description:
Lower Jenny Creek has channel simplification and incision, lack of instream LWD, lack of habitat structure and cover, invasive plant species, high fine sediment load from upstream sources, and cleared riparian areas. There is an existing wetland area in the right bank floodplain and a remnant levee between the wetland and the stream channel.

Project Objective:
Enhance channel structure and habitat. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Increase the availability of off-channel habitat by removing the levee and connecting the existing wetland habitat to the stream. Reforest riparian and floodplain areas with native and locally-adapted species. Upstream sediment sources must be identified and controlled as part of this effort.

Special Considerations:
Combination of private property and Clark County property. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho - all freshwater life-stages
Steelhead - all freshwater life-stages

Limiting Factors Addressed:
Channel stability, habitat diversity, temperature, key habitat quantity, sediment load

Data Gaps / Needs:
Identify and control upstream sediment sources

Project Name: Lower McCormick channel enhancement **Project ID#:** MC 01

Reach Name: McCormick 1 A

River Mile: 0 - 0.6

Location Description:
Mouth to stream mile 0.6

Species Use:
Coho, steelhead, chum (potential)

Site Description:
The lower half mile of McCormick Creek has channel simplification and incision, lack of wood cover, and abundant invasive plant species. There is considerable beaver activity in this area.

Project Objective:
Enhance channel structure and habitat. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Increase the availability of off-channel habitat for coho and steelhead rearing. Look for opportunities to enhance floodplain connectivity. Reforest riparian and floodplain areas with native and locally-adapted species.

Special Considerations:
Clark County property. This project must be consistent with a future greenway trail and should consider maintenance, management, and flood protection issues. There may be other potential funding sources for project work in this area.

Major Life Stages Addressed:
Coho - all freshwater life-stages
Steelhead - all freshwater life-stages
Chum (potential) - all freshwater life-stages

Limiting Factors Addressed:
Channel stability, habitat diversity, temperature, key habitat quantity

Data Gaps / Needs:
Detailed site investigation, including topographic survey, geomorphic analysis, and development of potential alternatives

Project Name: Restore passage at La Center Road Crossing **Project ID#:** MC 02

Reach Name: McCormick Creek 1A and 1B

River Mile: 1

Location Description:
La Center Road crossing

Species Use:
Coho, steelhead

Site Description:
The stream crossing at La Center Road is listed as a complete barrier in the WDFW database and the 1997 Clark County barrier study. LiDAR data shows the culvert is about 510 feet long, has a 10 -15 foot drop, and is under about 70 feet of road fill.

Project Objective:
Restore passage at the La Center Road crossing

Special Considerations:
Appears to be located within County road right of way. Work should be conducted in coordination with Clark County. This is a long culvert with a deep road fill.

Major Life Stages Addressed:
Coho - all freshwater lifestages
Steelhead - all freshwater lifestages

Limiting Factors Addressed:
Passage

Data Gaps / Needs:
Passage evaluation

Project Name: Residential pond reach 1 D **Project ID#:** MC 03

Reach Name: McCormick 1 D & 1 E

River Mile: 2.25

Location Description:
2.25 miles up McCormick Creek

Species Use:
Coho, steelhead

Site Description:
The dam at Hilm Reservoir is a complete barrier (Clark County Conservation District survey). The following information is based on aerial photograph interpretation; a site visit in coordination with willing landowners will be required to develop designs. There are assumed to be water temperature concerns related to private residential ponds. Ponds, cleared riparian areas and adjacent residential uses suggest impacts to riparian, streambank, and in-channel habitats.

Project Objective:
In cooperation with willing landowners, enhance/restore fish passage and habitat in this area. Alternatives may include pond removal or disconnection from the mainstem. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Reforest riparian and floodplain areas with native and locally-adapted species.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho - all freshwater life-stages
Steelhead - all freshwater life-stages

Limiting Factors Addressed:
Passage, channel stability, habitat diversity, temperature, key habitat quantity, sediment load

Data Gaps / Needs:
Need info on specific passage conditions and excavation/restoration details

Project Name: Residential pond reach 1G and 1H **Project ID#:** MC 04

Reach Name: McCormick 1G and 1H

River Mile: 2.8

Location Description:
2.8 miles up McCormick Creek

Species Use:
Coho, steelhead

Site Description:
Fish passage conditions at the private road crossing are unknown. The following information is based on aerial photograph interpretation; a site visit in coordination with willing landowners will be required to develop designs. There are assumed to be water temperature concerns related to private residential ponds. Ponds, cleared riparian areas and adjacent residential uses suggest impacts to riparian, streambank, and in-channel habitats.

Project Objective:
In cooperation with willing landowners, enhance/restore fish passage and habitat in this area. Alternatives may include pond removal or disconnection from the mainstem. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Reforest riparian and floodplain areas with native and locally-adapted species.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho - all freshwater life-stages
Steelhead - all freshwater life-stages

Limiting Factors Addressed:
Passage, channel stability, habitat diversity, temperature, key habitat quantity, sediment load

Data Gaps / Needs:
Need info on specific passage conditions and excavation/restoration details

Project Name: Manley Creek stream habitat enhancement (downstream of 259th)
Project ID#: MN 02

Reach Name: Manley Creek 1B - 1C

River Mile: 0.2 - 0.75

Location Description:
Lower Manley Creek

Species Use:
Coho, steelhead, chum (potential)

Site Description:
Channel simplification and incision, lack of cover, invasive plant species. Affected by past channel re-location, residential development, agriculture, riparian clearing, and upstream gravel mining. Possible passage limitation at driveway culvert.

Project Objective:
Enhance channel structure and habitat. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Add spawning gravels as necessary. Increase the availability of off-channel habitat that is connected to Manley Creek during summer flow levels. Look for opportunities to enhance floodplain connectivity. Assess and enhance passage at driveway culvert if necessary. Reforest riparian and floodplain areas with native and locally-adapted species.

Special Considerations:
The property is currently owned by Columbia Land Trust, with a memorandum of understanding with Clark County that the property will eventually be transferred to County ownership. Projects need to be consistent with the County's master planning process at this site. Projects need to take into consideration the future of the house that is located at the site, bank erosion, flood damage protection, and the relationship with potential future recreation facilities. Mitigation credits should be pursued. Additional funding sources may be available.

Major Life Stages Addressed:
Coho - all freshwater life-stages
Steelhead - all freshwater life-stages
Chum (potential) - all freshwater life-stages

Limiting Factors Addressed:
Channel stability, habitat diversity, temperature, key habitat quantity, sediment load, passage

Data Gaps / Needs:
Detailed site investigation, including topographic survey, geomorphic analysis, and development of potential alternatives

Project Name: Manley Creek passage restoration and habitat enhancement (upstream of 259th)
Project ID#: MN 03

Reach Name: Manley Creek 1C - 1G

River Mile: 0.75 - 1.5

Location Description:
Lower Manley Creek

Species Use:
Coho, steelhead, chum (potential)

Site Description:
Multiple passage obstructions (partial) at road and driveway culverts (at least 7 crossings). Channel simplification and incision, lack of cover, invasive plant species. Affected by past channel re-location, residential development, agriculture, riparian clearing, and upstream gravel mining. Culverts located at stream miles 0.15, 0.6, 1, 1.05, 1.2, 1.4, and 1.5.

Project Objective:
Restore passage at stream crossings. Enhance channel structure and habitat. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Increase the availability of off-channel habitat that is connected to Manley Creek during summer flow levels. Look for opportunities to enhance floodplain connectivity. Reforest riparian and floodplain areas with native and locally-adapted species.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho - all freshwater life-stages
Steelhead - all freshwater life-stages
Chum (potential) - all freshwater life-stages

Limiting Factors Addressed:
Passage obstruction, channel stability, habitat diversity, temperature, key habitat quantity, sediment load

Data Gaps / Needs:
Detailed site investigation, including culvert hydrology/hydraulics, topographic survey, geomorphic analysis, and development of potential alternatives

Project Name: Lower Mason channel enhancement **Project ID#:** MS 01

Reach Name: Mason Creek 1

River Mile: 0 - 1

Location Description:
Lower Mason Creek in EF valley bottom

Species Use:
Coho, steelhead, chum (potential)

Site Description:
Channel simplification and incision, lack of wood cover, invasive plant species. Affected by historical channel re-locations, riparian clearing, agricultural uses.

Project Objective:
Enhance channel structure and habitat. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Increase the availability of off-channel habitat that is connected to Mason Creek during summer flow levels. Look for opportunities to enhance floodplain connectivity. Reforest riparian and floodplain areas with native and locally-adapted species.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho - all freshwater life-stages
Steelhead - all freshwater life-stages
Chum (potential) - all freshwater life-stages

Limiting Factors Addressed:
Channel stability, habitat diversity, temperature, key habitat quantity, sediment load

Data Gaps / Needs:
Detailed site investigation, including topographic survey, geomorphic analysis, and development of potential alternatives

Project Name: Mason channel enhancement reach 3-4 **Project ID#:** MS 02

Reach Name: Mason Creek 3, 4

River Mile: 3.2 - 3.6

Location Description:
Upstream and downstream of Anderson Road

Species Use:
Coho, steelhead

Site Description:
These reaches of Mason Creek show signs of incision, accelerated erosion rates, and a lack of in-channel habitat structure, complexity, cover, and LWD. These reaches are affected by road crossings, channel re-alignments, and residential development.

Project Objective:
Enhance channel structure and habitat. Enhance the quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris. Use structure to speed the recovery of incised channels.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho - all freshwater life-stages
Steelhead - all freshwater life-stages

Limiting Factors Addressed:
Channel stability, habitat diversity, key habitat quantity, sediment load

Data Gaps / Needs:
Some work has been conducted in this segment already. Identify remaining needs. Confirm potential project extents

Project Name: Mill Creek 1 C habitat enhancement **Project ID#:** MI 01

Reach Name: Mill Creek 1 C

River Mile: 1 - 1.3

Location Description:
Middle mainstem Mill Creek

Species Use:
Coho, steelhead

Site Description:
The information provided is based on aerial photograph interpretation; a site visit in coordination with willing landowners will be required to develop designs. Cleared riparian areas and adjacent residential uses suggest impacts to riparian, streambank, and in-channel habitats.

Project Objective:
Enhance stream channel structure and habitat. Reforest riparian and floodplain areas with native and locally-adapted species.

Special Considerations:
Private land. No project will be conducted at this site without full landowner willingness. Any potential landowner concerns, such as erosion, flooding, or safety considerations should be addressed as specific design criteria for the project.

Major Life Stages Addressed:
Coho - all freshwater life-stages
Steelhead - all freshwater life-stages

Limiting Factors Addressed:
Channel stability, habitat diversity, key habitat quantity, sediment load

Data Gaps / Needs:
Detailed site investigation, including topographic survey, geomorphic analysis, and development of potential alternatives

Project Name: Dean Creek land acquisition **Project ID#:** DE-P 01

Reach Name: Dean Cr 1 A

River Mile: 0.4-0.9

Location Description:
Dean Creek upstream of Becker Property

Species Use:
Coho, steelhead, chum (potential)

Site Description:
This site encompasses Dean Creek from the upstream boundary of the Becker Property upstream to J.A. Moore Road. This area is subject to future land-use impacts and has good restoration potential. It is currently privately owned.

Project Objective:
Explore opportunities for entering into a conservation easement or purchasing land from willing sellers in order to implement channel, riparian, and floodplain protection and restoration measures.

Special Considerations:
Private property. No project will be conducted at this site without full landowner willingness. This site provides a potential opportunity to leverage resources with the Clark County Clean Water Fund.

Major Life Stages Addressed:
All freshwater life-stages for coho, steelhead, and chum

Limiting Factors Addressed:
Multiple

Data Gaps / Needs:
It is necessary to assess landowner interest

Project Name: Ridgefield Pits Alternatives (includes lower Dyer Creek area)
Project ID#: EF-A 01

Reach Name: EF Lewis 6B; Dyer Cr 1 and 2

River Mile: 7.3 - 8.3

Location Description:
Ridgefield Pit avulsion area and surrounding floodplain

Species Use:
All

Site Description:
Channel avulsion / stream capture in 1996 re-routed mainstem through pits with severe impacts on key habitat quantity, habitat diversity, temperature, sediment, and invasive aquatic and plant species. There is a very large deficit of valley bottom material. There are now large deep ponds with invasive and predatory species. The riparian and floodplain area is severely degraded and overrun with invasive plant species.

Project Objective:
Evaluate alternatives for re-configuring this reach to enhance existing habitat and recover this area. Alternatives to be evaluated should range from no-action to full reach re-configuration. Conceptual designs for addressing channel and habitat conditions in this reach should be included as a product of this evaluation.

Alternatives for restoration/enhancement of lower Dyer Creek within the valley bottom should also be included in this evaluation and should include conceptual designs for this tributary.

Special Considerations:
Multiple private and public (Clark County) land parcels are located in this area. On-the-ground investigative work will only occur in full coordination with all landowners.

Major Life Stages Addressed:
All freshwater life-stages for coho, steelhead, fall Chinook, and chum

Limiting Factors Addressed:
Channel stability, habitat diversity, sediment load, temperature, key habitat quantity, competition, predation, flow

Data Gaps / Needs:
Detailed site investigation including detailed topographic survey, geomorphic and sediment transport analysis, development of potential alternatives, hydraulic modeling of alternatives.

Project Name: Daybreak Pits avulsion risk assessment **Project ID#:** EF-A 02

Reach Name: EF Lewis 6A, 6B, 6C, 7, 8A

River Mile: 7.3 - 9.5

Location Description:
Below Ridgefield pit avulsion to RM 9.5

Species Use:
All

Site Description:
Daybreak Pits are in floodplain adjacent to river and pose a potential risk of stream capture that would severely degraded existing habitat conditions.

Project Objective:
Assess the potential of stream capture of Daybreak Pits. Develop measures to protect against stream avulsion while also enhancing habitat and river processes. Assess the impact of existing levees in this area (north of mainstem between RM 8.3 and 9.5). Evaluate potential alternatives for reducing risk of pit capture while restoring habitat and protecting river processes to the extent possible (e.g. removing/relocating existing levees or creating connected off-channel habitat at existing RM 9 pond complex). Describe analyses that will be required to evaluate alternatives.

Special Considerations:
Multiple private and public (Clark County) land parcels are located in this area. Assessment work will occur in full coordination with all landowners.

Major Life Stages Addressed:
All freshwater life-stages for coho, steelhead, fall Chinook, and chum

Limiting Factors Addressed:
Multiple

Data Gaps / Needs:
Detailed site investigation including detailed topographic survey, geomorphic and sediment transport analysis, and hydraulic modeling of a variety of potential flood and avulsion scenarios. There is existing information that relates to this matter that will need to be incorporated into the analysis.

Project Name: Groundwater and temperature monitoring to support off-channel enhancement
Project ID#: EF-A 03

Reach Name: EF Lewis 5A, EF Lewis 5B, EF Lewis 6A, EF Lewis 6C, EF Lewis 7, EF Lewis 8A, EF Lewis 8B

River Mile: 5.7 - 15

Location Description:
Lower mainstem from Mason Creek to Lewisville Park

Species Use:
Coho, steelhead, Chinook, chum (potential)

Site Description:
There are multiple sites for potential enhancement of off-channel areas (side-channels and connected backwaters) along the lower mainstem that could provide temperature and velocity refuge to support juvenile rearing. Specifics of temperature conditions and groundwater connectivity are unknown for many of the sites. For many sites already identified as restoration projects, site observations suggest there is suitable groundwater connectivity; however, specific water table depths, temperatures, water quality, and seasonal groundwater flow rates are unknown.

Project Objective:
Assess temperature, water quality (e.g. D.O., minerals) and groundwater (hyporheic) flow conditions at multiple potential off-channel enhancement sites in order to help select project sites and to support design at selected sites. Monitoring will help to identify sites that have the best potential and cheapest cost for tapping into cool, consistent groundwater sources. Multiple seasons of temperature and groundwater monitoring is not an absolute requirement for project advancement, but it will enhance the ability to compare project cost/benefit; and for projects that are carried forward, it will provide a robust dataset to be used in project design.

Special Considerations:
Some potential off-channel enhancement sites are located on private lands. No investigative work will be conducted without full landowner willingness.

Major Life Stages Addressed:
Coho - summer rearing
Steelhead - summer rearing
All species and all freshwater life-stages affected to some degree

Limiting Factors Addressed:
Temperature, key habitat quantity, habitat diversity

Data Gaps / Needs:
This fills a key data gap

Conceptual Designs

A total of 13 projects were carried forward to the conceptual design phase. These projects are listed in the table below. The conceptual designs are included in Attachment 1.

Project ID	Project Name	Reach Name	River Mile
EF-A 02	Daybreak Pits avulsion risk assessment	EF Lewis 6A, 6B, 6C, 7, 8A	7.3 - 9.5
EF 28	Side-channel restoration	EF Lewis 8A	9.0 – 9.5
EF 41	Riparian restoration	EF Lewis 5A, 5B	5.7 - 7.3
MS 01	Lower Mason habitat enhancement	Mason Creek 1	0 - 1
EF 10	Side-channel habitat enhancement	EF Lewis 8B	13 - 13.5
MN 02	Manley Creek habitat enhancement (downstream of 259th)	Manley Creek 1B - 1C	0.2 - 0.75
EF 21	Side-channel habitat enhancement	EF Lewis 8A	10.5
EF 42	Levee and drainage ditch removal	EF Lewis 4B	5.1
EF 20	Side-channel and backwater habitat enhancement	EF Lewis 8B	10.7
EF 12	Instream habitat enhancement	EF Lewis 8B	11 - 11.3
EF-A 01	Ridgefield Pits alternatives assessment	EF Lewis 6B; Dyer Cr 1,2	7.3 - 8.3
EF-A 03	Temperature and groundwater assessment	EF Lewis 5A-8B	5.7 - 15
EF 05	Off-channel habitat enhancement	EF Lewis 8B	14

REFERENCES

Groot, C., and L. Margolis editors. 1991. Pacific salmon life histories. University of British Columbia Press, Vancouver.

Knighton, *D.* 1998. Fluvial forms and processes: A new perspective. Oxford University Press, Oxford, England. UK.

Lestelle, L.L, L.E. Mobrand, & W.E. McConnaha. 2004. Information structure of Ecosystem Diagnosis and Treatment (EDT) and habitat rating rules for Chinook salmon, coho salmon, and steelhead trout. Mobrand Biometrics, Inc., Vashon Island, WA.

Lichatowich, J., L. Mobrand, L. Lestelle, and T. Vogel. 1995. An approach to the diagnosis and treatment of depleted Pacific salmon populations in Pacific Northwest watersheds. Fisheries 20: 10-18.

Lower Columbia Fish Recovery Board. 2004. Lower Columbia Salmon and Steelhead Recovery and Sub-basin Plan. Lower Columbia Fish Recovery Board. Longview, WA.

Lower Columbia Fish Recovery Board. 2004a. Lower Columbia Salmon and Steelhead Recovery and Sub-basin Plan. Volume II – Subbasin Plan Chapter G – NF and EF Lewis River. Lower Columbia Fish Recovery Board. Longview, WA.

Lower Columbia Fish Recovery Board. 2005. East Fork Lewis River Habitat Assessment. Prepared by SP Cramer and Associates.

Lower Columbia Fish Recovery Board. 2008. Lower Columbia Salmon Recovery 6-Year Habitat Work Schedule and Lead Entity Habitat Strategy

Melchior, M. and M. Brunfelt. 2005. The Importance of Side-channels: An Inter-Fluve White Paper. Prepared for Portland General Electric, Portland, Oregon.

Norman, D. K. 1998. Reclamation of flood-plain sand and gravel pits as off-channel salmon habitat. Washington Geology 26(2/3):21–28.

Poole, G.C, and C.H. Berman. 2002. Pathways of Human Influence on Water Temperature Dynamics in Stream Channel. Environmental Management.

Poole, G.C. and C.H. Berman. 2001. An Ecological Perspective on In-Stream Temperature: Natural Heat Dynamics and Mechanisms of Human-Caused Thermal Degradation. Environmental Management 27(6): 787–802.

Roni, P. 2002. Habitat use by fishes and pacific giant salamanders in small western Oregon and Washington streams. Transactions of the American Fisheries Society 131:743–761

Wade, G. 2000. Salmon and steelhead habitat limiting factors: water resource inventory area 27. Washington Conservation Commission, Olympia, Washington.

WDOE. Washington Department of Ecology Instream Flow Monitoring: EF Lewis River at Dollar Corner.https://fortress.wa.gov/ecy/wrx/wrx/flows/station.asp?sta=27D090

WDOE. 1998a. Washington State 303(d) list of impaired water bodies due to exceedances of temperature and fecal coliform standards: http://www.ecy.wa.gov/programs/wq/303d/1998/1998ByWrias.html

WDOE, 2008b. Washington Department of Ecology Instream Flow Rules for WRIA 27/28. http://www.ecy.wa.gov/biblio/0811006.html

APPENDIX A – REACH OBJECTIVES AND STRATEGIES

APPENDIX B – TRIBUTARY EXISTING CONDITIONS

APPENDIX C – ANNOTATED BIBLIOGRAPHY

APPENDIX D – PERMITTING GUIDANCE

APPENDIX E – PROJECT SCORING DETAIL

APPENDIX F – PUBLIC AND LCFRB TAC COMMENTS ON DRAFT PLAN

ATTACHMENT 1 – CONCEPTUAL DESIGNS

APPENDIX A: REACH OBJECTIVES AND STRATEGIES

Overview

The reach-scale objectives and strategies provided in this appendix outline a comprehensive approach for the restoration and preservation of salmon and steelhead habitat in the lower East Fork Lewis River. Known constraints for achieving those objectives also are included. The objectives and strategies were developed by the EFWG and are based on existing information related to species recovery goals, fish usage, key life stages, watershed processes, and habitat conditions, and the local experience and knowledge of EFWG members.

The objectives focus on addressing the root causes of habitat degradation to ensure that restoration actions result in long-lasting benefits. Since many processes that create habitat operate on time-scales of decades or longer, it is also important to implement restoration actions that address both near-term needs (e.g. instream structures and LWD placement to increase habitat structure and complexity) and long-term needs, such as recovering riparian and floodplain forests. For each objective, multiple strategies are identified that support both short- and long-term habitat forming processes.

The objectives and strategies are organized according to the segments described below. The beginning of each segment contains a summary of existing information from the Recovery Plan, including fish use and timing, life stage limiting factors, species-specific reach priorities, and restoration vs. preservation value.

Segment 1 (EDT Reach 1A to 4C)

This segment extends from RM 0.0 to RM 5.7 in the mainstem EF Lewis River. The valley type is unconfined in this segment and is a tidally-influenced backwater of the Columbia River. The species with highest priority for recovery in this segment is chum (in 4C only). Recovery importance for all other species is low in all the reaches (Table 1).

Table 1. Summary of EDT results for segment including species and habitat limiting factor by lifestage, relevant months, the values for restoration or preservation, and the importance of the reach to population recovery. For low priority species, limiting factor information is not included.

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Restoration v. Preservation Value	Reach Importance to Population Recovery
Chum	Prespawn holding Egg incubation	Hab diversity/quantity Sediment	Oct-Jan Oct-Apr	69/31	High
Fall Chinook, Coho, Summer/Winter Steelhead					Low

Segment 1 Objectives:

1. **Preserve existing functioning habitat and allow no further degradation in order to preserve Chinook and chum (potential) habitat conditions.**

   Constraints:

   - *Private land ownership.*

   Strategies:

   - *Preserve quality habitat (paleochannels, high flow side-channels etc.) in the entire segment.*
   - *Work with willing landowners (public and private) to preserve quality riparian, floodplain, and off-channel habitat throughout this segment on both the north and south banks and at tributary junctions. Consider conservation easements, landowner education and other methods to ensure preservation.*
   - *Consider actions which would benefit other important fish and wildlife species in this segment.*
   - *Enforce the newly adopted Instream Flow Rule for WRIA's 27/28 which regulates withdrawals in streams and lists streams with protective closures and instream flow numbers (WDOE 2008a).*

2. **Reduce elevated summer and fall stream temperatures (to TMDL standard) in order to benefit fall Chinook, coho, and chum prespawn holding and migration.**

   Constraints:

   - *High temperatures are partially created by upstream conditions.*

   Strategies:

   - *Work with public and private landowners to plant native trees and shrubs in riparian areas and on streambanks on both the north and south banks of this segment.*
   - *Reduce width-to-depth ratios by placing LWD structures along stream margins experiencing rapid lateral erosion.*
   - *Promote rapid succession from hardwoods to conifers where conifers are climax species.*
   - *Restore channel structure to capture substrate, increase bar formation, active channel migration, and increase hyporheic exchange.*

3. **Reduce fine sediment input from upstream and local sources to reduce fine sediment impacts to egg incubation for chum. Reduce sediment to <10% fines and <20% embedded in non-backwatered reaches.**

   Constraints:

   - *Basin-scale and upland processes are contributing to fine sediment entering reach.*
   - *Basin-scale hydrologic impacts potentially increase flood risk and energy for erosion/incision.*
   - *Reach is backwatered under certain flow conditions (Columbia flow and tidal flow conditions also have an impact).*

   Strategies:

   - *Reduce rapid erosion of streambanks through the addition of combination LWD and boulder structures that also provide habitat*

complexity and pool formation.
- *Livestock exclusion fencing on north bank between RM 2.0 and 3.0.*

4. **Enhance availability of off-channel and side-channel groundwater fed chum spawning habitat in order to benefit chum egg incubation.**

Constraints:
- *Substrate is highly embedded with fines in the tidally influenced area which may limit spawning success.*
- *Pair restoration actions with Lower Columbia Salmon Recovery and Fish & Wildlife Plan regarding chum. WDFW would need to develop or select a suitable chum salmon broodstock for the EFL in the absence of one.*

Strategies:
- *Improve access to existing off-channel habitat areas.*
- *Identify and enhance off-channel habitat in areas with hyporheic/groundwater flow input that will provide upwelling areas for chum spawning.*
- *Utilize existing meander scars and paleochannels that have been mapped along this segment.*
- *Look for opportunities near the mouths of tributaries and along the base of the hillslope on the north (east) side that may have cool upwelling conditions.*

5. **Increase the abundance (>50%) and quality (>1 meter residual depth) of mainstem pool habitat for coho rearing and chum pre-spawn holding.**

Constraints:
- *Avoid structures that will limit river recreation uses.*

Strategies:
- *Add structure that creates and maintains quality pool habitat. Focus on the type of structure that was historically present and can currently be supported given existing conditions.*

6. **Increase LWD quantities (mainstem and off-channel areas) to >57 pieces/100 m in order to increase pool abundance and habitat complexity for chum pre-spawning holding.**

Constraints:
- *There is little near-term potential LWD input from upstream reaches.*

Strategies:
- *Add LWD in the form of stable accumulations of multiple pieces (jams) with sufficient ballast to ensure they remain in place and functional up to the design flood. Add as much structure/cover to tidal area as is feasible given recreational constraints. Consider locating structures so they are activated at higher water such that they will not inhibit summer recreation use.*

7. **Restore native riparian forest communities to increase long-term bank stability, shade, and LWD recruitment to benefit multiple species and life stages.**

Constraints:
- *A plan to manage reed canary grass should be incorporated into*

riparian and floodplain planting plans.

Strategies:

- *Plant native trees and shrubs in riparian areas and on stream banks.*
- *Remove and control non-native invasive plant species particularly in the lower tidal area where cover is critical for estuary rearing.*
- *Preserve existing native ash groves along the south bank.*

8. **Restore channel migration zone (CMZ) where feasible to support long-term habitat forming processes that will support multiple species and life stages.**

Constraints:

- *There are private properties that use the river for recreation along this section.*
- *The large ponds/wetlands on the south bank between RM 3.0 and 5.0 are important waterfowl habitat.*

Strategies:

- *Assess the feasibility of removing the long levee perpendicular to the stream at RM 5.1.*
- *Consider adding structure to aggrade the channel bed and re-water floodplain and other off channel habitat.*

9. **Preserve and enhance existing cold water refugia in the channel, floodplain, off-channel, and side channel habitats for coho and steelhead rearing and Chum spawning.**

Constraints:

- *Cold water habitats are often associated with groundwater/hyporheic flow and may have low dissolved oxygen which may limit fish use.*
- *Cold water sources such as those identified at Mason Creek Spring have high iron content which may limit fish use.*

Strategies:

- *Identify existing cold water locations (daily max temperature meets TMDL requirements for season and life stage). Consider using volunteers to point sample during the summer to identify cold water habitat.*
- *Improve capacity/use of existing refugia by adding cover (substrate and wood).*
- *Restore channel structure to capture substrate, increase bar formation, active channel migration, and increase hyporheic exchange.*
- *Focus restoration actions for juvenile rearing at cold water sources to create cold water refugia.*
- *Enhance off-channel/side-channel habitat in areas with hyporheic/ groundwater flow input that will provide cool water refuge for rearing juveniles and/or chum spawning.*

Segment 2 (EDT Reach 5A, 5B, 6A)

This segment extends from RM 5.7 to RM 7.3 in the mainstem EF Lewis River. The valley type is unconfined in this segment and the channel type is pool-riffle. The species with highest priority for recovery in this segment are fall Chinook, coho, and chum (Table 2, Table 3). Summer and winter steelhead are a low priority for recovery in this segment. EDT results were the same for Reach 5A & 5B.

Table 2. Summary of EDT results for segment 2 (Reach 5A & 5B) including species and habitat limiting factor by lifestage, relevant months, the values for restoration or preservation, and the importance of the reach to population recovery For low priority species, limiting factor information is not included.

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Restoration v. Preservation Value	Reach Importance to Population Recovery
Chum	Prespawn holding Egg incubation	Habitat div/quantity Sediment	Oct-Jan Oct-Apr	56/44	High
Fall Chinook	Egg incubation Spawning	Sediment Temperature	Nov-May Oct-Nov	43/57	High
Coho	Age-0 inactive Age-0 active rear	Key habitat quantity Temp/key hab quan.	Oct-Mar Mar-Oct	93/07	High
Summer & Winter Steelhead					Low

Table 3. Summary of EDT results for segment 2 (Reach 6A) including species and habitat limiting factor by lifestage, relevant months, the values for restoration or preservation, and the importance of the reach to population recovery. For low priority species, limiting factor information is not included.

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Restoration v. Preservation Value	Reach Importance to Population Recovery
Fall Chinook	Egg incubation Fry colonization	Sediment Key Habitat quantity	Nov-May Apr-May	41/59	High
Coho	Age-0 inactive Age-0 active	Key habitat quantity Temp/key habitat	Oct-Mar Mar-Oct	96/04	High
Chum	Prespawn hold Egg incubation	Habitat div/quantity Sediment	Oct-Jan Oct-Apr	56/44	High
Summer & Winter Steelhead					Low

Segment 2 Objectives:

1. **Preserve existing functioning riparian habitat and upland forest and allow no further degradation in order to preserve existing habitat conditions.**

   Constraints:

   - *Private land ownership.*

   Strategies:

   - *Preserve/acquire quality habitat (paleochannels, high flow side-channels etc) on north (east) bank through this segment.*

- *Work with willing landowners (public and private) to preserve quality riparian, floodplain, and off-channel habitat throughout this segment on both the north and south banks. Consider conservation easements, landowner education and other methods to ensure preservation.*
- *Consider actions which would benefit other fish and wildlife species in this segment.*

2. **Reduce fine sediment input from upstream and local sources to reduce fine sediment impacts to egg incubation for Chinook and chum. Reduce sediment to <10% fines and <20% embedded.**

   Constraints:
   - *Basin-scale and upland processes are contributing to fine sediment entering reach.*
   - *Basin-scale hydrologic impacts potentially increase flood risk and energy for erosion/incision.*

   Strategies:
   - *Reduce rapid erosion of stream banks through the addition of combination LWD and boulder structures that also provide habitat complexity and pool formation.*

3. **Reduce elevated summer and fall stream temperatures (to TMDL standard) in order to benefit coho rearing and Chinook spawning.**

   Constraints:
   - *High temperatures are partially created by upstream conditions.*

   Strategies:
   - *Work with public and private land owners to plant native trees and shrubs in riparian areas and on stream banks on both the north and south banks of this segment.*
   - *Reduce width-to-depth ratios by placing LWD structures along stream margins experiencing rapid lateral erosion.*
   - *Promote rapid succession from hardwoods to conifers where conifers are climax species.*
   - *Restore channel structure to capture substrate, increase bar formation, active channel migration, and increase hyporheic exchange.*

4. **Preserve and enhance existing cold water refugia in the channel, floodplain, off-channel, and side channel habitats for coho and steelhead rearing and Chum spawning.**

   Constraints:
   - *Cold-water habitats are often associated with groundwater/hyporheic flow and may have low dissolved oxygen which may limit fish use.*
   - *High iron content in Mason Creek springs may limit fish use.*

   Strategies:
   - *Identify existing cold-water locations. Consider using volunteers to point sample during the summer to identify cold water habitat.*
   - *Improve capacity/use of existing refugia by adding cover (substrate and wood).*

- *Preserve/enhance existing cold-water spring habitat located on the north bank near RM 6.5 (chum spawning channel).*
- *Preserve/enhance existing cold-water springs located on the north bank near Mason Creek.*
- *Restore channel structure to capture substrate, increase bar formation, active channel migration, and increase hyporheic exchange.*
- *Focus restoration actions for juvenile rearing at cold water sources to create cold water refugia.*
- *Enhance off-channel/side-channel habitat in areas with hyporheic/ groundwater flow input that will provide cool water refugia for rearing juveniles and/or chum spawning.*

5. **Increase the abundance and quality of available off-channel rearing habitat to increase key habitat quantity and to provide summer temperature refugia for coho age-0 active rearing.**

Constraints:

- *Channel incision and lack of sediment supply due to upstream pits will limit ability to reconnect summer channels.*

Strategies:

- *Improve access to existing off-channel habitat areas.*
- *Enhance off-channel habitat in areas with hyporheic/groundwater flow input that will provide cool water refugia.*
- *Enhance off-channel areas through excavation of off-channel ponds connected with the mainstem. Utilize existing meander scars and paleochannels that have been mapped along this segment.*
- *Enhance new and existing off-channel areas by adding LWD for cover and complexity.*
- *Opportunities for off-channel and side-channel restoration between RM 6 and 7 on public and private land.*

6. **Enhance availability of off-channel and side-channel groundwater fed chum spawning habitat in order to benefit chum egg incubation.**

Constraints:

- *Pair restoration actions with Lower Columbia Salmon Recovery and Fish & Wildlife Plan regarding chum. WDFW would need to develop or select a suitable chum salmon broodstock for the EFL in the absence of one.*

Strategies:

- *Enhance off-channel habitat in areas with hyporheic/groundwater flow input that will provide upwelling areas for chum spawning.*
- *Enhance off-channel areas through excavation of off-channel ponds connected with the mainstem. Utilize existing meander scars and paleochannels that have been mapped along this segment.*
- *Opportunities for off channels and side channels between RM 6 and 7 on public and private land. Consider side channels to support chum rearing as part of long term chum recovery planning.*
- *Evaluate the feasibility of enhancing the chum channel on Swanson property.*
- *Consider creating chum spawning channels in nearby tributaries*

(Mason, Dean and Dyer).
- *Base of Mason Creek terrace may provide groundwater/chum spawning opportunity.*

7. **Increase the abundance (>50%) and quality (>1 meter residual depth) of mainstem pool habitat for coho rearing and chum pre-spawn holding.**
   Constraints:
   - *Avoid structures that will limit river recreation uses.*

   Strategies:
   - *Add structure that creates and maintains quality pool habitat. Focus on the type of structure that was historically present and what can currently be supported given existing conditions.*

8. **Increase LWD quantities (mainstem and off-channel areas) to >57 pieces/100 m in order to increase pool abundance and habitat complexity for coho rearing and chum pre-spawning holding.**
   Constraints:
   - *There is little near-term potential LWD input from adjacent riparian areas or upstream reaches.*

   Strategies:
   - *Add LWD in the form of stable accumulations of multiple pieces (jams) with sufficient ballast to ensure they remain in place and functional up to the design flood.*

9. **Restore native riparian forest communities to increase long-term bank stability, shade, and LWD recruitment to benefit multiple species and life stages.**
   Constraints:
   - *None identified.*

   Strategies:
   - *Plant native trees and shrubs in riparian areas and on stream banks*
   - *Remove and control non-native invasive plant species.*

10. **Enhance availability of main-stem and side-channel spawning habitat.**
    Constraints:
    - *Heavy use by boats and other recreation. Avoid structures that will limit river uses.*

    Strategies:
    - *Restore channel structure to capture substrate, increase bar formation, restore natural rates of channel migration, and increase hyporheic exchange.*
    - *Add LWD jams with boulder ballast to retain and sort substrate and to create diverse pool-riffle habitats that contain high quality spawning areas.*
    - *Increase the availability of secondary channels (i.e. active side-channels and groundwater fed off-channels) that provide quality spawning habitat for multiple species.*

11. **Restore CMZ where feasible to support long-term habitat forming processes that will support multiple species and life stages, and chum specifically.**

    Constraints:

    - *Some private properties, farm fields, and structures are within the historical CMZ and floodplain (including the airstrip).*
    - *Building grade will be costly and may not be feasible if it negatively impacts private land.*

    Strategies:

    - *Remove bank armoring on left (south) bank at RM 6.6 and 6.8 if feasible.*
    - *Evaluate the feasibility of adding channel structure in the mainstem to add grade to the river and reactive off-channel and side-channel habitat.*
    - *Work proactively with local landowners to prevent the use of additional rip-rap and bank armoring.*

12. **Increase habitat diversity where feasible at areas with bank armoring and actively eroding banks to benefit coho rearing, and pre-spawning holding.**

    Constraints:

    - *Some bank armoring is protecting the airstrip at RM 6.5.*

    Strategies:

    - *Incorporate vegetation and LWD into bank armoring in areas where armoring is necessary to protect private property.*

Segment 3 (EDT Reach 6B)

This segment extends from RM 7.3 to 8 in the mainstem EF Lewis River. The valley type is unconfined and the channel type is pool-riffle. This section is also known as the "Ridgfield Pits" avulsed reach. The species with highest priority for recovery in this segment are fall Chinook, coho, and chum (Table 4). Winter and summer steelhead are a low priority for recovery in this reach.

Table 4. Summary of EDT results for segment 3 (Reach 6B) including species and habitat limiting factor by lifstage, relevant months, the values for restoration or preservation, and the importance of the reach to population recovery. For low priority species, limiting factor information is not included.

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Restoration v. Preservation Value	Reach Importance to Population Recovery
Fall Chinook	Egg incubation Fry colonization	Sediment Key Habitat quantity	Nov-May Apr-May	38/62	High
Coho	Egg incubation Age-0 active rearing	Sediment Temp/key hab quant.	Oct-May Mar-Oct	86/14	High
Chum	Prespawn holding Egg incubation	Habitat div/quantity Sediment	Oct-Jan Oct-Apr	56/44	High
Summer & Winter Steelhead					Low

Segment 3 Objectives:

1. **Reduce fine sediment input from upstream and local sources to reduce fine sediment impacts to egg incubation for Chinook, coho, and chum. Reduce sediment to <10% fines and <20% embedded.**

   Constraints:

   - *Basin-scale and upland processes are contributing to fine sediment entering reach.*
   - *Basin-scale hydrologic impacts potentially increase flood risk and energy for erosion/incision.*
   - *Pit avulsions have created backwatered conditions that collect fine sediment.*

   Strategies:

   - *There may be several approaches for addressing the avulsed reach. These include reactivating the abandoned channel, filling the pits with cobbles and boulders, or waiting for natural processes to fill the pits over time.*
   - *Any work in the abandoned pits should evaluate the costs vs. benefits as well as the potential for channel migration into and out of the pits.*

2. **Reduce elevated summer and fall stream temperatures (meet TMDL standard) in order to benefit coho rearing and Chinook spawning.**

   Constraints:

   - *High temperatures may result from stagnant water in the backwatered pits and from reduction in hyporheic exchange through river bed and bank alluvium.*
   - *High temperatures are partially created by upstream conditions.*
   - *Lack of reliable temperature and flow data in the pits. It is not known if the pits contribute to river warming or not.*
   - *BPA power line runs through the property (at least 3 towers) which may limit restoration opportunities. Work with BPA on this issue.*
   - *Area is overrun by invasive species including Himalayan blackberry, reed canary grass, scotch broom, and Japanese knotweed.*

   Strategies:

   - *Plant native trees and shrubs in riparian areas and on stream banks.*
   - *Reduce width-to-depth ratios through channel reconstruction and/or through isolation of backwatered pits from the main channel.*
   - *Evaluate the feasibility of pumping groundwater into pits/reach segment to reduce summer temperatures.*

3. **Restore CMZ where feasible to support long-term habitat forming processes that will support multiple species and life stages.**

   Constraints:

   - *The existing Storedahl mining operation is within the historic CMZ and floodplain and restricts channel migration and floodplain inundation.*
   - *The 1996 channel avulsion has served to lock the river in place within the avulsed pits until they fill with material and the river can*

resume lateral channel adjustment.

Strategies:

- *Evaluate the feasibility and cost vs. benefit of filling the pits with excess material (or floodplain material) available at the site.*
- *Evaluate the cost vs. benefit of any activity in the pit against natural process recovery.*

4. **Enhance channel structure and physical habitat conditions within the avulsed reach.**

Constraints:

- *High water temperatures in the pits.*
- *Invasive species may limit the benefit of habitat improvements.*

Strategies:

- *Evaluate the feasibility and cost vs. benefit of filling the pits with excess material available at the site, or use fill to further isolate the pits from the river during the summer (isolate warm water in the pools).*
- *Evaluate the cost vs. benefit of any activity in the pit against natural process recovery.*
- *Evaluate the feasibility of actions that would improve juvenile and adult migration through this segment.*
- *Evaluate the feasibility and cost vs. benefit of realigning the current channel into the historic channel.*

5. **Increase the abundance and quality of available off-channel rearing habitat to increase key habitat quantity and to provide summer temperature refuge for coho age-0 active rearing.**

Constraints:

- *The avulsed pits do not constitute quality off-channel habitat. They are overly deep, lack sufficient cover, and have disrupted natural hyporheic exchange processes.*

Strategies:

- *There may be the potential to reconstruct the main channel and develop portions of the avulsed ponds into off-channel habitat connected with the mainstem. Considerable restoration work would be needed to make the ponds into high quality off-channel habitats.*
- *Enhance new and existing off-channel areas by adding LWD for cover and complexity.*

6. **Enhance availability of off-channel and side-channel groundwater-fed chum spawning habitat in order to benefit chum egg incubation.**

Constraints:

- *The 1996 channel avulsion has served to lock the river in place within the avulsed pits and may be limiting potential off-channel connectivity.*
- *Pair restoration actions with Lower Columbia Salmon Recovery and Fish & Wildlife Plan regarding chum. WDFW would need to develop or select a suitable chum salmon broodstock for the EFL in the absence of one.*

Strategies:

- *Improve access to existing off-channel habitat areas.*
- *Enhance off-channel habitat in areas with hyporheic/groundwater flow input that will provide upwelling areas for chum spawning.*

7. **Enhance pool habitat in the avulsed section for Chinook fry colonization, coho rearing, steelhead rearing, and chum pre-spawn holding.**

Constraints:

- *Current avulsed pools provide low quality habitat that support invasive, predatory species.*

Strategies:

- *There may be opportunities for reconstructing the main channel to create higher quality pool habitat.*

8. **Increase LWD quantities (mainstem and off-channel areas) to >57 pieces/100 m in order to increase pool quality and habitat complexity for coho rearing, steelhead rearing, and chum pre-spawning holding.**

Constraints:

- *There is little near-term potential LWD input from riparian areas or upstream reaches.*

Strategies:

- *Add LWD in the form of stable accumulations of multiple pieces (jams) with sufficient ballast to ensure they remain in place and functional up to the design flood.*

9. **Restore native riparian forest communities to increase long-term bank stability, shade, and LWD recruitment to benefit multiple species and life stages.**

Constraints:

- *The area is overrun with invasives, including Scotch broom, reed canary grass, and Japanese knotweed.*
- *Land around/adjacent to ponds is highly compacted and perched above the water table, extensive site preparation is necessary prior to planting.*

Strategies:

- *Plant native trees and shrubs in riparian areas and on stream banks.*
- *Remove and control non-native invasive plant species.*

Segment 4 (EDT Reach 6C, 7, 8A, 8B)

This segment extends from RM 8 to RM 13 in the mainstem EF Lewis River. The valley type is unconfined in this segment and the channel type is pool-riffle. The species with highest priority for recovery in this segment are fall Chinook, coho, and chum (Table 6,Table 7, Table 8, Table 8). Winter steelhead are a medium priority in Reach 7 and 8B and summer steelhead are a low priority for recovery in all the reaches.

Table 5. Summary of EDT results for segment 4 (Reach 6C) including species and habitat limiting factor by life stage, relevant months, the values for restoration or preservation, and the importance of the reach to population recover. For low priority species, limiting factor information is not included.

Priority Species	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Restoration v. Preservation Value	Reach Importance to Population Recovery
Fall Chinook	Egg incubation Fry colonization	Sediment Key habitat quantity	Nov-May Apr-May	42/58	High
Coho	Age-0 active rearing Egg incubation	Temp/Key hab. quant. Sediment	Mar-Oct Oct-May	91/09	High
Chum	Egg incubation Prespawn holding	Sediment Hab. diversity/quantity	Oct-Apr Oct-Jan	56/44	High
Summer & Winter Steelhead					Low

Table 6. Summary of EDT results for segment 4 (Reach 7) including species and habitat limiting factor by life stage, relevant months, the values for restoration or preservation, and the importance of the reach to population recover. For low priority species, limiting factor information is not included.

Priority Species	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Restoration v. Preservation Value	Reach Importance to Population Recovery
Fall Chinook	Egg incubation Spawning	Sediment Temperature	Nov-May Oct-Nov	34/66	High
Coho	Age-0 active rear Egg incubation	Temp/key hab quant. Sediment	Mar-Oct Oct-May	82/18	High
Chum	Egg incubation Prespawn holding	Sediment Key habitat quantity	Oct-Apr Oct-Jan	45/55	High
Winter Steelhead	Egg incubation Age-0 active rear	Sediment/temp Temp/predation	Mar-Jul May-Oct	46/64	Medium
Summer Steelhead					Low

Table 7. Summary of EDT results for segment 4 (Reach 8A) including species and habitat limiting factor by life stage, relevant months, the values for restoration or preservation, and the importance of the reach to population recover. For low priority species, limiting factor information is not included.

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Restoration v. Preservation Value	Reach Importance to Population Recovery
Fall Chinook	Egg incubation Spawning	Sediment Temp./Key habitat	Nov-May Oct-Nov	33/67	High
Coho	Egg incubation Age-0 active rearing	Sediment Temp/key hab quant.	Oct-May Mar-Oct	83/17	High
Chum	Egg incubation Prespawn holding	Sediment/Key Hab. Habitat Diversity	Oct-Apr Oct-Jan	52/48	High
Winter Steelhead	Egg incubation Age-0 active rearing	Sediment/temp. Temp./predation	Mar-Jul May-Oct	68/32	Medium
Summer Steelhead					Low

Table 8. Summary of EDT results for segment 4 (Reach 8B) including species and habitat limiting factor by life stage, relevant months, the values for restoration or preservation, and the importance of the reach to population recover. For low priority species, limiting factor information is not included.

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Restoration v. Preservation Value	Reach Importance to Population Recovery
Chum	Egg incubation Prespawn holding	Sediment/key hab. Habitat diversity	Oct-Apr Oct-Jan	52/48	High
Fall Chinook	Egg incubation Spawning	Sediment/key hab. Temp./key hab.	Nov-May Oct-Nov	38/62	Medium
Coho	Egg incubation Age-0 active rearing	Sediment Temp/key hab. quan.	Oct-May Mar-Oct	83/17	Medium
Winter Steelhead	Egg incubation Age-0 active rearing	Sediment/temp. Temp./predation	Mar-Jul May-Oct	66/34	Medium
Summer Steelhead					Low

Segment 4 Objectives:

1. **Preserve existing functioning riparian habitat and upland forest and allow no further degradation in order to preserve existing habitat conditions.**

   Constraints:

   - *Private land ownership in this section is fragmented into small parcels.*

   Strategies:

   - *Preserve/acquire quality habitat (paleochannels, high-flow side channels etc) along south bank between RM 11.5 and 12.3.*
   - *Conservation easement along south bank near RM 10.8.*
   - *Work with landowners (public and private) to preserve quality riparian and floodplain habitat in the following areas: large intact riparian and floodplain located on both sides of the river near RM 12.0; intact riparian corridor and floodplain located on the north side near RM 11.0; intact riparian corridor located on the south side near RM 10.5. Consider conservation easements, landowner education and other methods to ensure preservation.*

2. **Reduce fine sediment input from upstream and local sources to reduce fine sediment impacts to egg incubation for Chinook, coho, steelhead, and chum. Reduce sediment to <10% fines and <20% embedded.**

   Constraints:

   - *Basin-scale and upland processes are contributing to fine sediment entering reach.*
   - *Basin-scale hydrologic impacts potentially increase flood risk and energy for erosion/incision.*
   - *Lack of reliable sediment data. Unclear about the scope of the sediment problem in this reach.*

   Strategies:

   - *Reduce rapid erosion of low terraces through the addition of*

combination LWD and boulder structures that also provide habitat complexity and pool formation.

3. **Reduce elevated summer and fall stream temperatures (to TMDL standard) in order to benefit coho rearing and Chinook spawning.**

   Constraints:

   - *High temperatures are partially created by upstream conditions.*

   Strategies:

   - *Work with public and private landowners to plant native trees and shrubs in riparian areas and on streambanks in the following areas: along the south bank from RM 9.3 to 10 and RM 10.8 to 11.8.*
   - *Reduce width-to-depth ratios by placing LWD structures along stream margins experiencing rapid lateral erosion.*
   - *Promote rapid succession from hardwoods to conifers where conifers are climax species.*
   - *Restore channel structure to capture substrate, increase bar formation, active channel migration, and increase hyporheic exchange.*

4. **Preserve and enhance existing cold water refugia in the channel, floodplain, off-channel and side channel habitats for coho and steelhead rearing and Chinook spawning.**

   Constraints:

   - *Cold-water habitats are often associated with groundwater/ hyporheic flow and may have low dissolved oxygen which may limit fish use.*

   Strategies:

   - *Identify existing cold-water locations. Consider using volunteers to point sample during the summer to identify cold-water habitat.*
   - *Improve capacity/use of existing refugia by adding cover (substrate and wood).*
   - *Preserve/enhance existing cold-water spring habitat located on the north bank near the confluence of Manly and Mill Creeks (RM 9.3).*
   - *Preserve/enhance existing cold water springs located on the south bank side below Manly Creek (RM 9.0 to 9.3).*
   - *Restore channel structure to capture substrate, increase bar formation, active channel migration, and increase hyporheic exchange*
   - *Focus restoration actions for juvenile rearing at cold water sources to create cold water refugia.*
   - *Enhance off-channel/side-channel habitat in areas with hyporheic/ groundwater flow input that will provide cool water refuge for rearing juveniles and/or chum spawning (north bank near the confluence of Manly and Mill Creeks (RM 9.3) and south bank side below Manly Creek (RM 9.0 to 9.3).*

5. **Increase the abundance and quality of available off-channel rearing habitat to increase key habitat quantity and to provide summer temperature refuge for coho age-0 active rearing.**

   Constraints:

   - *Private land ownership.*

- *May not be feasible to relocate the County Shop.*
- *Summer temperatures in off-channel/side channel habitat may be too warm for salmon and trout.*

Strategies:

- *Improve access to existing off-channel habitat areas.*
- *Enhance off-channel habitat in areas with hyporheic/groundwater flow input that will provide cool water refuge.*
- *Enhance off-channel areas through excavation of off-channel ponds connected with the mainstem. Utilize existing meander scars and paleochannels that have been mapped along this segment.*
- *Enhance new and existing off-channel areas by adding LWD and boulder substrate for cover and complexity.*
- *Focus on confluence areas of tributaries.*
- *Restore existing off-channel/side-channel areas on north side of RM 9.5 (near Manley) and below County Shop.*
- *Evaluate the feasibility of relocating the County Shop outside of the floodplain/CMZ to improve off channel habitat and CMZ processes. Approach adjacent landowners about removing levees and improving off channel habitat.*

6. **Enhance availability of off-channel and side-channel groundwater fed chum spawning habitat in order to benefit chum egg incubation.**

Constraints:

- *Channel incision from pit avulsion may be limiting potential off-channel connectivity near RM 9.0.*
- *Pair restoration actions with Lower Columbia Salmon Recovery and Fish & Wildlife Plan regarding chum. WDFW would need to develop or select a suitable chum salmon broodstock for the EFL in the absence of one.*

Strategies:

- *Improve access to existing off-channel habitat areas.*
- *Enhance off-channel habitat in areas with hyporheic/groundwater flow input that will provide upwelling areas for chum spawning.*
- *Enhance off-channel areas through excavation of off-channel ponds connected with the mainstem. Utilize existing meander scars and paleochannels that have been mapped along this segment.*

7. **Increase the abundance (>50%) and quality (>1 meter residual depth) of mainstem pool habitat for Chinook fry colonization, coho rearing, steelhead rearing, and chum pre-spawn holding.**

Constraints:

- *River recreation use, avoid channel structures that would impair river uses.*

Strategies:

- *Add structure that creates and maintains quality pool habitat. Focus on the type of structure that was historically present and what can currently be supported given existing conditions.*

8. **Increase LWD quantities (mainstem and off-channel areas) to >57 pieces/100 m in order to increase pool abundance and habitat complexity for coho rearing, steelhead rearing, and chum pre-spawning holding.**

Constraints:

- *There is little near-term potential LWD input from upstream reaches*
- *Avoid channel structures that would impair river uses.*

Strategies:

- *Add LWD in the form of stable accumulations of multiple pieces (jams) with sufficient ballast to ensure they remain in place and functional up to the design flood.*
- *Add LWD in areas to divert flow into off-channel/side-channel habitat.*

9. Restore native riparian forest communities to increase long-term bank stability, shade, and LWD recruitment to benefit multiple species and life stages

Constraints:

- *None identified.*

Strategies:

- *Plant native trees and shrubs in riparian areas and on streambanks*
- *Enhance new and existing off-channel areas by adding LWD and boulder substrate for cover and complexity*

10. Enhance availability of main-stem and side-channel spawning habitat.

Constraints:

- *Heavy use by boats and other recreation. Avoid structures that will limit river uses.*

Strategies:

- *Restore channel structure to capture substrate, increase bar formation, restore natural rates of channel migration, and increase hyporheic exchange.*
- *Add LWD jams with boulder ballast to retain and sort substrate and to create diverse pool-riffle habitats that contain high quality spawning areas.*
- *Increase the availability of secondary channels (i.e. active side-channels and groundwater fed off-channels) that provide quality spawning habitat for multiple species.*

11. Restore CMZ where feasible to support long-term habitat forming processes that will support multiple species and life stages.

Constraints:

- *Daybreak Bridge and associated road fill constricts CMZ.*
- *There are houses, roads, businesses, and farms within the historical CMZ and floodplain.*
- *Will need to protect existing infrastructure (e.g. access roads on Storedahl property).*
- *Gravel pits will continue to affect channel migration for the short term (decades).*

Strategies:

- *Remove remnant levees near RM 8.1, 8.2, 8.7, 8.9, 9.4, and 10.7 if it can be determined they are no longer serving any flood protection function.*
- *Assess where bank armoring could be removed.*

- *Evaluate the feasibility of relocating the County Shop outside of the floodplain to improve off channel habitat. Approach adjacent landowners about removing levees and improving off channel habitat (RM 8 to 9).*

12. **Increase habitat diversity where feasible at areas with bank armoring and actively eroding banks to benefit coho rearing, steelhead rearing, and pre-spawning holding.**

Constraints

- *Some bank armoring is protecting private property from erosion (RM 10 and 11.5).*

Strategies

- *Incorporate vegetation and LWD into bank armoring in areas where armoring is necessary to protect private property.*
- *Evaluate the feasibility of removing, or incorporating vegetation and wood into the armored bank near RM 11.5 (south side).*

Segment 5 (EDT 8B)

This segment extends from RM 13 to RM 15 in the mainstem EF Lewis River. The valley is moderately confined in this segment and the channel type is pool-riffle. The species with highest priority for recovery in this reach are chum (Table 9). Recovery priorities for Fall Chinook, coho, and winter steelhead are medium in this reach and low for summer steelhead.

Table 9. Summary of EDT results for segment 5 including species and habitat limiting factor by life stage, relevant months, the values for restoration or preservation, and the importance of the reach to population recover. For low priority species, limiting factor information is not included.

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Restoration v. Preservation Value	Reach Importance to Population Recovery
Chum	Egg incubation Prespawn holding	Sediment/key habitat Habitat diversity	Oct-Apr Oct-Jan	52/48	High
Fall Chinook	Egg incubation Spawning	Sediment/key habitat Temperature/key hab.	NovMay Oct-Nov	38/62	Medium
Coho	Egg incubation Age-0 active rearing	Sediment Temp/key hab quan.	Oct-May Mar-Oct	83/17	Medium
Winter Steelhead	Egg incubation Age-0 active rearing	Sediment/temperature Temperature/predation	Mar-Jul May-Oct	66/34	Medium
Summer Steelhead					Low

Segment 5 Objectives:

1. **Preserve existing functioning riparian habitat and upland forest and allow no further degradation in order to preserve existing habitat conditions.**

Constraints:

- *Private land ownership.*

Strategies:

- *Work with landowners (public and private) to preserve quality*

riparian and upland forest habitat. Consider conservation easements, landowner education and other methods to ensure preservation. There may specific opportunities in the following areas: large intact riparian and upland forest located on the north side near RM 15.0; intact riparian corridor and floodplain located on the south side between RM 14.5-14.0; intact riparian corridor located on both sides of the river between RM 13.0-13.5.

2. **Reduce fine sediment input from upstream and local sources to reduce fine sediment impacts to egg incubation for Chinook, coho, and chum. Reduce sediment to <10% fines and <20% embedded.**

   Constraints:

   - *Basin-scale and upland processes are contributing to fine sediment entering reach.*
   - *Basin-scale hydrologic impacts potentially increase flood risk and energy for erosion/incision.*
   - *There are few actively eroding streambanks along this section.*

   Strategies:

   - *Restore actively eroding banks within Lewisville Park near RM 13.7. Work proactively with Vancouver/Clark County Parks to develop a long term strategy for bank stabilization to prevent continued use of emergency rip-rapping.*
   - *Control fine sediment at areas in Lewisville Park where recreational access points contribute to bank erosion.*

3. **Reduce elevated summer and fall stream temperatures (to TMDL standard) in order to benefit coho rearing and Chinook spawning.**

   Constraints:

   - *High temperatures are partially created by upstream conditions*
   - *The riparian canopy in this reach is largely intact. There are few opportunities for planting to offset existing temperature.*

   Strategies:

   - *Plant native trees and shrubs in riparian areas and on stream banks in the following areas: along south bank near RM 13.0; along north bank in Lewisville Park (RM 13.5 to 14.2).*
   - *Promote rapid succession from hardwoods to conifers where conifers are climax species.*
   - *Restore channel structure to capture substrate, increase bar formation, active channel migration, and increase hyporheic exchange.*

4. **Preserve and enhance existing cold water refugia in the channel, floodplain, off-channel and side-channel habitats for coho and steelhead rearing and Chinook spawning.**

   Constraints:

   - *Cold water habitats are often associated with groundwater/hyporheic flow and may have low dissolved oxygen which may limit fish use.*

   Strategies:

   - *Identify and preserve existing cold water habitat.*

- *Improve capacity/use of existing refugia by adding cover (substrate and wood).*
- *Restore channel structure to capture substrate, increase bar formation, active channel migration, and increase hyporheic exchange.*
- *Focus restoration actions for juvenile rearing at cold water sources to create cold water refugia.*
- *Enhance off-channel/side-channel habitat in areas with hyporheic/groundwater flow input that will provide cool-water refugia for rearing juveniles and/or chum spawning habitat.*

5. **Increase the abundance and quality of available off-channel/side-channel active rearing and winter refugia where feasible to increase key habitat quantity for rearing coho and steelhead.**

Constraints:

- *Private land ownership.*
- *Summer recreational use.*
- *Limited opportunities for active summer side-channels in this reach.*
- *Summer temperatures in off-channel/side-channel habitat may be too warm for salmon and trout.*

Strategies:

- *Improve access to existing off-channel/side-channel habitat areas.*
- *Enhance off-channel areas through excavation of off-channel ponds connected with the mainstem. Utilize existing meander scars and paleochannels along this segment.*
- *Enhance new and existing off-channel areas by adding LWD and substrate for cover and complexity.*
- *Enhance existing high-flow channel on north side at RM 13.5 in Lewisville Park. Remove armoring at the head of the channel.*
- *Enhance existing side-channel on south side at RM 14-14.5.*

6. **Enhance availability of off-channel and side-channel groundwater fed chum spawning habitat in order to benefit chum egg incubation**

Constraints:

- *Pair restoration actions with Lower Columbia Salmon Recovery and Fish & Wildlife Plan regarding chum. WDFW would need to develop or select a suitable chum salmon broodstock for the EFL in the absence of one.*

Strategies:

- *Improve access to existing off-channel habitat areas.*
- *Enhance off-channel habitat in areas with hyporheic/groundwater flow input that will provide upwelling areas for chum spawning.*
- *Enhance off-channel and side-channel areas using existing meander scars and paleochannels that are present along this segment.*

7. **Increase the abundance (>50%) and quality (>1 meter residual depth) of mainstem pool habitat for coho rearing and chum pre-spawn holding.**

Constraints:

- *Heavy use through the park area by boats, swimmers and other recreation. Avoid structures that will limit river uses.*

Strategies:

- *Add structure that creates and maintains quality pool habitat. Focus on the types of structures that were historically present and what can currently be supported given existing conditions.*

8. **Increase LWD quantities (mainstem and off-channel areas) to >57 pieces/100 m in order to increase pool abundance and habitat complexity for coho rearing, steelhead rearing, and chum pre-spawning holding.**

Constraints:

- *There is little near-term potential LWD input from riparian areas or upstream reaches. Heavy use through the park area by boats, swimmers and other recreation.*

Strategies:

- *Add LWD in the form of stable accumulations of multiple pieces (jams) with sufficient ballast to ensure they remain in place and functional up to the design flood.*
- *Avoid structures that will limit river uses.*

9. **Restore native riparian forest communities to increase long-term bank stability, shade, and LWD recruitment to benefit multiple species and life stages.**

Constraints:

- *None identified.*

Strategies:

- *Plant native trees and shrubs in riparian areas and on stream banks.*
- *Remove and control non-native invasive plant species*
- *Camp Juliana planting.*

10. **Enhance availability of main-stem and side-channel spawning habitat.**

Constraints:

- *Heavy use by boats and other recreation. Avoid structures that will limit river uses.*

Strategies:

- *Restore channel structure to capture substrate, increase bar formation, restore natural rates of channel migration, and increase hyporheic exchange.*
- *Add LWD jams with boulder ballast to retain and sort substrate and to create diverse pool-riffle habitats that contain high quality spawning areas.*
- *Increase the availability of secondary channels (i.e. active side-channels and groundwater fed off-channels) that provide quality spawning habitat for multiple species.*

11. **Restore CMZ where feasible to support long-term habitat forming processes that will support multiple species and life stages.**

Constraints:

- *Residences, roads, and parts of Lewisville Park are within the historical CMZ and 100-year floodplain.*
- *Lewisville Bridge and associated road fill constrict the CMZ.*

- *There are few opportunities to restore the historical CMZ without land acquisitions, major reconfiguration of the HWY 503 Bridge and fill, or incorporation of Lewisville Park into the CMZ.*

Strategies:

- *Land acquisition.*
- *Incorporate portions of Lewisville Park into the CMZ where feasible.*
- *Work proactively with local landowners to prevent the use of rip-rap along banks.*

12. **Increase habitat diversity where feasible at areas with bank armoring and actively eroding banks to benefit coho rearing, steelhead rearing, and pre-spawning holding.**

Constraints:

- *Some bank armoring is protecting portions of Lewisville Park*

Strategies:

- *Incorporate vegetation and LWD into bank armoring in areas where armoring is necessary to protect property*

Segment 6 (Lower Valley Tributary Reaches):

These are tributary reaches that occur within the CMZ of the EF Lewis River. Valley types vary from unconfined to marginally unconfined. Channel type varies by tributary as doe the species of highest priority. Reach tiers included in Segment 6 are: Tier 1 (Brezee Cr 2, Dean Cr 1A, Dyer Cr 1, Manley Cr 1A, D, E, F and G). Tier 2 (Dyer Cr 2, Lockwood Cr 1, Manley Cr 1B-C, McCormick 1A, Mason Cr 1, Swanson Cr). Tier 4 (Brezee Cr 1, Beasley Cr 1 & 2, Mason Cr 2, Stoughton Cr 1). The species with highest priority for recovery in this segment are coho, the segment is of medium to low importance for steelhead and chum recovery, and low importance for fall Chinook and summer steelhead (Table 10).

Table 10. Summary of EDT results for segment 6 (see above) including species and habitat limiting factor by life stage, relevant months, the values for restoration or preservation, and the importance of the reach to population recovery. For low priority species, limiting factor information is not included.

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Restoration v. Preservation Value	Reach Importance to Population Recovery
Coho	Egg incubation, Fry Colonization, Age-0 active/inactive rearing	Sediment, Key habitat quantity, Channel stability, Temperature, Habitat diversity	Oct-May Mar-Oct	varies by reach	High to Medium
Winter Steelhead	Spawning, Egg Incubation, Fry Colonization , Age-0/1 active/inactive rearing	Sediment, Temperature, Habitat diversity, Oxygen, Pathogens, Flow	Mar-Jul May-Oct	varies by reach	Medium to Low
Chum	Egg incubation Prespawn holding	Habitat diversity, key habitat quantity, sediment, channel stability	Oct-Apr Oct-Jan	varies by reach	Medium to Low
Fall Chinook, Summer Steelhead					Low

Segment 6 Objectives:

1. **Preserve existing functioning headwater, floodplain, wetland, and riparian habitat and allow no further degradation in order to preserve existing coho, steelhead, and chum habitat conditions.**

   Constraints:

   - *There are houses, roads, businesses, and farms within the headwaters, riparian and floodplain of most of the tributaries.*

   Strategies:

   - *Work with willing landowners to preserve existing functioning habitat.*
   - *Identify potential land acquisition opportunities.*
   - *Preserve instream flows.*

2. **Reduce elevated summer and fall stream temperatures (to TMDL standard) in order to benefit coho and steelhead rearing and chum migration.**

   Constraints:

   - *High temperatures are partially created by headwater conditions which are primarily held in private ownership.*
   - *Headwater springs/tributaries have been converted into small ponds and reservoirs for private use.*

   Strategies:

   - *Focus on restoration and preservation of headwater tributaries and springs.*
   - *Work with willing landowners to convert headwater diversions such as ponds/small reservoirs back into functioning cold water stream channel/spring habitat.*
   - *Plant native trees and shrubs in riparian areas and on stream banks.*
   - *Remove non-native invasive plants.*
   - *Reduce width-to-depth ratios by placing LWD structures along stream margins experiencing rapid lateral erosion.*
   - *Control and rebuild grade in incised channels in order to restore more frequent floodplain inundation, channel migration, and increase groundwater and surface water interactions.*
   - *Place in-stream structures to capture and retain substrate to improve hyporheic exchange through the substrate.*
   - *Restore instream flows (surface and groundwater) by working with willing landowners to purchase or lease existing water rights or relinquish existing unused water rights.*

3. **Restore instream habitat complexity on tributaries within the valley floor of the EF Lewis to enhance summer rearing and winter refugia for coho and steelhead.**

   Constraints:

   - *Channel incision within the EF Lewis limits the ability to restore tributary connectivity with its floodplain.*
   - *Basin-scale hydrologic impacts potentially increase flood risk and*

energy for erosion/incision.

Strategies:

- *Reduce rapid erosion of streambanks through the addition of combination LWD and boulder structures that also provide habitat complexity and pool scour.*
- *Add LWD structures that create and maintain quality pool formation, cover, bank stability and sediment sorting. Focus on the types of accumulations that were historically present and can currently be supported given existing conditions.*
- *Control and rebuild grade in incised channels in order to restore more frequent floodplain inundation, channel migration, and increase groundwater and surface water interactions.*
- *Identify sites where channel relocation is necessary to restore channel structure and habitat.*

4. **Reduce fine sediment input from upstream and local sources by protecting and restoring natural sediment supply processes to reduce fine sediment impacts to egg incubation for coho, steelhead, and chum.**

Constraints:

- *Basin-wide private agriculture and development are contributing to fine sediment entering reach.*
- *Basin-scale hydrologic impacts potentially increase flood risk and energy for erosion/incision.*
- *Private fords/culverts exist on almost every tributary.*

Strategies:

- *Reduce rapid erosion of streambanks through the addition of combination LWD and boulder structures that also provide habitat complexity and pool scour.*
- *Livestock exclusion fencing.*
- *Restore streambank stability by restoring eroding stream banks and addressing mass wasting (e.g. landslides).*
- *Address road-related sediment sources by disconnecting ditch lines from stream channels.*
- *Work with willing landowners to reduce sediment impacts at stream fords.*
- *Work with willing landowners to increase riparian buffer size, plant native trees and shrubs, and remove non-native invasive plants.*

5. **Remove fish barriers to expand adult and juvenile passage.**

Constraints:

- *Private culverts/fords exist in every tributary.*
- *Private ponds/reservoirs exist in a couple of lower valley tributaries.*
- *Lack of data on fish barriers.*

Strategies:

- *Remove/replace culverts or other structures that create full or partial barriers and replace with passable culvert or bridge on all the tributaries.*
- *Work with willing landowners on privately-owned culvert replacement.*
- *Work with willing landowners to remove barriers caused by*

damming streams/springs for ponds and reservoirs

- *Address the sources of thermal, low flow, or channel morphology barriers*

6. **Increase the abundance and quality of available off-channel rearing habitat to increase key habitat quantity and to provide summer temperature refuge for coho age-0 active rearing.**

Constraints:

- *There are houses, roads, businesses, and farms within the riparian and floodplain of most of the tributaries.*
- *Artificial channel confinement on private lands.*
- *Cold water refugia habitat created by groundwater/hyporheic flow is often low in dissolved oxygen.*

Strategies:

- *Work with willing landowners to set back, breach or remove artificial channel confinement structures.*
- *Improve access to existing off-channel habitat areas.*
- *Enhance off-channel habitat in areas with hyporheic/groundwater flow input that will provide cool-water refugia, while maintaining DO levels.*
- *Create and enhance new and existing off-channel areas by adding LWD for cover and complexity.*

7. **Enhance availability of groundwater fed chum spawning habitat in order to benefit chum egg incubation.**

Constraints:

- *May be limited availability of suitable upwelling sites.*

Strategies:

- *Identify/preserve/enhance stream channel areas with hyporheic/groundwater flow input that will provide upwelling areas for chum spawning.*
- *Place in-stream structures to capture and retain substrate to improve hyporheic exchange through the substrate.*
- *Control and rebuild grade in incised channels in order to restore more frequent floodplain inundation, channel migration, and increase groundwater and surface water interactions.*

8. **Increase the abundance and quality of pool habitat for coho and steelhead fry colonization, rearing, and chum pre-spawn holding.**

Constraints:

- *None identified.*

Strategies:

- *Add LWD structure that creates and maintains quality pool habitat. Focus on the types of accumulations that were historically present and can currently be supported given existing conditions.*

9. **Increase LWD quantities to >3 pieces/channel width in order to increase pool abundance and habitat complexity for coho rearing, steelhead rearing, and chum pre-spawning holding.**

Constraints:

- *There is little near-term potential LWD input from most riparian areas or upstream contributing reaches.*

Strategies:

- *Add LWD that creates and maintains quality pool formation, cover, bank stability and sediment sorting. Focus on individual log placements and on the types of accumulations that were historically present and can currently be supported given existing conditions.*

10. Restore native riparian forest communities to increase long-term bank stability, shade, and LWD recruitment to benefit multiple species and life stages.

Constraints:

- *There are houses, roads, businesses, and farms within the riparian and floodplain of most of the tributaries.*

Strategies:

- *Work with willing landowners to increase riparian buffer size and plant native trees and shrubs.*
- *Remove and control invasive plant species.*

11. Restore CMZ where feasible to support long-term habitat forming processes that will support multiple species and life stages

Constraints:

- *Existing infrastructure such as bridges, culverts, and levees*
- *There are houses, roads, businesses, and farms within the historical CMZ and floodplain.*

Strategies:

- *Assess where bank armoring could be removed and work with willing landowners.*
- *Control and rebuild grade in incised channels in order to restore more frequent floodplain inundation, channel migration, and increase groundwater and surface water interactions.*
- *Remove or set-back levees where feasible.*

12. Improve water quality conditions by restoring runoff processes.

Constraints:

- *Private agriculture and development contribute chemical contaminants, turbidity, stormwater runoff, and farm waste.*

Strategies:

- *Livestock exclusion fencing.*
- *Work with commercial nurseries and tree farms to increase riparian buffers and reduce runoff by disconnecting ditch lines from stream channels.*
- *Work with willing landowners to increase riparian buffer size and plant native trees and shrubs.*
- *Restore wetlands.*

Segment 7 (Upper Valley Tributary Reaches)

These reaches include upper tributary reaches that occur upstream of the East Fork Lewis River valley floor. Valley types vary from confined to marginally unconfined. Channel type varies by tributary as does the species of highest priority. Reach tiers included in Segment 6 are: Tier 1 (McCormick Cr 1 D, G-H, Mason Cr RB Trib 1A, Mill Cr 1C). Tier 2 (McCormick Cr 1C & 1I, Dean Cr 3, Dyer Cr 4, Mason Cr 3 & 8, Mill Cr 1A). Tier 4 (All others). The species with highest priority for recovery in this segment are coho, with medium to low priority for steelhead. These are the only species present in the upper reaches (Table 11).

Table 11. Summary of EDT results for segment 7 (see above) including species and habitat limiting factor by life stage, relevant months, the values for restoration or preservation, and the importance of the reach to population recovery. For low priority species, limiting factor information is not included.

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Restoration v. Preservation Value	Reach Importance to Pop. Recovery
Coho	Egg incubation, Fry Colonization, Age-0 active/inactive rearing	Sediment, Key habitat quantity, Temperature	Oct-May Mar-Oct	varies by reach	High to Medium
Winter Steelhead	Spawning, Egg Incubation, Fry Colonization	Sediment, Temperature, Key habitat quantity	Mar-Jul May-Oct	varies by reach	Medium to Low

Segment 7 Objectives:

1. **Preserve existing functioning headwater, floodplain, wetland, and riparian habitat and allow no further degradation in order to preserve existing coho and steelhead habitat conditions.**

   Constraints:

   - *There are houses, roads, businesses, and farms within the headwaters, riparian and floodplain of most of the tributaries.*

   Strategies:

   - *Work with willing landowners to preserve existing functioning habitat.*
   - *Identify potential land acquisition opportunities.*
   - *Enforce newly adopted Instream Flow Rule for WRIA's 27/28 which regulates withdrawals in streams and lists streams with protective closures (WDOE 2008a).*

2. **Reduce elevated summer stream temperatures in order to benefit coho and steelhead rearing.**

   Constraints:

   - *High temperatures are partially created by headwater conditions which are primarily held in private ownership.*
   - *Headwater springs/tributaries have been converted into small ponds and reservoirs for private use.*

   Strategies:

   - *Focus on restoration and preservation of headwater tributaries and springs.*

- *Work with willing landowners to convert headwater diversions such as ponds/small reservoirs back into functioning cold water stream channel/spring habitat.*
- *Plant native trees and shrubs in riparian areas and on streambanks.*
- *Remove non-native invasive plants.*
- *Reduce width-to-depth ratios by placing LWD structures along stream margins experiencing rapid lateral erosion.*
- *Control and rebuild grade in incised channels in order to restore more frequent floodplain inundation, channel migration, and increase groundwater and surface water interactions.*
- *Place in-stream structures to capture and retain substrate and improve hyporheic exchange through the substrate.*
- *Restore instream flows (surface and groundwater) by working with willing landowners to purchase or lease existing water rights or relinquish existing unused water rights.*

3. **Reduce fine sediment input from upstream and local sources by protecting and restoring natural sediment supply processes to reduce fine sediment impacts to egg incubation for coho and steelhead.**

Constraints

- *Private agriculture and development are contributing to fine sediment entering reach.*
- *Basin-scale hydrologic impacts potentially increase flood risk and energy for erosion/incision.*
- *Private fords/culverts exist on almost every tributary.*

Strategies

- *Reduce rapid erosion of streambanks through the addition of combination LWD and boulder structures that also provide habitat complexity and pool scour.*
- *Livestock exclusion fencing.*
- *Restore streambank stability by restoring eroding stream banks and mass wasting (landslides, debris flows).*
- *Address road related sediment sources by disconnecting ditch lines from stream channels.*
- *Work with willing landowners to reduce sediment impact at stream fords.*
- *Work with willing landowners to increase riparian buffer size, plant native trees and shrubs, and remove non-native invasive plants.*

4. **Remove fish barriers to expand coho and steelhead fry colonization and summer and winter rearing habitat.**

Constraints:

- *Private culverts/fords exist on almost every tributary.*
- *Private ponds/reservoirs exist on almost every tributary.*

Strategies:

- *Remove/replace culverts or other structures that create full or partial barriers and replace with passable culvert or bridge.*
- *Work with willing landowners on privately owned culvert replacement.*
- *Work with willing landowners to remove barriers caused by*

damming streams/springs for ponds and reservoirs.

- *Address the sources of thermal, low flow, or channel morphology barriers.*

5. **Increase the abundance and quality of available off-channel rearing habitat to increase key habitat quantity and to provide summer temperature refuge for coho age-0 active rearing.**

   Constraints:

   - *There are houses, roads, businesses, and farms within the riparian and floodplain of most of the tributaries.*
   - *Artificial channel confinement on private lands.*
   - *Cold water refugia habitat created by groundwater/hyporheic flow is often low in dissolved oxygen.*

   Strategies:

   - *Work with willing landowners to set back, breach or remove artificial channel confinement structures.*
   - *Improve access to existing off-channel habitat areas.*
   - *Enhance off-channel habitat in areas with hyporheic/groundwater flow input that will provide cool-water refugia, while maintaining DO levels.*
   - *Create and enhance new and existing off-channel areas by adding LWD for cover and complexity.*

6. **Increase the abundance and quality of pool habitat for coho and steelhead fry colonization, rearing, and adult holding.**

   Constraints:

   - *None identified.*

   Strategies:

   - *Add LWD structures that create and maintain quality pool habitat. Focus on the types of accumulations that were historically present and can currently be supported given existing conditions.*

7. **Increase LWD quantities to >3 pieces/channel width in order to increase pool abundance and habitat complexity for coho rearing, steelhead rearing, and adult pre-spawn holding.**

   Constraints:

   - *There is little near-term potential LWD input from most riparian areas or upstream contributing reaches.*

   Strategies:

   - *Add LWD for pool formation, cover, bank stability and sediment sorting. Focus on the types of accumulations that were historically present and can currently be supported given existing conditions.*

8. **Restore native riparian forest communities to increase long-term bank stability, shade, and LWD recruitment to benefit multiple species and life stages.**

   Constraints:

   - *There are houses, roads, businesses, and farms within the riparian and floodplain of most of the tributaries.*

Strategies:

- *Work with willing landowners to increase riparian buffer size and plant native trees and shrubs.*
- *Remove and control invasive plant species.*

9. **Restore CMZ where feasible to support long-term habitat forming processes that will support multiple species and life stages.**

Constraints:

- *Existing infrastructure such as bridges, culverts, and levees*
- *There are houses, roads, businesses, and farms within the historical CMZ and floodplain.*

Strategies:

- *Assess where bank armoring could be removed and work with willing landowners.*
- *Remove levees or other confining structures.*
- *Control and rebuild grade in incised channels in order to restore more frequent floodplain inundation, channel migration, and increase groundwater and surface water interactions.*

10. **Improve water quality conditions by restoring runoff processes.**

Constraints:

- *Private agriculture and development contribute chemical contaminants, turbidity, stormwater runoff, and farm waste*

Strategies:

- *Livestock exclusion fencing.*
- *Work with commercial nurseries and tree farms to increase riparian buffers.*
- *Reduce runoff by disconnecting ditch lines with stream channels.*
- *Work with willing landowners to increase riparian buffer size and plant native trees and shrubs.*
- *Restore wetlands.*

11. **Restore habitat complexity in channel and off-channel to increase pool quality and habitat complexity for coho and steelhead rearing.**

Constraints:

- *There is little near-term potential LWD input from riparian areas or upstream reaches.*

Strategies:

- *Add LWD in the form of stable accumulations of multiple pieces (jams) with sufficient ballast to ensure they remain in place and functional up to the design flood.*
- *Add structure to mainstem channel.*

APPENDIX B: TRIBUTARY EXISTING CONDITIONS & REACH-SCALE LIMITING FACTORS

Brezee Creek

Physical/Riparian/Channel Habitat Condition: The Brezee Creek watershed has a drainage area of ~9.17 km^2. Current land cover in the drainage is primarily pasture and forest land, with an expanding area of urban development in the lower watershed around the city of La Center, and rural residential development throughout the drainage. For much of its length, Brezee Creek flows in a narrow, steep-sided canyon with intact riparian forest. Upland areas are largely cleared or open. Stormwater inputs to Brezee Creek consist of an expanding network of piped urban storm sewers in the lower watershed, within the town of La Center, and limited roadside ditches in the unincorporated upper watershed. Road density above the index reach is ~4.35 km/km^2 (2001 data). The index reach is located near the mouth of Brezee Creek, approximately 90 m upstream of its confluence with the East Fork Lewis River. The reach is characterized by pool-riffle morphology and a low gradient (1.9%), but is also fairly straight with a low sinuosity of 1.2. Mean wetted width at baseflow was ~3.4 m in 2002, with an estimated discharge of <1 cfs (Clark County 2003). Both the Lockwood Road crossing and Mill Dam which is located ~60 m upstream of the road crossing are significant fish passage barriers.

Fish Passage: Based on a review of SSHIAP 2008 and Clark County Public Works (PW), there are at least 12 stream crossings on the mainstem channel and tributaries (SSHIAP 2008, Clark PW 2008, Wade 2000) many of which are fish passage barriers. Binford dam and reservoir (located at the headwaters of the easternmost tributary) is likely a passage barrier (Table 1).

Table 1. Fish Passage potential barriers on Brezee Creek

Location	Description	Status
Mainstem		
NE Lockwood Creek Rd	Road crossing	barrier
14th Ave	Dam	barrier
NE 23rd Ave	Road crossing	barrier
NE 351st	Road crossing	barrier
NE 369th	Road crossing	barrier
NE 379th	Road crossing	barrier
Headwaters	Ponds/reservoirs	not surveyed, may not provide passage
Tributaries		
NE 23rd Ave	Road crossing	barrier
Private Road	Road crossing	not surveyed
NE 369th	Road crossing	barrier
Headwaters	Ponds/reservoirs	not surveyed, may not provide passage

Water quality: The headwaters of Brezee Creek are largely intact and 7DMAX temperatures at the mouth have been recorded as high as 20.5ºC (Clark County PW). Brezee Creek has exceeded DEQ water quality criteria for fecal coliform (Clark County Unpublished Data) from Station BRZ010 (Brezee Creek upstream of LaCenter Bridge) with a geometric mean of 652CFU/100 mL from six samples collected in 2002. Urban stormwater runoff may contribute to pollution and sediment in the lower river and is being evaluated by Clark PW. The Clark PW

monitoring site is near its outlet to the East Fork. At this site, the stream health is rated poor, mainly based on high harmful bacteria counts. Otherwise it would rate fair.

Water Diversions: There are approximately 8 documented surface water withdrawals and 1 documented reservoir withdrawal identified by WDOE (2008). A newly adopted Instream Flow Rule for WRIA's 27/28 regulates withdrawals in streams and lists streams with protective closures and instream flow numbers (WDOE 2008a).

Flow: Spot flow measurements conducted at the County Road 42 crossing in 1998 estimated flow at 0.7/1.0/1.9 cfs in September/October/November respectively (IFIM 1998, as found in WDFW 2001).

EFWG Comments: Clark PW is currently evaluating the replacement of the Lockwood Creek road culvert. The only Tier 1 reach is behind the Mill Dam due to the small reservoir behind the dam. Restoration actions should be sequenced to occur during or after the fish passage problems at the Lockwood Road culvert and Mill Dam have been repaired. Cooler summer stream temperatures may provide thermal refuge opportunities (to the extent fish can get in during summer low flows).

Past/Current Restoration Activities: Clark PW is evaluating the replacement of the Lockwood Road culvert.

Additional Information Needs: Evaluate possible undocumented water diversions (ponds). Evaluate fish passage at private and public road crossings. Monitor stream temperature and water quality (pollutants). Monitor juvenile and adult fish use throughout the tributary. Consider conducting stream habitat surveys in the upper basin.

Tier 1 Reaches: Brezee Creek 2, Description: Culvert to Dam, Length: 0.05 mi

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Age-0 inactive Age-0 active rearing	Key habitat quantity Key habitat quantity	Oct-Mar Mar-Oct	74/26	High
Winter Steelhead	Egg incubation Fry colonization Spawning	Sediment Habitat Diversity Habitat Diversity	Mar-Jul May-Jul May-Oct	31/69	Low

Dean Creek

Physical/Riparian/Channel Habitat Condition: Physical habitat information is limited to data gathered on the lower section of stream within the EF Lewis valley floor (CFS 2004). Dean Creek was surveyed from the intersection with J. A. Moore Road downstream 0.7 km. Land ownership within the survey reach is private agricultural and industrial. The right descending bank is entirely in farmland and the left descending bank is owned by Storedahl & Sons (Daybreak Mine), though much of the land is under agricultural usage. Below JA Moore Road, Dean Creek is low gradient and is within an unconfined valley. The stream itself has downcut into the streambed leaving itself entrenched. The upstream end of the survey area has been manually channelized as indicated by severe entrenchment and a lack of stream sinuosity. The mean wetted width in Dean Creek riffles is only 1.3 m. The wetted depth is very shallow, and consequently few deep pools are available, however much of the habitat is comprised of slow water ponds created by beaver dams. LWD recruitment potential is low but LWD presence is fair and largely derived from beaver ponds. Sandy substrate dominates the lower channel and embeddedness was as high as 75% (CFS 2004).

Additional existing habitat data was gathered based on a review of aerial photos (Google 2008). Dean Creek enters the EF Lewis CMZ downstream of the Ridgefield pits and travels north along the ponds through a narrow channel that is crossed by dirt roads and has little riparian canopy. Once the tributary gets above NE JA Moore Road, the riparian habitat improves slightly, although the channel is incised and riparian cover is spotty as it runs through a farm where blackberry and reed canary grass are dominant and a gravel quarry may be contributing to fines. The riparian cover improves with mature hardwoods and conifers until it nears NE 82nd Ave where the channel size and riparian cover diminish significantly as it runs through private property. Once the channel crosses NE 82nd, it splits. The mainstem channel goes west (Dean Creek 4) until it is turned into ponds, the east channel (Dean Creek LB Trib B) runs through private farms where it is turned into a series of ponds/reservoirs.

Fish Passage: Based on a review of SSHIAP and Clark PW, there are at least 6 stream crossings on the mainstem channel and LB Trib B and a series of ponds (SSHIAP 2008, Clark PW 2008). The two public road crossing at JA Moore Road were partial barriers but were replaced in 2008 (Clark County Conservation District). Two private culverts on 299th were replaced in 2008. Potential low-flow and thermal barrier passage problems near the mouth (TAG Members). Mid- and late-summer flow is often subterranean in heavy gravel deposits just downstream of J.A. Moore Rd (TAG Members) (Table 2).

Table 2. Fish passage potential barriers on Dean Creek

Location	Description	Status
JA Moore Road bridges	Road crossing (2)	Former barrier, improved in 2008
NE 66th Road	Road crossing	Former barrier, improved in 2007
299th (Nitowskie)	Road crossing (2)	Former barrier, improved in 2008
NE 82nd Avenue	Road crossing	unsurveyed
NE 96th Avenue	Road crossing	unsurveyed
NE 289th Street	Road crossing	not barrier
Mainstem and LB Trib B	Ponds/dams	don't appear to provide fish passage

Water Quality: Temperature conditions in summer are unlikely to support salmonid rearing and may cause passage barriers at the mouth of Dean Creek where 7DMAX temperatures of 25.3°C have been recorded. Temperatures at JA Moore Road have been recorded at 22.67°C (7DMAX). Other water quality parameters have not been monitored. The riparian corridor is significantly altered with large sections of poor riparian cover. Sections of mature hardwoods and conifers exist but are spotty. The headwater tributaries of LB Trib B have been extensively ponded/dammed which is likely to reduce summer flow and contribute to summer stream temperatures. Agriculture and development in the headwater may be contributing to sediment, pollutants, and temperature problems.

Water Diversions: There are approximately 9 documented surface water withdrawals and 7 documented ground water source withdrawals identified by WDOE (WDOE 2008). Multiple ponds exist at the headwater of Dean Creek (Google Earth 2008). A newly adopted Instream Flow Rule for WRIA's 27/28 regulates withdrawals in streams and lists streams with protective closures and instream flow numbers (WDOE 2008a)..

Flow: unknown

EFWG Comments: Potential for land acquisition of large parcels southwest of current mouth of Dean Creek. Potential to re-align channel back into historic location. Invasive species removal (blackberries). Work with landowners to use BMP's.

Past/Current Restoration Activities: Two private culverts (299th) were replaced in 2008. An impassable culvert at NE 66th was replaced in 2007. The two public road crossing at JA Moore Road were partial barriers but were replaced in 2008 (Clark County Conservation District). LCFEG has received funding for work in lower Dean Creek. Potential for land acquisition of large parcels southwest of current mouth of Dean Creek.

Additional Information Needs: Evaluate sediment and pollutant sources. Evaluate possible undocumented water diversions (ponds). Evaluate fish passage at private and public road crossings. Monitor stream temperature and water quality (pollutants). Monitor juvenile and adult fish use throughout the tributary.

Tier 1 Reaches: Dean Creek 1A (Mouth to Canyon, Length: 0.87 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg Incubation Age-0 active rearing Age-0 inactive rearing	Sediment Key habitat quantity Key habitat quantity	Oct-May May-Oct Oct-Mar	93/07	High
Winter Steelhead	Age-0 active rearing Egg Incubation Fry Colonization	Temperature Sediment/Temp. Temperature	Mar-Jul Mar-Jul May-Jul	46/54	Low
Chum	Egg Incubation Prespawn holding	Sediment Key habitat quan/Div	Oct-Apr Oct-Dec	52/48	Low

Tier 2 Reaches: Dean Ck 3 (Culvert 2 - Culvert 3, Length: 0.13 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg Incubation Age 0 active rearing Age 0 inactive rearing	Sediment Key habitat quantity Key habitat quantity	Oct-May May-Oct Oct-Mar	87/13	Medium

Dyer Creek

Physical/Riparian/Channel Habitat Condition: Stream habitat surveys have not been conducted on Dyer Creek, therefore limited physical data is available. Based on a review of aerial photos, the potential useable fish habitat has been significantly shortened by the development of private ponds/reservoirs on the mainstem channel above NE 259th Street which do not appear to provide fish passage. Downstream of NE 259th, the stream travels through marginal riparian cover interspersed with dense blackberry and reed canary grass. The entire tributary has been heavily altered due to agriculture and development. The two small tributaries are crossed by a number of roads and private drives and, in both cases, their headwaters have been dammed and ponded for private use. A series of springs/wetlands at the headwaters have been altered. The channel within the EF CMZ is deeply incised and has limited flow during the summer months. Dyer is unlikely to provide much summer habitat currently but may provide winter habitat for coho and steelhead.

Fish Passage: Based on a review of SSHIAP and Clark PW, there is at least 1 stream crossing and 1 reservoir located on the mainstem channel (SSHIAP 2008, Clark PW 2008) (Table 3).

Table 3. Fish Passage potential barriers in Dyer Creek

Location	Description	Status
NE 259th St	Road crossing	barrier
Houser Reservoir	Dam	barrier

Water Quality: The riparian corridor is significantly altered with large sections of poor riparian cover. Sections of mature hardwoods and conifers exist infrequently and most of the channel is dominated by blackberry and reed canary grass. The headwaters of the mainstem and tributaries have been extensively ponded/dammed which is likely to reduce summer flow and contribute to summer stream temperatures. Agriculture and development in the headwater may be contributing to sediment, pollutants, and temperature problems.

Water Diversions: There are approximately 2 documented surface water withdrawals and 2 documented ground water source withdrawals identified by WDOE (WDOE 2008). Multiple ponds exist at the headwaters of Dyer Creek (Google Earth 2008). A newly adopted Instream Flow Rule for WRIA's 27/28 regulates withdrawals in streams and lists streams with protective closures and instream flow numbers (WDOE 2008a).

Flow: Unknown

EFWG Comments: Group had little knowledge of Dyer Creek.

Past/Current Restoration Activities: None identified

Additional Information Needs: Evaluate possible undocumented water diversions (ponds). Evaluate fish passage at private and public road crossings. Monitor stream temperature and water quality (pollutants). Monitor juvenile and adult fish use throughout the tributary. Identify and protect important wetland/spring habitat in the headwaters.

Tier 1 Reaches: Dyer Creek 1 (Mouth - Dyer Ck. LB Trib., Length: 0.14 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg Incubation Age-0 active rearing	Sediment/channel stability Temp/Key habitat quality	Oct-May Mar-Oct	87/13	High
Winter Steelhead	Age-0,1 inactive Age-1 active	Habitat Diversity Habitat Diversity	Oct-Mar Mar-Oct	24/76	Low
Summer Steelhead	Age-0,1 inactive rearing Age-2+ active rearing	Habitat Diversity Habitat Diversity	Oct-Mar Mar-Oct	0/100	Low

Tier 2 Reaches: Dyer Creek 2 (Dyer Ck. LB Trib. to Dyer Ck. Canyon, Length: 0.49 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg Incubation Age-0 active rearing	Sediment/channel stability Temp/Key habitat quant.	Oct-May Mar-Oct	83/17	Medium
Winter Steelhead	Age-0,1 inactive Age 1 active	Habitat Diversity Habitat Diversity	Oct-Mar Mar-Oct	0/100	Low
Summer Steelhead	Age-0,1 inactive rearing Age-2+ active rearing	Habitat Diversity Habitat Diversity	Oct-Mar Mar-Oct	15/85	Low

Tier 2 Reaches: Dyer Creek 4 (Top of Canyon to Dyer Creek Dam (end of presumed coho use), Length 0.39)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg incubation Age-0 active rearing Age-0 Inactive rearing	Sediment Key habitat quantity Key habitat quantity	Oct-May Mar-Oct Oct-Mar	90/10	Medium

Jenny Creek

Physical/Riparian/Channel Habitat Condition: Stream habitat surveys have not been conducted on Jenny Creek. Based on a review of aerial photos, the stream channel appears to be well shaded with mature hardwood and conifer in the riparian and upland corridors, although there are short sections where the stream runs through agricultural property and has poor riparian cover. A barrier falls exists at RM 0.13 which naturally limits salmon and steelhead production. Limited water

quality data indicates that Jenny Creek may provide summer temperature refuge from the mouth to the barrier falls.

A brief survey (Interfluve/CFS 2008) of the County owned land from the mouth to the barrier falls noted that substrate was highly embedded with fines and dominated by cobble sized angular rock (likely native basalt from canyon). Spawning habitat appeared to be very limited due to sediment load and size of substrate. Some limited rearing habitat is available in the summer. The channel may provide some winter flow refugia from the mainstem EF Lewis. Non native invasive species such as reed canary grass, bamboo, and Himalayan blackberry dominate the riparian understory. Salmonids (not ID'd) were observed in the channel below the falls.

Fish Passage: A barrier falls exists at RM 0.13 which naturally limits salmon and steelhead distribution. Based on a review of SSHIAP and Clark PW, there are at least 12 road/stream crossings on the mainstem channel (Clark PW 2008, SSHIAP 2008). It appears that some of the road/stream crossings have not been surveyed, but many others have been identified as barriers (Table 4).

Table 4. Fish passage potential barriers on Jenny Creek

Location	Description	Status
RM 0.13	Road crossing	barrier falls
NW Pacific Highway	Road crossing	barrier
NW 14th Avenue	Road crossing	Barrier
Cedar Creek. Rd	Road crossing	barrier
NW 359th Street	Road crossing	barrier
NE 8th Avenue/NW Jenny	Road crossing	barrier
private drive	Road crossing	unsurveyed
private drive	Road crossing	unsurveyed
NE 378th	Road crossing	barrier
NE Jenny	Road crossing/ small concrete dam	barrier
NE 12th	Road crossing	barrier
NE Jenny	Dam/Berm	unsurveyed
NE 389th Street	Road crossing	unsurveyed

Water Quality: Largely unknown. Water temperatures appear to be cooler than in other Lower Basin tributaries. WDEQ conducted temperature monitoring at the Pacific Highway road crossing. 7DMAX was 19.97°C in 2003 and 19.6ºC in 2005.

Water Diversions: There are 11 surface water withdrawals, and 1 ground water source withdrawal from the Jenny Creek Watershed (WDOE). A newly adopted Instream Flow Rule for WRIA's 27/28 regulates withdrawals in streams and lists streams with protective closures and instream flow numbers (WDOE 2008a).

Flow: unknown

EFWG Comments: Evaluate the potential for thermal refuge during mainstem EF Lewis summer low flows?

Past/Current Restoration Activities: Unknown

Additional Information Needs: Evaluate possible undocumented water diversions (ponds). Evaluate fish passage at private and public road crossings. Monitor stream temperature and water quality (pollutants). Monitor resident

(rainbow and cutthroat) juvenile and adult fish use throughout the tributary and presence/absence above the barrier falls.

Tier 1 Reach: Jenny Creek (Mouth to Barrier Falls, Length: 0.13 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg incubation Age-0 in active rearing	Sediment Habitat Diversity	Oct-May Oct-Mar	82/18	High
Winter Steelhead	Egg Incubation	Sediment/temperature	Mar-Jul	07/93	Low

Lockwood/Riley Creek

Physical/Riparian/Channel Habitat Condition: Stream surveys are limited to the lower reaches of Lockwood Creek. Physical habitat surveys were conducted on Lockwood Creek from stream mile 0.8 to 1.3 in 2004 (CFS 2004). Landownership within the survey reach is private rural residential. Land use within the stream valley is mostly unmanaged, with some small scale agriculture and timber uses. There is one residence near the stream at the upstream end of the surveyed segment. Lockwood Creek is comprised primarily of pools with a significant amount of small gravel/cobble riffles and beaver ponds. A majority of the surveyed portion of Lockwood Creek has a pool-riffle morphology. The downstream end of the survey area is dominated by beaver ponds. Upstream of the beaver ponds there are clearly defined pools and riffles (CFS 2004). Lockwood Creek is low gradient and unconfined throughout the survey area, though it has undergone some entrenchment that may be related to anthropogenic influences. The valley bottom maintains a broad wetland that probably historically received overflow from Lockwood Creek on an annual basis. With the current entrenchment, the wetland is likely inundated less frequently than historically. The wetland may have functioned as an important over-winter rearing area in the past. Riffles are shallow and average 5.5 m wide. There are 23.4 pools per kilometer, but few of those are greater than 1 m deep (CFS 2004). There were 35 pieces of LWD per kilometer in the surveyed section of Lockwood Creek. Small pieces made up the largest portion among size classes, followed by medium and then large pieces. There was 1 log-jam and 1 rootwad per kilometer (CFS 2004). Characterization of substrate based on visual observation showed that the dominant and subdominant substrate classes in pools is gravel and sand, respectively. The same is true in riffles, except the percentage of substrate as gravel is greater. Sand makes up 38% of the substrate in pools and 18% of the substrate in riffles (CFS 2004).

Based on a review of aerial photographs the riparian area above the survey area, has variable riparian cover/shading with extensive sections of mature hardwood and conifer and other sections which run through developed and agricultural lands. Invasive Himalayan blackberry and reed canary grass are common along agricultural lands.

Fish Passage: Based on a review of SSHIAP and Clark PW, there are multiple public and private road/stream crossings on Lockwood Creek (7) and its tributaries (12) (Clark PW 2008, SSHIAP 2008). A small dam was found to block 0.8 miles of potential winter steelhead and coho habitat on Riley Creek (Clark County Passage

Assessment). A partially blocking/impassable culvert was located at the Taylor Valley Road crossing on Tributary 1 and this was replaced in 2001 (SSHIAP, Clark County Public Works). A series of cascades below this culvert may limit fish distribution. It is recommended that a survey for coho above the cascades be completed prior to any repair or modifications to the culvert (WDFW 2001). Buckbee Dam/Reservoir on Riley Creek is a complete fish passage barrier (Table 5).

Table 5. Fish passage potential barriers on Lockwood Creek

Location	Description	Status
Mainstem		
NE 315th	Road crossing	not a barrier
NE Lockwood Creek Road	Road crossing	partial barrier (SSHIAP)
private drive	Road crossing	unsurveyed
private drive, NE Lester Avenue	Road crossing	not a barrier
private drive	Road crossing	unsurveyed
private drive	Road crossing	partial barrier (SSHIAP)
private drive	Road crossing	unsurveyed
NE Sorenson	Road crossing	barrier
headwater tributary's above known/assumed fish use	stream crossings and ponds	unknown
Riley Creek		
NE Johnson Creek Road	Road crossing	not a barrier
NE Finalburg Road	Road crossing	replaced (Clark PW)
NE 52nd	Road crossing	barrier
headwater tributary's above known/assumed fish use	stream crossings and ponds	unknown
Tributary 1		
NE Lockwood Creek Rd	Road crossing	barrier
NE 379th	Road crossing	not surveyed
Buckbee Dam/Reservoir	Dam/Reservoir	barrier
Tributary 2		
NE 379th	Road crossing	barrier
NE Lockwood Creek Rd	Road crossing	partial barrier (SSHIAP)
private drive	Road crossing	not surveyed
private drive	Road crossing	not surveyed
NE 339th Street	Road crossing	barrier
Tributary 3		
NE Taylor Valley Rd	Road crossing	not a barrier
NE 379th	Road crossing	barrier
Tributary 4		
NE Taylor Valley Rd	Road crossing	replaced 2001
NE Sorenson	Road crossing	barrier

Water Quality: Water temperatures in lower Lockwood Creek have been as high as 22.15ºC (7DMAX) and 26.1ºC (7DMAX). There are several ponds/reservoirs located in the mainstem and tributaries to Lockwood Creek. These ponds may reduce flow and contribute to elevated temperatures in the summer. Clark County rates Lockwood Creek as fair (degraded but may support residential/aquatic life and recreation). Lockwood Creek exceeded water quality criteria for fecal coliform standards based on surveys conducted in 1991 and 1992 (Hutton) at the Lockwood Creek Road Station. There are a number of sediment/pollutant source opportunities at each road crossing and via the small tributaries which run through agricultural land.

Water Diversions: There are approximately 22 documented surface water withdrawals, and 7 documented ground water source withdrawals, and 1 dam withdrawal (Buckbee Reservoir) from the Lockwood Creek Watershed (WDOE 2008). Multiple ponds exist at the headwater of both Lockwood and its tributaries (Google Earth 2008). A newly adopted Instream Flow Rule for WRIA's 27/28 regulates withdrawals in streams and lists streams with protective closures and instream flow numbers (WDOE 2008a).

Flow: Spot flows measurements conducted at County Road 42 crossing in 1998 estimated flow at 0.7/1.4/5.9 cfs in September/October/November respectively (IFIM 1998, in WDFW 2001).

EFWG Comments: The intact riparian area of the headwaters of Lockwood should be preserved.

Past/Current Restoration Activities: Recent activities include riparian planting (50 acres) and LWD placement from Lockwood Road to the mouth, creation of a coho rearing pond near Lockwood road, pulling banks back (610 m) and replanting. In addition, a total of 0.64 km of diking on the left bank only has now been removed on lower Lockwood Creek, lowering the known total length of diking to 10 km (currently identified) in the East Fork Lewis River subbasin (WDFW 2001). A concrete fishway was installed below the Johnson road culvert by CCPW in 1994. An impassable culvert at Finalburg Road crossing was replaced on Riley Creek in 2001 (Clark PW). The Taylor Valley road crossing on Tributary 4 was replaced in 2001. The Taylor Valley Road crossing has been corrected by Clark County Public Works (CCPW) in 2001. A channel structure and riparian restoration project is underway above Lockwood Road (2008 LCFEG). CCPW added log weirs below Lockwood Creek Rd culvert in 1993. Additional funding has been acquired to replace an impassable culvert on Riley Creek.

Additional Information Needs: Evaluate sediment and pollutant sources in Lockwood and Riley. Evaluate possible undocumented water diversions (ponds). Evaluate fish passage at private and public road crossings which intersect with known fish use. Monitor stream temperature and water quality (pollutants). Monitor juvenile and adult fish use throughout the tributary, especially above the falls on the tributary.

Tier 2 Reaches: Lockwood 1 (Mouth – Riley Ck., Length: 1.39 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg Incubation Age-0 active rearing	Sediment/channel stability/ Key habitat quantity	Oct-May Mar-Oct	87/13	Low
Winter Steelhead	Age-0,1 inactive rearing	Habitat diversity	Oct-Mar	52/48	Low
Chum	Egg Incubation Prespawn holding	Sediment/channel stability Key habitat quantity/diversity	Oct-Apr Oct-Jan	47/53	Medium

Manley Creek

Physical/Riparian/Channel Habitat Condition: Stream habitat surveys have not been conducted on Manley Creek. Based on a review of aerial photos, the lower channel is forced against the south valley wall by levees and berms and a private drive brackets the channel on the other side. A large private pool/pond existed near the mouth of the tributary but was removed and a natural channel design was created (Fish First 2008). The channel then meanders through the EF Lewis CMZ through a number of private properties with roads that cris-cross the creek. The riparian conditions within the CMZ are very poor and sometimes non-existent. At the Manley Road crossing the channel enters into more mature riparian conditions but the channel conditions may be affected by the adjacent TEBO gravel mine. The channel then meanders through private land with some sections of mature riparian habitat interspersed with no riparian cover until the stream reaches its headwater source.

Fish Passage: Based on a review of SSHIAP and Clark PW, there are at least 16 road/stream crossings on the mainstem channel (SSHIAP 2008, Clark PW 2008). Many were found to be full or partial barriers. Clark County PW is currently evaluating the culvert at NE 259th. Neither coho or steelhead have been observed in the upper reaches (Reach 2) (Table 6).

Table 6. Fish passage potential barriers on Manly Creek

Location	Description	Status
NE Septan	Road crossing	barrier
private road	Road crossing, gravel ford	unsurveyed
NE 259th	Road crossing	barrier (Clark PW evaluating)
NE 257th	Road crossing	barrier
NE 257th	Road crossing	barrier
NE 257th	Road crossing	barrier
NE Manley	Road crossing	barrier
NE Manley	Road crossing	barrier
NE Manley	Road crossing	barrier
NE 92nd Avenue	Road crossing/ small concrete dam	barrier
TEBO gravel road	Road crossing	barrier
NE 92nd Avenue	Road crossing	barrier
private road	Road crossing	unsurveyed
NE 108th	Road crossing	barrier
NE 112th Avenue	Road crossing	unsurveyed

Water Quality: The riparian corridor is significantly altered with large sections of poor riparian cover. Sections of mature hardwoods and conifers exist infrequently and much of the riparian has been landscaped. The TEBO gravel mine likely contributes fines into the stream. Agriculture and development in the headwater may be contributing to sediment, pollutants, and temperature problems. Temperature monitoring at the mouth has recorded 7DMAX of as high as 25.2ºC (Clark PW).

Water Diversions: There are approximately 9 documented surface water withdrawals, and 2 documented ground water source withdrawals from the Manly Creek Watershed (WDOE 2008). Some private ponds exist in the headwaters (Google Earth 2008). A newly adopted Instream Flow Rule for WRIA's 27/28

regulates withdrawals in streams and lists streams with protective closures and instream flow numbers (WDOE 2008a).

Flow: unknown

EFWG Comments: Manly Creek used to enter near RM 11 and was diverted to avoid agricultural land. There is a berm that keeps the creek in its current channel. The tree farm in Reach 1C may contribute to water quality (pesticide) issues. Manly has a series of springs near the mouth in reach 1A that may provide cold water inputs. TEBO gravel mining may contribute to water quality issues (temperature and fine sediment). Clark PW is evaluating 259th culvert.

Past/Current Restoration Activities: Fish First is currently working on improving channel structure at the mouth of the tributary (pond filling and placement of structure and gravel in Reach 1A). Fish First is also working with private landowners in lower Manly Creek to identify possible stream crossing improvement projects. There is a small cement dam, remnants of an old water wheel, on private property just downstream from 92nd Ave on Manley Creek.

Additional Information Needs: Evaluate possible undocumented water diversions (ponds). Evaluate fish passage at private and public road crossings. Monitor stream temperature and water quality (pollutants). Monitor juvenile and adult fish use throughout the tributary

Tier 1 Reaches: Manly 1A (Mouth to Manly Ck. Culvert 1, Length: 0.15 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Age-0 active rearing Egg incubation Age-0 inactive rearing	Key habitat quality/temp Sediment/Channel stability Key habitat quality/diversity	Oct-Mar Oct-May Mar-Oct	92/08	High
Winter Steelhead	Egg Incubation Age-0,1 inactive rearing	Habitat diversity Habitat diversity	Oct-Mar Mar-Oct	40/60	Low
Chum	Prespawn holding Egg Incubation	Habitat diversity/quality Sediment/channel stability	Oct-Dec Oct-Apr	72/28	Low

Tier 1 Reaches: Manly 1D (Culvert 3 - Culvert 4, Length: 0.13 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg incubation Age-0 active rearing Fry colonization	Sediment/Channel stability Key habitat quality/temp Key habitat quality	Oct-May Oct-Mar Mar-Oct	93/07	High
Winter Steelhead	Egg Incubation Age-0,1 inactive rearing	Sediment/temperature Temp/oxygen/pathogen	Oct-Mar Mar-Oct	50/50	Low
Chum	Prespawn holding Egg Incubation	Habitat diversity/quality Sediment/channel stability	Oct-Dec Oct-Apr	72/28	Low

Tier 1 Reaches: Manly 1E (Culvert 4 - Culvert 5, Length: 0.24 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Age-0 active rearing Egg incubation Age-0 inactive	Key habitat quality/temp Sediment/Channel stability Key habitat quality	Oct-Mar Oct-May Oct-Mar	91/09	High
Winter Steelhead	Egg Incubation Age-0 active rearing	Sediment/temperature Temp/oxygen/pathogens	Mar-Jul May-Oct	55/45	Low
Chum	Prespawn holding Egg Incubation	Habitat diversity/quality Sediment/channel stab.	Oct-Jan Oct-Apr	72/28	Low

Tier 1 Reaches: Manly 1F (Culvert 5 - Culvert 6, Length: 0.11 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Age-0 active rearing Egg incubation Fry colonization	Key habitat quality/temp Sediment/Channel stability Key habitat quality	Oct-Mar Oct-May Oct-May	90/10	High
Winter Steelhead	Egg Incubation Fry colonization	Sediment/temperature Habitat diversity/temp	Mar-Jul May-Oct	59/41	Low
Chum	Prespawn holding Egg Incubation	Habitat diversity/quality Sediment/channel stability	Oct-Jan Oct-Apr	72/28	Low

Tier 1 Reaches: Manly 1G, (Culvert 6 - Culvert 7, Length: 0.03 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg incubation Fry colonization	Sediment/Channel stability Key habitat quality	Oct-May Mar-May	73/27	High
Winter Steelhead	Egg Incubation Fry colonization	Sediment/temperature Habitat diversity/quality	Mar-Jul May-Jul	50/50	Low
Chum	Prespawn holding Egg Incubation	Habitat diversity/quality Sediment/channel stability	Oct-Jan Oct-Apr	72/28	low

Tier 2 Reaches: Manly 1B (Culvert 1- Culvert 2, Length: 0.44 mi), Manly 1C(Culvert 2 - Culvert 3, Length 0.42mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Age-0 active rearing Egg incubation Age-0 inactive rearing	Key habitat quantity/temp Sediment/Channel stability Key habitat quantity	Oct-Mar Oct-May Mar-Oct	91/09	Medium
Winter Steelhead	Egg Incubation Age-0 active rearing	Habitat diversity Temperature/flow	Oct-Mar May-Oct	30/70	Low
Chum	Prespawn holding Egg Incubation	Habitat diversity/quantity Sediment/channel stability	Oct-Dec Oct-Apr	72/28	Low

Mason Creek

Physical/Riparian/Channel Habitat Condition: Stream habitat surveys have not been conducted on Mason Creek. Clark County describes Mason Creek as, "originating in rolling uplands near the View and Fargher lakes areas. For most of its length, Mason Creek flows though a gravelly canyon. Once it leaves the canyon at J. A. Moore Road, it flows approximately one mile across the East Fork Lewis River flood plain. Nearly half of Mason Creek's drainage area is fields, pastures, and other cleared land. About 40 percent is forest. Overall stream health for Mason Creek is rated fair. This is based on early 1990s data for stream insects, bacteria, and water quality data collected near its confluence with the East Fork. Much of the creek lacks large trees to provide shade and wood for stream habitat. Small ponds are fairly common in the upper parts of Mason Creek. These ponds can result in warmer stream temperatures and increases in nutrients. Loss of forest and increasing development threaten to further degrade Mason Creek. Rural residential development will likely increase runoff" (Clark County 2002).

Based on a review of SSHIAP and Clark PW, there are at least 15 public and private road/stream crossings on Mason Creek and its tributaries (Clark PW 2008, SSHIAP 2008). Many of the road crossings are listed as impassable. The culvert at N.E. 102nd is considered passable but needs additional assessment to determine its status (Clark County Public Works). Clark County Public Works identified 3 impassable culverts on Mason Creek tributary; one at Underwood Road crossing, one at Peart Road crossing, and one in between these two roads. 1.57 miles of potential habitat affected (WDFW 2001) (Table 7).

Table 7 Fish passage potential barriers on Mason Creek

Location	Description	Status
Mainstem		
Private Road	Road crossing, bridge	not a barrier
NE JA Moore Road	Road crossing, bridge	not a barrier
Private drive to residence	Road crossing	unsurveyed
NE JR Anderson Road	Road crossing, bridge	not a barrier
NE 102nd Ave	Road crossing	passable but needs further assessment
NE 127th Ave	Road crossing	barrier
Underwood Road	Road crossing	impassable
private road	Road crossing	unsurveyed
Peart Road	stream crossings and ponds	impassable
NE Shamrock	Road crossing	barrier
NE 359th	Road crossing	barrier
NE 379th	Road crossing	barrier
NE 135th	Road crossing	barrier
Tributary 1		
NE JR Anderson Road	Road crossing	barrier
NE 82nd Ave	Road crossing	barrier

Water Quality: Many of the headwater tributaries have been ponded or dammed. These headwater ponds likely increase stream temperatures in summer. Agriculture and development in the headwater may be contributing to sediment and pollutant sources. There are two years of temperature monitoring information. Clark County collected daily temperature data at JA Moore Road in 2004 and recorded a 7DMAX

of 21.7ºC (Clark PW). TMDL monitoring in 2005 recorded a 7DMAX of 17.75ºC below Heitman Creek (aka SwansonCreek) (DEQ 2005) confluence with Mason Creek. Additional temperature data will be available from Clark County in the summer of 2008. Elevated fecal coliform was detected at the JA Moore monitoring station (Hutton 1995).

Water Diversions: There are approximately 8 documented surface water withdrawals, 2 documented ground water source withdrawals, and one dam withdrawal (Tsugawa Brothers) from the Mason Creek Watershed (WDOE 2008). Multiple ponds exist at the headwater of Mason Creek (Google Earth 2008). A newly adopted Instream Flow Rule for WRIA's 27/28 regulates withdrawals in streams and lists streams with protective closures and instream flow numbers (WDOE 2008a).

Flow: Spot flows measurements conducted at 11th Ave crossing in 1998 estimated flow at 0.3/0.6/5.1 cfs in September/October/November respectively (IFIM 1998, as found in WDFW 2001).

EFWG Comments: Lower Mason Creek has flow issues from Anderson road to mouth. Cutthroat and salmon (not specified) are present in the upper basin. Mason Creek has a rearing pond located on Heitman Creek (aka Swanson Creek) that is used by Fish First.

Past/Current Restoration Activities: In 2008 LCFEG completed a bank erosion project on the Cushman property below J.R. Anderson Rd the project was designed to protect bank erosion and enhance salmon habitat. A FFFPP project was completed last summer on the Rashford Tree Farm crossing located above 102nd Ave on Mason Creek.

Additional Information Needs: Evaluate sediment and pollutant sources. Evaluate possible undocumented water diversions (ponds). Evaluate fish passage at private and public road crossings. Monitor stream temperature and water quality (pollutants). Monitor juvenile and adult fish use throughout the tributary.

Tier 1 Reaches: Mason Creek Trib 1 (Mason Ck trib 1 to end of coho use, Length: 0.99 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Age-0 active rearing Egg incubation	Temp/key habitat quantity/ Sediment/channel stability	Mar-Oct Oct-May	99/01	High
Winter Steelhead	Age-0,1 inactive rearing Age-1 active rearing	Habitat diversity Habitat diversity	Oct-Mar Mar-Oct	00/00	Low

Tier 2 Reaches: Mason 1A (Mouth to Trib 1A Culvert, Length: 0.04 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg incubation Fry colonization	Sediment/channel stability Key habitat quant/qual	Oct-May Mar-May	69/31	High
Winter Steelhead	Fry colonization	Hab diversity/temp/flow	May-Jul	05/95	Low

Tier 2 Reaches: Mason 3 (Length: 1.0 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Age-0 active rearing Egg incubation	Temp/key habitat quantity Sediment/channel stability	Mar-Oct Oct-May	87/13	Medium
Winter Steelhead	Egg Incubation Fry Colonization	Sediment/temp Habitat diversity	Mar-Jul May-Jul	75/25	Low

Tier 2 Reaches: Mason 8 (Culvert 4 - Culvert 5, Length: 0.77 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Age-0 active rearing Egg incubation	Temp/key habitat quantity Sediment/channel stability	Mar-Oct Oct-May	84/16	Medium

McCormick Creek

Physical Habitat Condition: no stream surveys have been conducted above NW LaCenter Road crossing. Physical habitat surveys were conducted on the lower 1 km in 2004 (CFS 2004). Below LaCenter Road the channel condition is poor with pool frequency <20%, fines dominating the substrate, LWD rates <1.0, and LWD recruitment potential low (CFS 2004).

Riparian Condition: Based on a review of aerial photographs, most of the stream channel appears to be well shaded with mature hardwood and conifer except in two sections; the first is from RM 0 to 0.5. This lower ½ mile stretch has no riparian cover and is dominated by reed canary grass. The second section occurs along a ¼ mile section of private agriculture land above NW Spencer road. Invasive Himalayan blackberry and reed canary grass are common along the length of the riparian corridor.

Channel Condition: The channel within the EF CMZ is deeply incised with almost vertical slopes cutting through fine alluvium. Active channel width is 0.6 to 1.2 m and bank heights exceed 2.1 to 2.4 vertical meters in places. Fine sediment dominates the substrate. The channel meanders through dense reed canary grass and a few ash groves in the lowermost ½ mile before it reaches more mature hardwood cover. A series of beaver dams provide deep pools and cover but may also act as partial passage barriers during summer low flows (CFS 2004). Channel structure above NW LaCenter Road crossing is unknown.

Fish Passage: Based on a review of SSHIAP and Clark PW, there are at least 12 road/stream crossings on the mainstem channel and tributaries (SHIAP 2008, Clark PW 2008, Wade 2000). Many of the road crossings are identified as barriers (Clark

PW). The dam at Hilm Reservoir is a complete passage barrier. Resident fish passage upstream of Hilm Reservoir is unknown (Table 8).

Table 8. Fish passage potential barriers on McCormick Creek

Location	Description	Status
Mainstem		
319th Street	Road crossing (2)	partial to total barrier (Clark County PW)
private road	Road crossing	not a barrier
NW 11th Avenue	Road crossing	barrier
Hilm Reservoir	Dam/Road crossing	complete barrier
private road (between Hilm reservoir and Timmons Road	Road crossing	unsurveyed
NE Timmons road	Road crossing	barrier
NE 289th St	Road crossing	unsurveyed
NE 279th	Road crossing	barrier
headwaters and tributaries	ponds/reservoirs	may not have passage
Tributary 1		
NW 310st	Road crossing	barrier
NW 289th	Road crossing	barrier
NW 279th	Road crossing	barrier

Water Diversions: There are 7 surface water withdrawals, and 2 ground water source withdrawals from the McCormick Creek Watershed (WDOE website). The headwaters have been ponded/dammed, at least 4 ponds/reservoirs are present including Hilm Reservoir. Multiple ponds exist at the headwater of McCormick Creek (Google Earth 2008). A newly adopted Instream Flow Rule for WRIA's 27/28 regulates withdrawals in streams and lists streams with protective closures and instream flow numbers (WDOE 2008a).

Water Quality: Clark County rates McCormick Creek as poor (inferior health, poorly suited for aquatic life and recreation). McCormick Creek exceeded water quality criteria for fecal coliform standards based on surveys conducted in 1991 and 1992 (Hutton) at the NW LaCenter Road Station. There are a number of sediment/pollutant source opportunities at each road crossing and via the small tributaries which run through agricultural land. McCormick Creek is also listed as impaired relative to water temperature (Wade 2000). There are a series of ponds/reservoirs on the mainstem and a couple of the lower tributaries. These ponds may reduce flow and increase temperature conditions in the summer.

Flow: Spot flows measurements conducted at 11th Ave crossing in 1998 estimated flow at 0.2/0.4/2.4 cfs in September/October/November respectively (IFIM 1998).

EFWG Comments: consider realigning outlet/lower channel with relict channel along south bank near terrace. Connecting the large off-channel pond that dominates the center of floodplain is not advocated (currently used as productive swan habitat).

Past/Current Restoration Activities: Partial to total barrier culvert at the 319th Street crossing (Clark County Public Works) blocks 3.7 km of potential habitat for winter steelhead and coho (*O.kisutch*) (WDFW 2001).

Additional Information Needs: Stream Habitat Survey Information above NW LaCenter Road to headwaters. Evaluate sediment and pollutant sources in McCormick. Evaluate possible undocumented water diversions (ponds). Evaluate fish passage at private and public road crossings. Monitor stream temperature and water quality (pollutants).

Tier 1 Reaches: McCormick D (LB Trib to Culvert, Length: 0.03 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg incubation Fry colonization	Sediment Key habitat quantity	Oct-May Mar-May	55/45	High
Winter Steelhead	Egg Incubation Spawning	Sediment/temperature Key habitat quality	Mar-Jul Mar-Jun	02/98	Low

Tier 1 Reaches: McCormick G (Ponds Associated with Culvert 4, Length: 0.11 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg incubation Age-0 inactive rearing	Sediment Sediment	Oct-May Oct-Mar	55/45	High

Tier 1 Reaches: McCormick H (Ponds Associated with Culvert 5, Length: 0.10 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg incubation	Sediment	Oct-May	85/15	High

Tier 2 Reaches: McCormick 1A (Mouth to Culvert 1, Length: 0.95 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg incubation Age-0 active rearing	Sediment/Temp/ key habitat quantity	Oct-May Mar-Oct	86/14	Low
Winter Steelhead	Egg Incubation	Sediment/temperature	Mar-Jul	35/65	Low
Chum	Egg Incubation Prespawn holding	Sediment/channel stab./Habitat diversity	Oct-Apr Oct-Jan	46/54	Medium

Tier 2 Reaches: McCormick 1C (Culvert 2 to LB Trib, Length: 0.43 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg incubation Age-0 active rearing	Sediment/Temp/key habitat quantity	Oct-May Mar-Oct	82/18	Medium
Winter Steelhead	Egg Incubation	Sediment/temperature	Mar-Jul	37/63	Low

Tier 2 Reaches: McCormick 1I (Mcormick Ck 8 (pond) to end of potential coho use, Length: 0.13 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg incubation Age-0 active rearing	Sediment/Temp/key habitat quantity	Oct-May Mar-Oct	74/26	Medium

Mill Creek

Physical/Riparian/Channel Habitat Condition: Physical habitat information is limited to data gathered on the lower section of stream within the EF Lewis valley floor (CFS 2004). Based on a review of aerial photos, the riparian condition below NE 239th Road is good with mature riparian cover and good LWD recruitment potential. The riparian and headwater conditions of this small stream appear to be better than some of the other lower basin tributaries, although the amount of useable fish habitat is naturally limited by the small size of this tributary. There are some ponds/reservoirs in the headwater but they don't appear to be connected to the mainstem channel. A pebble count was conducted in a relatively steep portion of the stream as it cuts through the valley wall of the mainstem East Fork. It therefore does not represent substrate conditions that would be found further upstream on the plateau. The upper portions (plateau) of Mill reflects moderate inputs of fine sediment from upstream, with 11% sand and 25% embeddedness (CFS 2004).

Fish Passage: Based on a review of SSHIAP and Clark PW, there are at least 4 stream crossing on the mainstem channel (Clark PW 2008, SSHIAP 2008). The public road crossing at NE 259th is a passable fish ladder which may need periodic review for maintenance (Clark County CD). The private culvert on NE 59th is being replaced in 2009 (Table 9).

Table 9. Fish passage potential barriers on Mill Creek

Location	Description	Status
NE 259th St	Road crossing , fish ladder	Passable, may need further review (Clark County)
NE 59th (24713 NE 59th)	Road crossing	barrier, being replaced in 2009 (Clark County)
NE 59th (24203 NE 59th)	Road crossing	barrier
NE 259th St	Road crossing	barrier

Water Quality: Clark County rates Mill Creek as Poor (inferior health, poorly suited for aquatic life and recreation). Temperature in Mill Creek appears to be suitable for most summer rearing and may provide summer refugia.

Water Diversions: There are approximately 3 documented surface water withdrawals and 4 documented ground water source withdrawals and 1 dam identified by WDOE (WDOE 2008). Multiple ponds exist at the headwater of Mill Creek (Google Earth 2008). A newly adopted Instream Flow Rule for WRIA's 27/28 regulates withdrawals in streams and lists streams with protective closures and instream flow numbers (WDOE 2008a).

Flow: unknown

EFWG Comments: Heavy coho use this past year (100's of spawners). Temperature is good, multiple springs. Steep/high gradient until 259th and then it returns to lower gradient. Gradient at mouth may limit coho use in summer for mainstem fish. D. Brown owns the east side property at mouth.

Past/Current Restoration Activities: Wooldridge culvert at 24713 NE 59th Ave. will be replaced in 2009 with FFFPP. Funds have not been identified to replace the Lane culvert at 24203 NE 59th Ave. yet. A concrete fishway was installed by CCPW below the 259th St culvert in 1994.

Additional Information Needs: Evaluate possible undocumented water diversions (ponds). Evaluate fish passage at private and public road crossings. Monitor stream temperature and water quality (pollutants). Monitor juvenile and adult fish use throughout the tributary.

Tier 1 Reaches: Mill Creek 1C (Culvert 1 – Culvert 2, Length: 0.28 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg incubation Age-0 active rearing	Sediment/Channel Stability Key habitat quantity	Oct-May Mar-Oct	84/16	High
Winter Steelhead	Age-0,1 inactive rearing Age-1 active rearing	Habitat diversity Habitat diversity	Oct-Mar Mar-Oct	0/100	Low

Tier 2 Reaches: Mill Creek 1A (Mouth – Mill Ck. fishway, Length: 0.34 mi)

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months	Rest. v. Pres. Value	Reach Importance to Pop. Recovery
Coho	Egg incubation	Sediment/Channel Stability	Oct-May	83/17	Low
Winter Steelhead	Age-0,1 inactive rearing Age-0 active rearing	Habitat diversity Habitat diversity	Oct-Mar May-Oct	24/76	Low
Summer Steelhead	Age-0,1 inactive	Habitat diversity	Oct-Mar	15/85	Low
Chum	Egg incubation Prespawn holding	Sediment/channel stability Habitat diversity/quantity	Oct-Apr Oct-Jan	53/47	Medium

APPENDIX C: ANNOTATED BIBLIOGRAPHY

Bilhimer, D., L. Sullivan, and S. Brock. 2005. Quality Assurance Project Plan –East Fork Lewis River Temperature and Fecal Coliform Bacteria Total Maximum Daily Load Study. WA Dept of Ecology – Environmental Assessment Program, Olympia, WA, Publication Number 05-03-110.

This study is a preliminary report for the East Fork Lewis Total Maximum Daily Load (TMDL) study that is being prepared in response to Clean Water Act Section 303(d) listings in the East Fork Lewis for exceedance of water temperature and fecal coliform bacteria standards. The Quality Assurance (QA) Project Plan describes the technical study that will evaluate pollutants in the impaired waterbodies. The plan states that it will build on previous data collection efforts conducted by a variety of governmental and private organizations and that it will be conducted by the Washington State Department of Ecology (Ecology) Environmental Assessment (EA) Program.

Blythe, L.S. 1995. Slide Creek – 1995 Stream Survey Narrative. Gifford Pinchot National Forest Central Skills Center, Amboy, WA.

USFS Level II stream survey report of 3.4 miles of Slide Creek and 1.06 miles of a tributary to Slide Creek. Surveys conducted July 1995 through August 1995.

Caldwell, B, J. Shedd, and H. Beecher. 1999. East Fork Lewis River Fish Habitat Analysis Using the Instream Flow Incremental Methodology and Toe-Width Method for WRIA 27. WA Dept of Ecology, Open File Technical Report, Publication #99-151.

This document reports on the Washington State Department of Ecology instream flow study conducted on the East Fork Lewis River using the Instream Flow Incremental Methodology (IFIM). The effort also collected Toe-Width information on 13 streams in WRIA 27. These studies provide information about the relationship between stream flows and fish habitat which can be used in developing minimum instream flow requirements for fish in the East Fork Lewis River and the 13 chosen streams in WRIA 27. For the IFIM study on the E.F. Lewis River one site was chosen, composed of eight transects. The site was located at approximate River Mile 10.8 at Daybreak County Park. Streamflow measurements and substrate information were recorded at high, medium and low flows. This information was entered into the IFG4 hydraulic model to simulate the distribution of water depths and velocities with respect to substrate and cover under a variety of flows. Using the HABTAT model, the simulated information was then used to generate an index of change in available habitat relative to changes in flow; this index is referred to as "weighted usable area" (WUA). Other variables, including water temperature, water quality, and sediment load were not addressed in this study. No instream flow recommendations were made in this report.

Clark County Public Works Department-Clean Water Program. 2002. Long-Term Index Site Monitoring Project: 2002 Physical Habitat Characterization.

This report compiles and provides summary information relevant to long term water quality monitoring in tributaries of the EF Lewis River. It describes water

quality monitoring and results and summarizes and incorporates new information as well as pre-existing information. In addition, it details goals and objectives to meet NPDES clean water program requirement and activities to improve stream health.

Clark County Public Works Department-Clean Water Program. 2008. Lockwood Creek Subwatershed Needs Assessment Report.

This report compiles and provides summary information relevant to stormwater management in Lockwood Creek. It proposes stormwater-related projects and activities to improve stream health and to assist with adaptive management of the County's Stormwater Management Program. Assessments are conducted at the subwatershed scale (1 to 20 square miles). The report summarizes and incorporates new information 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. This report produces information related to three general categories: 1) potential stormwater capital projects for County implementation or referral to other organizations, 2) management and policy recommendations, and 3) natural resource information. Descriptions of potential projects and recommended program management actions are provided to County programs. Potential project or leveraging opportunities are also referred to local agencies, groups, and municipalities.

Clark County Public Works Department-Clean Water Program. 2008. Mason Creek Subwatershed Needs Assessment Report.

This report compiles and provides summary information relevant to stormwater management in Mason Creek. It proposes stormwater-related projects and activities to improve stream health and to assist with adaptive management of the County's Stormwater Management Program. Assessments are conducted at the subwatershed scale (1 to 20 square miles). The report summarizes and incorporates new information 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. This report produces information related to three general categories: 1) potential stormwater capital projects for County implementation or referral to other organizations, 2) management and policy recommendations, and 3) natural resource information. Descriptions of potential projects and recommended program management actions are provided to County programs. Potential project or leveraging opportunities are also referred to local agencies, groups, and municipalities.

Clark County Public Works Department-Clean Water Program. 2008. Mill Creek Subwatershed Needs Assessment Report.

This report compiles and provides summary information relevant to stormwater management in Mill Creek. It proposes stormwater-related projects and activities to improve stream health and to assist with adaptive management of the county's Stormwater Management Program. Assessments are conducted at the subwatershed scale (1 to 20 square miles). The report summarizes and incorporates new information 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. This report produces information related to three general categories: 1) potential stormwater capital projects for county implementation or referral to other organizations, 2) management and policy recommendations, and 3) natural resource information. Descriptions of potential projects and recommended program management actions are provided to county programs. Potential project or leveraging opportunities are also referred to local agencies, groups, and municipalities.

Clearwater BioStudies, Inc. 2001. The 2001 Poison Gulch Stream Survey Report. Gifford Pinchot National Forest, Mount St Helens National Volcanic Monument, Amboy, WA.

USFS Level II stream survey report of 1.92 miles of Poison Gulch. Surveys conducted August 30, 2001, to September 1, 2001.

Collins, B. 1997. Application of geomorphology to planning and assessment of riverine gravel removal in Washington. Chapter IX in Geology and Geomorphology of Stream Channels – University of Washington, Seattle, WA.

This is a chapter in "Geology and Geomorphology of Stream Channels" that focuses on the history and geomorphic impacts of riverine gravel removal in Washington rivers. The following topics are covered: 1) riverine gravel removal, 2) floodplain mining, 3) gravel bar mining, and 4) methods for assessing the effects of gravel removal. Floodplain gravel mining on the East Fork Lewis is treated as a case study in the "floodplain mining" section.

Deschamps, S. and D. Hodges. 1998. East Fork Lewis River – 1998 Stream Survey Narrative. Gifford Pinchot National Forest, Mount St Helens National Volcanic Monument, Amboy, WA.

USFS Level II stream survey report of 7.6 miles of the upper East Fork Lewis River (RM 32.7, Sunset Falls, to RM 40.3, bedrock waterfall). Surveys conducted June 29, 1998 through August 5,1998.

Deschamps, S. and D. Hodges. 1998. Green Fork of the East Fork Lewis River – 1998 Stream Survey Narrative. Gifford Pinchot National Forest, Mount St Helens National Volcanic Monument, Amboy, WA.

USFS Level II stream survey report of 1.8 miles of the Green Fork of the East Fork Lewis River (RM 0 to 1.8). Surveys conducted August 31, 1998 through September 5,1998.

Dover Habitat Restoration, LLC. 2003. Assessment & Strategic Plan – East Fork Lewis River. Prepared for Friends of the East Fork.

This assessment and strategic plan is focused primarily on the main channel of the East Fork Lewis River. New data was obtained and analyzed along with data and information from existing plans, studies, reports, and projects. This plan outlines problems within the various reaches of the East Fork and describes potential remedial actions. This plan presents a concept of how the river would look and

function after restoration, but it does not present a final design or detailed construction specifications.

Hutton, R. 1995. East Fork Lewis River land use and water quality background report – for water quality protection from nonpoint source pollution. Clark County Dept of Community Development, Water Quality Division.

This report presents a simplified statistical and graphic evaluation of several potentially important nonpoint source pollution relationships between common land uses and monitored water quality in the East Fork Lewis River watershed. Significant relationships were plotted to examine how sampled water quality changed with different levels of specific land uses, and to look for unusual occurrences. Relationship characteristics were compared to generalized ideal values to aid interpretation. The proportions of significant relationships for various selected subarea land uses were evaluated for their relative impact on water quality. Conclusions and recommendations are provided.

Google Earth 2008. www.googlearth.com

We reviewed aerial imagery provided by Google Earth to evaluate some physical conditions including road/stream crossing locations, riparian cover, land use, and topography.

Hutton, R. 1995. East Fork Lewis River water quality assessment background report – for water quality protection from nonpoint source pollution. Clark County Dept of Community Development, Water Quality Division.

This report summarizes the surface water quality found in the watershed of the East Fork Lewis River. The report characterizes and documents the water quality status of the East Fork's mainstem and some of the major tributaries. This report provides baseline information and the foundation for the development of the East Fork Lewis River Watershed Action Plan.

Hutton, R. 1995. East Fork Lewis River watershed action plan – for water quality protection from nonpoint source pollution. Clark County Dept of Community Development, Water Quality Division.

This plan addresses, through coordinated nonpoint control strategies, the probable nonpoint source pollution problems in the East Fork Lewis River watershed. The plan is a developed as a working tool, developed from a screening of the East Fork's probable nonpoint problems at a subwatershed level of resolution, to assist the future implementation of more site specific corrective actions. A phased approach to implementation is suggested. Recommended strategies are targeted for specific regions of the watershed and are not site specific.

Hutton, R. 1995. East Fork Lewis River watershed characterization background report – for water quality protection from nonpoint source pollution. Clark County Dept of Community Development, Water Quality Division.

This report characterizes the East Fork Lewis River watershed so that potential nonpoint source and their impacts may be addressed in the context of both natural watershed features and human activities. Clark County's portion of the watershed

is emphasized. The degree of detail in this characterization is usually limited to watershed subbasins or areas with similar features and is not site specific.

Johnston, G., N. Ackerman, and B. Gerke. 2005. Chapter 4: East Fork Lewis River Basin - Habitat Assessment. Prepared by SP Cramer & Associates for Lower Columbia Fish Recovery Board, Longview, WA.

The assessment involved stream habitat, riparian, hydromodification, and sediment source evaluations in the East Fork Lewis Basin. The project identified conditions impacting salmonid production and recovery measures. Aquatic habitat surveys were performed on 40 km of stream following standard protocols. Riparian conditions were evaluated using aerial photos and field surveys. The ability of riparian zones to provide shade and large woody debris recruitment was determined for the current and potential (restored) conditions. Hydromodifications impacting channel dynamics were identified along the lower mainstem river corridor. Geomorphic assessment was used to identify the current and historical channel migration zone. Geographic Information System (GIS) and field surveys were used to characterize sediment supply conditions and land-use practices contributing to sediment impairments. Recommendations for additional data collection and a prioritized list of habitat enhancement projects were developed.

Kondolf, G.M., and D.D. Kelso. 1996. Effects of aggregate mining in river floodplains: Some observations relevant to the policy on floodplain mining in Clark County, Washington. Comments submitted to the Clark County Planning Commission, April 1996.

These comments discuss the Ridgefield Pit avulsion on the East Fork Lewis.

Kondolf, G.M., M. Smeltzer, and L. Kimball. 2002. Freshwater gravel mining and dredging issues. White Paper prepared for WA Dept of Fish & Wildlife, WA Dept of Ecology, and WA Dept of Transportation.

This report builds upon existing literature for Washington and elsewhere to summarize current scientific information regarding the environmental effects of mining gravel and sand for construction aggregation from rivers and streams, along with the effects of other freshwater dredging. The emphasis is on effects on salmonids in their various freshwater-based life stages, to provide a scientific basis for future development of guidelines that will be protective of the resource. This document does not make policy recommendations, but summarizes the scientific literature and unpublished research on gravel mining effects in Washington state and elsewhere. It also draws upon discussions with resource managers, site visits, and analysis of historical aerial photographs and maps of selected sites. The East Fork Lewis River and the 1995 and 1996 avulsions into streamside gravel mining pits are discussed.

Lenhart, J. and S. Reeder. 1995. McKinley Creek – 1995 Stream Survey Narrative. Gifford Pinchot National Forest Central Skills Center, Amboy, WA.

USFS Level II stream survey report of 2.3 miles of McKinley Creek. Surveys conducted July 20, 1995, through August 23, 1995.

Lower Columbia Fish Recovery Board. 2004. Lower Columbia Salmon and Steelhead Recovery and Subbasin Plan. Lower Columbia Fish Recovery Board. Longview, WA.

This is a plan for the protection and restoration of native fish, aquatic habitats, and sensitive wildlife species in Washington lower Columbia River subbasins. It serves as 1) a recovery plan for Washington lower Columbia salmon and steelhead populations and 2) a Northwest Power and Conservation Council Fish and Wildlife Plan for eleven lower Columbia subbasins. The East Fork Lewis Basin is one of the subbasins covered in this plan. The plan is the product of a collaborative process facilitated by the Lower Columbia Fish Recovery Board (LCFRB). The primary species focus is on salmon, steelhead and trout species listed under the ESA. The plan describes existing conditions, limiting factors, and threats to these and other target species. Recovery goals are provided as well as the suite of strategies, measures, and actions that are needed to accomplish those goals.

Lower Columbia Fish Recovery Board. 2008. Lower Columbia Salmon Recovery 6-Year Habitat Work Schedule and Lead Entity Habitat Strategy

The 6-Year Habitat Work Schedule is developed in order to support and carry out the critical elements identified in the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan. The work schedule accomplishes 2 primary objectives: 1) Assist agencies, local governments, tribes, non-profit organizations and others who fund and/or undertake habitat protection and restoration projects in identifying high priority salmon habitat needs in the Lower Columbia; and 2) Assist agencies, local governments, and landowners in developing and applying regulations, incentives, and land and resource management plans that will protect and restore important salmon habitat. This is an annually updated work plan developed by the LCFRB and is used to help make project funding decisions for Salmon Recovery Funding Board funds.

Lower Columbia Fish Recovery Board. 2006. Salmon-Washougal and Lewis Watershed Management Plan (WRIAs 27-28). Lead Agency: LCFRB. Prepared by LCFRB, EES Consulting, and HDR consulting. For Submission to the Planning Area Counties. WA Ecology Grant #9900294.

Under the State of Washington's Watershed Management Act (Chapter 90.82 RCW) local governments are authorized to initiate a watershed planning process. The process is broad in scope and involves stakeholders and agencies at the local, regional, state and federal levels. The watershed planning program is designed to foster planning for water quantity, water quality, aquatic habitat and instream flow in a comprehensive and integrated fashion. This Watershed Management Plan has been prepared for Water Resource Inventory Areas (WRIAs) 27 and 28. WRIA 27 comprises the Kalama and Lewis River Basins. WRIA 28 comprises the Salmon Creek, Burnt Bridge Creek, Lacamas Creek, and Washougal River Basins, as well as additional smaller creek basins. Planning objectives include: 1) protect or enhance conditions in the watershed, 2) develop and implement the watershed plan, and 3) improve information and data management. This Plan addresses a range of issues related to water resources in WRIAs 27 and 28, including water supply, stream flow management, water quality, and fish habitat. It reviews

alternative approaches for managing water resources in the area and recommends selected strategies for implementation.

Lower Columbia Fish Recovery Board. 2001. WRIA 27/28 Salmon-Washougal and Lewis Watershed Planning – Level 1 Assessment. Lead Agency: LCFRB. Prepared by LCFRB, GeoEngineers, Inc., WEST Consultants, Inc., and Hammond Collier Wade Livingstone.

Under the State of Washington's Watershed Management Act (Chapter 90.82 RCW) local governments are authorized to initiate a watershed planning process. The process is broad in scope and involves stakeholders and agencies at the local, regional, state and federal levels. The watershed planning program is designed to foster planning for water quantity, water quality, aquatic habitat and instream flow in a comprehensive and integrated fashion. The Level 1 Assessment is a comprehensive compilation and review of existing data. The assessment contains the following categories: Water Quantity, Water Quality, Water Use, Water Rights, Water Balance, Land Use, Hydraulic Continuity, Future Projections, Precipitation, Conclusions and Recommendations

Lower Columbia Fish Recovery Board. 2004. WRIA 27/28 Salmon-Washougal and Lewis Watershed Planning – Level 2 Assessment. Lead Agency: LCFRB. Prepared by LCFRB, EES Consulting, HDR Consulting, Pacific Groundwater Group, WA State University, Kennedy/Jenks Consultants, Pacific Water Resources Inc.

Under the State of Washington's Watershed Management Act (Chapter 90.82 RCW) local governments are authorized to initiate a watershed planning process. The process is broad in scope and involves stakeholders and agencies at the local, regional, state and federal levels. The watershed planning program is designed to foster planning for water quantity, water quality, aquatic habitat and instream flow in a comprehensive and integrated fashion. The Level 2 Assessment involves collection of new data to fill critical data gaps and support well-defined decision needs. The assessment comprises 14 Technical Memos including Water Reclamation and Reuse Opportunities, Comparison of Potential Water Supply Management Strategies, Instream Flow Conditions in Four Pilot Streams, Instream Flow Management Approaches in Four Pilot Streams, Ground Water Development Scenarios, Assessment of Priorities for Surface Water Cleanup Plan, Strategies for Managing Flows in Two Pilot Subbasins, Management Actions to Protect Ground Water Quality, EF Lewis River Ground Water And Surface Water Relationships, Effects of Exempt Wells on Baseflow in the Washougal Subbasin, Hydrologic Modeling, Surface Water Quality Monitoring Strategy, and Tidal Effects as Related to Stream Flow Rule.

Polacek, M.C. 1995. East Fork Lewis River – 1995 Stream Survey Narrative. Gifford Pinchot National Forest, Mount St Helens National Volcanic Monument, Amboy, WA.

USFS Level II stream survey report of 6.4 miles of Copper Creek. Surveys conducted August 29-30, September 6-7, and September 19-22, 1995.

Mundorff, M. J. 1964. Geology and ground water conditions of Clark County, with a description of a major alluvial aquifer along the Columbia River. USGS Water-Supply Paper. 1600. p 24-33, 38-41, 56, 67-74, 94-95, 161-165, and Plates 1-3.

This report presents the results of an investigation of the ground water resources of the populated parts of Clark County (in 1964). A summary of Clark County geology is presented with a description of available groundwater resources. This report was undertaken at the request of the US Bureau of Reclamation for the purpose of determining whether ground water supplies were sufficient for irrigation of the area.

Norman, D.K., C.J. Cederholm, and W.S. Lingley. 1998. Flood plains, salmon habitat, and sand and gravel mining. Washington Geology, vol. 26, no. 2/3.

This paper, published in Washington Geology, discusses the geomorphic impacts of riverine gravel mining in Washington. It describes which rivers in Washington have been affected by gravel mining and discusses 5 rivers where floodplain gravel mining pits have been recently captured by the river. The East Fork Lewis is included as one of these sites.

Rawding, D., N. Pittman, C. Stearns, S. VanderPloeg, and B. McTeague. 2001. The lower East Fork Lewis River subbasin: a summary of habitat conditions, salmonid distribution, and smolt production. Prepared *by* the WA Dept. of Fish and Wildlife Fish Management and Habitat Science Programs *for* the Lower Columbia Fish Recovery Board. Project No. 99-1113P. WA Dept. of Fish and Wildlife, Olympia.

This document reports on smolt trapping and habitat evaluation studies conducted by WDFW on the East Fork Lewis in 2000. Two rotary screw traps were installed in the mainstem of the EF Lewis River near the mouth of Mason Creek (RM 7) and below Lucia Falls (RM 21) to estimate natural salmonid smolt production in the spring of 2000. Smolt yield by species was estimated for each trap location and is reported in the document. Available habitat information was gathered and summarized across the following categories: access, floodplain connectivity, bank stability, large woody debris (LWD), pools, side channels, substrate fines, riparian conditions, water quality, water quantity, and biological processes. Additionally, the Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIAP) methodology was utilized to summarize aquatic habitat by type and gradient/confinement. Salmonid distribution was mapped on a SSHIAP hydrolayer using the Washington Conservation Commission (WCC) Limiting Factors Analysis (LFA) data generated in year 2000. Stream habitat restoration project recommendations are provided.

Schnabel, J. 2003. Long-Term Index Site Monitoring Project: 2002 Physical Habitat Characterization. Clark County Public Works, Water Resources Section. Clark County, WA.

This document reports on results of Clark County's physical habitat monitoring that is a component of the County's Long-term Index Site Project (LISP) that is conducted by Clark County Public Works Water Resources Section. The goal of the LISP is to identify trends in stream health at a set of stormwater-influenced streams. There are two LISP sites in the East Fork Lewis River Basin: 1) Brezee

Creek near the mouth, and 2) upper Rock Creek North. The LISP includes physical habitat, water quality, biological, and hydrologic components. This document summarizes the physical habitat characterization portion of the 2002 LISP. 2002 was the first year of LISP physical habitat data collection using EMAP protocols. Therefore, this summary focuses not on trends or changes in condition, but rather on establishing a baseline characterization of habitat conditions at each site. Discussions of watershed attributes, stressor identification, and causal factors for the observed conditions are beyond the scope of this report. This summary includes descriptions of individual habitat metrics and indices, results of multi-metric index calculations, a general comparison of LISP sites to reference conditions in the Willamette Valley and Cascades ecoregions, and an overall habitat characterization for each LISP reach based on a number of physical habitat attributes.

Steel, E.A., A. Fullerton, Y. Caras, M. Sheer, P. Olson, D. Jensen, J. Burke, M. Maher, D. Miller, and P. McElhany. 2007. Lewis River Case Study Final Report - A decision-support tool for assessing watershed-scale habitat recovery strategies for ESA-listed salmonids. NOAA Fisheries – NW Fisheries Science Center, Seattle, WA.

This effort predicts the impacts of 6 alternative watershed management strategies and evaluates those potential future landscapes with a suite of physical and biological response models. There are four main steps in the application of the decision support system. First, a series of potential watershed management strategies is generated. Next, specific actions that would result from the application of each strategy are identified and modeled. The physical habitat impacts of those actions are modeled, creating 6 potential future landscapes. Third, habitat quality and distribution for each potential future landscape is quantified and the biological implications for multiple species are predicted. And, fourth, results are synthesized using metrics that summarize predicted physical conditions and biological responses for each of the watershed management strategies. The outcomes of the analyses are predictions of the benefits and trade-offs across the watershed of each of the 6 modeled strategies. These predictions can help to guide the development of an on-the-ground watershed management strategy for the Lewis River basin.

Sweet, H.R., R2 Resource Consultants, Inc., IT Corporation, WEST Consultants, Inc., Ecological Land Services, Inc., Maul, Foster, and Alongi, Inc., Janice Kelly, Inc., Perkins Coie, LLP. 2003. Habitat Conservation Plan - J.L. Storedahl & Sons, Inc. Daybreak Mine Expansion and Habitat Enhancement Project. R2 Resource Consultants, Inc. Redmond, Washington.

This Habitat Conservation Plan (HCP) was developed to specify how J.L. Storedahl & Sons, Inc. (Storedahl) will operate its Daybreak Mine in Clark County, Washington and implement conservation measures in a manner that is consistent with the requirements of the federal Endangered Species Act. The Daybreak site is located near the East Fork Lewis River. A small tributary to the river, Dean Creek, flows along the northwest boundary of the site. Several threatened and candidate species under the Endangered Species Act occur in the waters near the site, including Chinook, coho, and chum salmon; steelhead; and possibly bull trout (native char) and Oregon spotted frog. In addition, three fish species of concern, coastal cutthroat trout, and Pacific and river lamprey also could occur in these

waters. The life histories, status, presence, and potential effects of implementing this HCP on these nine species are emphasized throughout this report. The report contains a Conceptual Restoration Plan for Ridgefield Pits, and a Geomorphic Analysis of the East Fork Lewis River in the vicinity of the pits.

U.S. Forest Service (USFS). 1995. Upper East Fork of the Lewis River Watershed analysis. Gifford Pinchot National Forest.

This document is a USFS watershed analysis for the upper East Fork Lewis, with a focus primarily on lands within the Gifford Pinchot National Forest.

Wade, G. 2000. Salmon and Steelhead Habitat Limiting Factors, WRIA 27 (Lewis). Washington Department of Ecology.

Section 10 of Engrossed Substitute House Bill 2496 (Salmon Recovery Act of 1998), directs the Washington State Conservation Commission, in consultation with local government and treaty tribes to invite private, federal, state, tribal, and local government personnel with appropriate expertise to convene as a Technical Advisory Group (TAG). The purpose of the TAG is to identify habitat limiting factors for salmonids. This report is based on a combination of existing watershed studies and the personal knowledge of the TAG participants. TAG members mapped fish distribution maps for coho, Chinook, and chum salmon, and for winter and summer steelhead in Water Resource Inventory Area (WRIA) 27. Salmonid habitat limiting factors were identified for each major anadromous stream within WRIA 27.

Washington Department of Ecology. 2008. Washington Water Resources Explorer Webpage. https://test-fortress.wa.gov/ecy/wrxt/statewide/viewer.htm

A webbased explorer provided by the Washington Department of Ecology which provides GIS information on the type and location of existing or claimed water rights throughout the State of Washington.

WEST Consultants. 1996. East Fork Lewis River Hydrology, Hydraulics and River Mechanics Study. Submitted to J.L. Storedahl & Sons, Inc.

This study evaluates the impacts of mining a 342-acre site on stream channel morphology, sedimentation, and flooding. Investigations are included with respect to: 1) historic river pattern changes, 2) the February 1996 flood, 3) future channel pattern change, and 4) streambank stabilization at Storedahl offices. Recommendations and conclusions are provided.

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

This document summarizes water quality monitoring conducted by the Clark County Water Resources Program. It is intended to support the watershed assessment effort in Clark County led by the Lower Columbia Fish Recovery Board (LCFRB) in support of salmon recovery. The component of water temperature monitoring and benthic macroinvertebrate sampling targeted reach scale

assessments of water quality and were intended to support habitat data collected at a similar scale. Monitoring for hydrology, physical habitat, water temperature, and benthic macroinvertebrates occurred through the coordinated efforts of Clark County Water Resources and the Lower Columbia Fish Recovery Board. The primary goal of this project was to describe benthic macroinvertebrate communities and to identify water temperature limitations to salmonid production at priority salmon recovery reaches in Clark County. The benthic macroinvertebrate and water temperature data augments physical habitat surveys performed by the project partners, including the LCFRB and consultants. Results also provide information to characterize conditions as a baseline for future reference and for comparison to other subwatershed characteristics under further analysis of receiving water conditions and stormwater program effectiveness.

Wierenga, R. 2005. Subwatershed Characterization and Classification – Clark County Washington – Technical Report. Clark County Water Resources Program.

This report was created for use internally by Water Resources Program staff in support of monitoring activities for the Water Resources Program, including designing water quality monitoring projects, data analysis, and reporting. This approach to watershed analysis is applied to ongoing and future water quality monitoring projects, including Clark County's Centennial Grant Watershed Characterization Project and the Long Term Index Site Project. Future NPDES storm water permit monitoring intended to assess receiving waters in the county will utilize the watershed attribute data. The report presents a broad suite of information at the subwatershed scale (1 to 20 square miles), including metrics related to land cover, development, hydrology, geology/soils, and land use/zoning. The report covers all of Clark County, including subwatersheds within the East Fork Lewis River Basin.

OTHER DATA WITH RELEVANCE TO THE EF LEWIS BASIN

Description	*Source*	*Date*
GIS files		
EF Lewis Parcel Ownership (private, County, DNR, conservation easements)	WDNR, Clark County	2004
LIDAR Ground Surface	Clark County	
LiDAR derived contours	Clark County	2002
WA Soils (STATSGO)	USDA - NRCS	1994
WA Soils (state soil survey)	WA DNR	2000
WA Geology (southwest quadrant)	USGS	1999
Transportation data layer	WA DNR	1996
FEMA flood boundaries	FEMA	2004
Cadastral maps (georeferenced)	LCFRB / CFS	2004
Surveyed reaches (2004 assessment)	LCFRB / CFS	2004
EDT reach data	LCFRB / CFS	2004/08
Recovery Planning Reach Tiers	LCFRB / CFS	2004
Lower EF Lewis Hydromodifications	LCFRB / CFS	2004
Lower EF Lewis riparian buffers and condition ratings	LCFRB / CFS	2004
SHIAP fish passage barriers	WDFW	2008
Urban Growth Boundaries, Comprehensive Land Use	Clark County	2004
Aerial Photos		
Digital Orthophotos (0.5' and 2')	Clark County	2002
Digital Orthophotos (1990)	Clark County	1990
Digital Orthophotos (1984)	Clark County	1984
Digital Orthophotos (1978)	Clark County	1978
Digital Orthophotos (1974)	Clark County	1974
Digital Orthophotos (1968)	Clark County	1968
Digital Orthophotos (1955)	Clark County	1955
1939 aerials (digitized)	USACE	1939
Infrared orthophotos	Clark County	2002
Other data and reports		
Habitat survey data (lower mainstem and selected tribs)	LCFRB / CFS	2004
Habitat survey data (portions of lower mainstem, for EDT)	WDFW (Vancouver office)	2003
Chinook and Steelhead spawning surveys	WDFW (Vancouver office)	2005-present
Water Quality Monitoring (Brezee Creek, Rock Creek north)	Clark County (Water Resources)	ongoing
Stream Flow Gaging (Heisson Gage)	USGS	ongoing
Annual reports of the Chief of Engineers to the Secretary of War (circa 1876 – early 1900s) – clearing and snagging reports on the East Fork	US Army Corps of Engineers	1876 to early 1900s
Government Land Office (GLO) cadastral survey reports and maps (survey and map dates as far back as 1853)	Government Land Office (now BLM)	as far back as 1853
US Army Corps of Engineers Condition of Improvement Report for the Lewis River	US Army Corps of Engineers	September 30, 1990
USACE map of the East Fork Lewis River	US Army Corps of Engineers	1935
USGS topo quad map from a 1910 survey	USGS	1910

Description	*Source*	*Date*
Corps of Engineers “Emergency Flood Control” project report (rip-rap bank and levee at RM 11.5)	US Army Corps of Engineers	1967
Sampling for the invasive amur goby in the La Center wetland complex on the lower East Fork Lewis River	USGS – Biological Resources Division and US Fish & Wildlife Service	2008
Friends of the East Fork habitat and water quality data	Friends of the East Fork	ongoing
Fish First habitat and water quality data	Fish First	ongoing
Clark County water quality and habitat data	Clark County Public Works – Clean Water Program	ongoing

APPENDIX D: PERMITTING GUIDANCE

Environmental permits are typically required for work in and around water. However, many of the applicable permitting processes have "streamlined" options for beneficial habitat restoration projects. Proponents of projects defined in the Plan may qualify for one or more of the following streamlined processes. A complete description of these and other environmental permitting processes can be found at the WA Governor's Office of Regulatory Assistance (2009).

U.S. Army Corps of Engineers Section 404, or Section 10 Permits
Work below the Ordinary High Water Mark (OHWM) or Mean High Water Line (MHWL) requires an approval from the U.S. Army Corps of Engineers (Corps). Habitat restoration projects may qualify for two types of streamlined Corps permit processes: Letters of Permission or Coverage under Nationwide Permits (likely Nationwide Permits 13 (Bank Stabilization) and 27 (Stream and Wetlands Restoration Activities). More complex projects that do not qualify for these permitting processes would require an individual permit. Guidance on permit options can be found at the Corps' Seattle District web site (2009).

Section 7 Endangered Species Act (ESA) Consultation
Projects requiring a federal action (a Corps permit for example) are required to undergo consultation with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) on potential impacts to ESA listed species, including the fish targeted for recovery in this implementation plan. In order to create efficiencies in habitat restoration work, a statewide restoration programmatic consultation covering species under the responsibility of both NMFS and USFWS has been adopted by the Corps, NMFS and USFWS. This programmatic consultation addresses many restoration activities that would potentially occur under the Plan. Activities that fit within the programmatic consultation do not undergo the more lengthy informal or formal consultation processes. The programmatic consultation can be found on the Corps' Seattle District website (USFWS and NMFS 2008).

WDFW Hydraulic Project Approval
Work below the Ordinary High Water Mark (OHWM) or Mean High Water Line (MHWL) requires a Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife (WDFW). Fish enhancement projects can qualify for streamlined review if the project meets specific criteria (RCW 77.55.181). WDFW processes applications for fish enhancement projects within 45 days. More information can be found at the WDFW HPA website (WDFW 2009).

Local Agency Permits
Many cities and counties have ordinances or regulations that protect their critical areas and shorelines. The restoration projects prescribed in this plan may trigger one or more permits related to these ordinances. Project proponents should check with their local jurisdictions to identify specific requirements.

Literature or Web Sites Cited

US Army Corps of Engineers. 2009. http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=REG&pagename=Home_Page.

USFWS and NMFS. 2008. Endangered Species Act Section 7 Consultation Biological Opinion And Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. FWS No.: 13410-2008-FWS # F-0209; NMFS No.: 2008/03598. http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=REG&pagename=2008FishRestora ion.

WA Governor's Office of Regulatory Assistance. 2009. http://www.ora.wa.gov/.

WDFW. 2009. http://wdfw.wa.gov/hab/hpapage.htm.

APPENDIX E – PROJECT SCORING DETAIL

The following tables display the project scoring results. See Chapter 5 for scoring methods.

Project ID	Project Description	Reach / Population								Access								Restoration						Assessment	Final Scoring		
		Targeted Reaches	Tier	Species	Pop Class	SRP	Species Reach/Pop Score	Raw Reach /Pop Score	Reach/Pop Score (adjusted) (0 100)	Upstream habitat quality factor	Passage Improve %	Passage Improve factor	Habitat Quality factor score	# of miles opened	Quantity factor	Access Rating	Access Score	Restoration Type	Restoration Ranking	Habitat Units	Effectiveness Factor	Single Proj Type Score	Restoration Score	Assessment correction	PAR (unadjusted)	PAR Score (adjusted) (0 100)	Benefit Score (0-200)
Restoration Projects																											
EF 01	Side-channel restoration	EF Lewis 8B	1	FC	P	M	5	25	93									side/off channel	H	1.4	1	4.2	4.2		4.2	8.2	101
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 02	Side/off-channel restoration	EF Lewis 8B	1	FC	P	M	5	25	93									side/off channel	H	2.4	1	7.2	7.2		7.2	14.0	107
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 03	Side-channel restoration	EF Lewis 8B	1	FC	P	M	5	25	93									side/off channel	H	0.8	0.75	1.8	1.8		1.8	3.5	96
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 04	Streambank / in-channel enhancement	EF Lewis 8B	1	FC	P	M	5	25	93									stream channel structure	H	1	1	3	3		3	5.8	98
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 05	Off-channel restoration	EF Lewis 8B	1	FC	P	M	5	25	93									side/off channel	H	0.6	1	1.8	1.8		1.8	3.5	96
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 06	Streambank enhancement	EF Lewis 8B	1	FC	P	M	5	25	93									stream channel structure	H	0.12	1	0.36	0.36		0.36	0.7	93
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 07	Side-channel / in-channel enhancement	EF Lewis 8B	1	FC	P	M	5	25	93									side/off channel	H	2.8	1	8.4	8.4		8.4	16.4	109
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 08	Riparian restoration / Streambank enhancement	EF Lewis 8B	1	FC	P	M	5	25	93									stream channel structure	H	1	1	3	4.5		4.5	8.8	101
				CO	P	M	5											riparian function	H	0.5	1	1.5					
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 09	Side-channel restoration	EF Lewis 8B	1	FC	P	M	5	25	93									side/off channel	H	1.6	1	4.8	4.8		4.8	9.4	102
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 10	Side-channel restoration	EF Lewis 8B	1	FC	P	M	5	25	93									side/off channel	H	5.2	1	15.6	15.6		15.6	30.4	123
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 11	Side/off-channel restoration	EF Lewis 8B	1	FC	P	M	5	25	93									side/off channel	H	2	0.75	4.5	4.5		4.5	8.8	101
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 12	In-channel habitat enhancement	EF Lewis 8B	1	FC	P	M	5	25	93									stream channel structure	H	3.2	1	9.6	9.6		9.6	18.7	111
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 13	Side/off-channel restoration	EF Lewis 8B	1	FC	P	M	5	25	93									side/off channel	H	8	1	24	24		24	46.8	139
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 14	Side/off-channel restoration	EF Lewis 8B	1	FC	P	M	5	25	93									side/off channel	H	4	1	12	12		12	23.4	116
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				

Project ID	Project Description	Reach / Population								Access								Restoration						Assessment	Final Scoring		
		Targeted Reaches	Tier	Species	Pop Class	SRP	Species Reach/Pop Score	Raw Reach /Pop Score	Reach/Pop Score (adjusted) (0 100)	Upstream habitat quality factor	Passage Improve %	Passage Improve factor	Habitat Quality factor score	# of miles opened	Quantity factor	Access Rating	Access Score	Restoration Type	Restoration Ranking	Habitat Units	Effectiveness Factor	Single Proj Type Score	Restoration Score	Assessment correction	PAR (unadjusted)	PAR Score (adjusted) (0 100)	Benefit Score (0-200)
EF 15	Streambank (rip-rap) enhancement	EF Lewis 8B	1	FC	P	M	5	25	93									stream channel structure	H	1.6	0.5	2.4	3.6		3.6	7.0	100
				CO	P	M	5											riparian function	H	0.8	0.5	1.2					
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 16	Side/off-channel restoration	EF Lewis 8B	1	FC	P	M	5	25	93									side/off channel	H	3	1	9	9		9	17.5	110
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 17 (A)	Riparian restoration	EF Lewis 8B	1	FC	P	M	5	25	93									riparian function	H	1.5	1	4.5	4.5		4.5	8.8	101
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 17 (B)	Riparian restoration	EF Lewis 8B	1	FC	P	M	5	25	93									riparian function	H	1.5	1	4.5	4.5		4.5	8.8	101
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 18	Streambank / in-channel habitat enhancement	EF Lewis 8B	1	FC	P	M	5	25	93									stream channel structure	H	1.2	1	3.6	5.4		5.4	10.5	103
				CO	P	M	5											riparian function	H	0.6	1	1.8					
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 20	Side/off-channel restoration	EF Lewis 8B	1	FC	P	M	5	25	93									side/off channel	H	3.6	1	10.8	10.8		10.8	21.0	114
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 21	Side-channel enhancement	EF Lewis 8A	1	FC	P	H	6	27	100									side/off channel	H	3.2	1	9.6	9.6		9.6	18.7	119
				CO	P	H	6																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 22	Chum channel	EF Lewis 8A	1	FC	P	H	6	27	100									side/off channel	H	0.8	1	2.4	2.4		2.4	4.7	105
				CO	P	H	6																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 24	Side-channel / off-channel restoration	EF Lewis 8A	1	FC	P	H	6	27	100									side/off channel	H	1.8	1	5.4	5.4		5.4	10.5	111
				CO	P	H	6																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 25	Side-channel restoration	EF Lewis 8A	1	FC	P	H	6	27	100									side/off channel	H	2	0.5	3	3		3	5.8	106
				CO	P	H	6																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 26	Streambank / in-channel habitat enhancement	EF Lewis 8A	1	FC	P	H	6	27	100									stream channel structure	H	3	1	9	13.5		13.5	26.3	126
				CO	P	H	6											riparian function	H	1.5	1	4.5					
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 27	Off-channel restoration	EF Lewis 7	1	FC	P	H	6	27	100									side/off channel	H	1	0.75	2.25	2.25		2.25	4.4	104
				CO	P	H	6																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 28	Side-channel restoration	EF Lewis 8A	1	FC	P	H	6	27	100									side/off channel	H	6.8	1	20.4	20.4		20.4	39.8	140
				CO	P	H	6																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
EF 34	Streambank restoration; channel structure	EF Lewis 5B	1	FC	P	H	6	26	96									stream channel structure	H	0.6	1	1.8	2.7		2.7	5.3	102
				CO	P	H	6											riparian function	H	0.3	1	0.9					
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				

Project ID	Project Description	Reach / Population								Access								Restoration							Assessment	Final Scoring		
		Targeted Reaches	Tier	Species	Pop Class	SRP	Species Reach/Pop Score	Raw Reach /Pop Score	Reach/Pop Score (adjusted) (0-100)	Upstream habitat quality factor	Passage Improve %	Passage Improve factor	Habitat Quality factor score	# of miles opened	Quantity factor	Access Rating	Access Score	Restoration Type	Restoration Ranking	Habitat Units	Effectiveness Factor	Single Proj Type Score	Restoration Score	Assessment correction	PAR (unadjusted)	PAR Score (adjusted) (0-100)	Benefit Score (0-200)
EF 35	Remove rip-rap / in-channel enhancement	EF Lewis 5A	1	FC	P	L	4	22	81									stream channel structure	H	2	1	6	9		9	17.5	99
				CO	P	L	4											riparian function	H	1	1	3					
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				
EF 36	Remove rip-rap / in-channel enhancement	EF Lewis 5A	1	FC	P	L	4	22	81									stream channel structure	H	1	1	3	4.5		4.5	8.8	90
				CO	P	L	4											riparian function	H	0.5	1	1.5					
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				
EF 37	Enhance rip-rap	EF Lewis 5A	1	FC	P	L	4	22	81									stream channel structure	H	0.6	0.5	0.9	0.9		0.9	1.8	83
				CO	P	L	4																				
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				
EF 38	Off-channel enhancement	EF Lewis 5A	1	FC	P	L	4	22	81									side/off channel	H	1.4	1	4.2	4.2		4.2	8.2	90
				CO	P	L	4																				
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				
EF 39	Off-channel enhancement	EF Lewis 5A	1	FC	P	L	4	22	81									side/off channel	H	2	1	6	6		6	11.7	93
				CO	P	L	4																				
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				
EF 40	Streambank restoration; channel structure	EF Lewis 5A	1	FC	P	L	4	22	81									stream channel structure	H	0.4	1	1.2	1.8		1.8	3.5	85
				CO	P	L	4											riparian function	H	0.2	1	0.6					
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				
EF 41	Riparian restoration	EF Lewis 5A	1	FC	P	L	4	24	89									riparian function	H	5	1	15	19.5		19.5	38.0	127
				CO	P	L	4																				
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				
		EF Lewis 5B	1	FC	P	H	6											riparian function	H	1.5	1	4.5					
				CO	P	H	6																				
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				
EF 42	Levee removal/set-back	EF Lewis 4B	1	FC	P	L	4	22	81									floodplain and CMZ	H	6	1	18	18		18	35.1	117
				CO	P	L	4																				
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				
EF 43	Levee removal/set-back	EF Lewis 3	4	FC	P	L	4	20	74									floodplain and CMZ	H	6.5	1	19.5	19.5		19.5	38.0	112
				CO	P	L	4																				
				CH	P	L	4																				
				WS	P	L	4																				
				SS	P	L	4																				
BR 01	Brezee Creek Dam	Brezee 2	1	CO	P	H	6	9	33	L	75%	H	2	5.6	10	M	15	stream channel structure	H	0.7	1	2.1	6.1		21.1	41.1	74
				WS	P	L	4																				
		Brezee 3	4	CO	P	L	4											stream channel structure	M	1	1	2					
				WS	P	L	4											riparian function	M	1	1	2					
DE 01	Lower Dean Creek Channel Enhancement (downstream portion)	Dean Cr 1 A	1	CO	P	H	6	14	52									stream channel structure	H	4	0.75	9	27		27	52.6	104
				CH	P	L	4											riparian function	H	4	0.75	9					
				WS	P	L	4											floodplain and CMZ	H	4	0.75	9					
DE 02	Lower Dean Creek Channel Enhancement (upstream portion)	Dean Cr 1 A	1	CO	P	H	6	14	52									stream channel structure	H	4.8	0.75	10.8	32.4		32.4	63.1	115
				CH	P	L	4											riparian function	H	4.8	0.75	10.8					
				WS	P	L	4											floodplain and CMZ	H	4.8	0.75	10.8					
DY 01	Lower Dyer Creek Channel Enhancement	Dyer Cr 1	1	CO	P	H	6	13.5	50									stream channel structure	H	1.5	1	4.5	30.375		30.375	59.2	109
				WS	P	L	4											riparian function	H	1.5	1	4.5					
				SS	P	L	4											floodplain and CMZ	H	1.5	1	4.5					
		Dyer Cr 2	2	CO	P	M	5											stream channel structure	H	2.5	0.75	5.625					
				WS	P	L	4											riparian function	H	2.5	0.75	5.625					
				SS	P	L	4											floodplain and CMZ	H	2.5	0.75	5.625					

Project ID	Project Description	Reach / Population								Access								Restoration							Assessment	Final Scoring		
		Targeted Reaches	Tier	Species	Pop Class	SRP	Species Reach/Pop Score	Raw Reach /Pop Score	Reach/Pop Score (adjusted) (0-100)	Upstream habitat quality factor	Passage Improve %	Passage Improve factor	Habitat Quality factor score	# of miles opened	Quantity factor	Access Rating	Access Score	Restoration Type	Restoration Ranking	Habitat Units	Effectiveness Factor	Single Proj Type Score	Restoration Score	Assessment correction	PAR (unadjusted)	PAR Score (adjusted) (0-100)	Benefit Score (0-200)
DY 02	Dyer reach 4 channel and passage enhancement	Dyer Cr 4	2	CO	P	M	5	5	19	L	100%	H	2	0.63	2	M	4	stream channel structure	H	3	1	9	9		13	25.3	44
JE 01	Lower Jenny Cr channel enhancement and off-channel creation	Jenny 1	1	CO	P	H	6	10	37									stream channel structure	H	1.2	0.75	2.7	4.5		4.5	8.8	46
				WS	P	L	4											side/off channel	H	0.8	0.75	1.8					
MC 01	Lower McCormick channel enhancement	McCormick 1 A	2	CO	P	L	4	13	48									stream channel structure	H	6	0.75	13.5	40.5		40.5	78.9	127
				CH	P	M	5											riparian function	H	6	0.75	13.5					
				WS	P	L	4											floodplain and CMZ	H	6	0.75	13.5					
MC 02	Passage restoration at La Center Road Crossing	McCormick 1 B	4	CO	P	L	4	8.5	31	M	100%	H	6	2.5	6	H	36								36		67
				WS	P	L	4																				
		McCormick 1 C	2	CO	P	M	5																				
				WS	P	L	4																				
MC 03	Residential pond reach 1 D	McCormick 1 D	1	CO	P	H	6	7	26	M	100%	H	6	0.88	2	H	12	stream channel structure	H	0.4	0.75	0.9	1.8		13.8	26.9	53
				WS	P	L	4											riparian function	H	0.4	0.75	0.9					
		McCormick 1 E	4	CO	P	L	4											access									
MC 04	Residential pond reach 1G and 1H	McCormick 1 G	1	CO	P	H	6	6	22	H	100%	H	10	0.34	1	H	10	stream channel structure	H	2.2	0.75	4.95	9.9		19.9	38.8	61
																		riparian function	H	2.2	0.75	4.95					
		McCormick 1 H	1	CO	P	H	6																				
MN 02	Manley Creek stream habitat enhancement (downstream of 259th)	Manley Creek 1B	2	CO	P	M	5	13.0	48	H	33%	M	10	1.82	4	H	13.2	stream channel structure	H	3.5	0.75	7.875	22.1		35.25	68.7	117
				CH	P	L	4											riparian function	H	3.5	0.75	7.875					
				WS	P	L	4																				
		Manley Creek 1C	2	CO	P	M	5											stream channel structure	H	1.4	0.75	3.15					
				CH	P	L	4											riparian function	H	1.4	0.75	3.15					
				WS	P	L	4																				
MN 03	Manley Creek passage restoration and habitat enhancement (upstream of 259th)	Manley Creek 1C	2	CO	P	M	5	13.8	51	H	33%	M	10	0.96	2	H	6.6	stream channel structure	H	1.3	0.75	2.925	17.6		24.2	47.2	98
				CH	P	L	4											riparian function	H	1.3	0.75	2.925					
				WS	P	L	4																				
		Manley Creek 1D	1	CO	P	H	6											stream channel structure	H	0.7	0.75	1.575					
				CH	P	L	4											riparian function	H	0.7	0.75	1.575					
				WS	P	L	4																				
		Manley Creek 1E	1	CO	P	H	6											stream channel structure	H	1.3	0.75	2.925					
				CH	P	L	4											riparian function	H	1.3	0.75	2.925					
				WS	P	L	4																				
		Manley Creek 1F	1	CO	P	H	6											stream channel structure	H	0.6	0.75	1.35					
				CH	P	L	4											riparian function	H	0.3	0.75	0.675					
				WS	P	L	4																				
		Manley Creek 1G	1	CO	P	H	6											stream channel structure	H	0.16	0.75	0.36					
				CH	P	L	4											riparian function	H	0.16	0.75	0.36					
				WS	P	L	4																				
MS 01	Lower Mason channel enhancement	Mason Creek 1	2	CO	P	M	5	13	48									stream channel structure	H	7.6	0.75	17.1	39.9		39.9	77.8	126
				CH	P	L	4											riparian function	H	7.6	0.75	17.1					
				WS	P	L	4											floodplain and CMZ	H	7.6	0.25	5.7					
MS 02	Mason channel enhancement reach 3-4	Mason Creek 3	2	CO	P	M	5	8.5	31									stream channel structure	H	1.5	0.75	3.375	7.5		7.5	14.6	46
				WS	P	L	4											riparian function	H	0.5	0.75	1.125					
		Mason Creek 4	4	CO	P	L	4											stream channel structure	M	1.5	0.75	2.25					
				WS	P	L	4											riparian function	M	0.5	0.75	0.75					
MI 01	Mill Creek 1 C habitat enhancement	Mill Creek 1 C	1	CO	P	H	6	10	37									stream channel structure	H	1.5	1	4.5	4.5		4.5	8.8	46
				WS	P	L	4																				
Assessment Projects																												
EF-A 01	Ridgefield Pits Alternatives	EF Lewis 6B	1	FC	P	H	6	26	96									stream channel structure	H	5.4	0.1	1.62	8.1	6.1	6.1	11.8	108
				CO	P	H	6											riparian function	H	5.4	0.1	1.62					
				CH	P	H	6											floodplain and CMZ	H	5.4	0.1	1.62					
				WS	P	L	4											side/off channel	H	5.4	0.1	1.62					
				SS	P	L	4											water quality	H	5.4	0.1	1.62					

Project ID	Project Description	Reach / Population								Access								Restoration						Assessment	Final Scoring		
		Targeted Reaches	Tier	Species	Pop Class	SRP	Species Reach/Pop Score	Raw Reach /Pop Score	Reach/Pop Score (adjusted) (0 100)	Upstream habitat quality factor	Passage Improve %	Passage Improve factor	Habitat Quality factor score	# of miles opened	Quantity factor	Access Rating	Access Score	Restoration Type	Restoration Ranking	Habitat Units	Effectiveness Factor	Single Proj Type Score	Restoration Score	Assessment correction	PAR (unadjusted)	PAR Score (adjusted) (0 100)	Benefit Score (0-200)
EF-A 02	Daybreak Pits Avulsion Risk Assessment	See Scoring Sheet for Preservation Projects. Because EF-A 02 is an assessment for resource "protection", it was scored using the protection project scoring methodology.																									
EF-A 03	Groundwater and temperature monitoring to support off-channel enhancement	EF Lewis 5A	1	FC	P	L	4											side/off channel	H	6	0.1	1.8					
				CO	P	L	4																				
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				
		EF Lewis 5B	1	FC	P	H	6											side/off channel	H	1.6	0.1	0.48					
				CO	P	H	6																				
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				
		EF Lewis 6A	1	FC	P	H	6											side/off channel	H	3	0.1	0.9					
				CO	P	H	6																				
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				
		EF Lewis 6B	1	FC	P	H	6											side/off channel	H	6	0.1	1.8					
				CO	P	H	6																				
				CH	P	H	6																				
				WS	P	L	4	26	95														2.6	3.3	3.3	6.4	101
				SS	P	L	4																				
		EF Lewis 6C	1	FC	P	H	6											side/off channel	H	2.6	0.1	0.78					
				CO	P	H	6																				
				CH	P	H	6																				
				WS	P	L	4																				
				SS	P	L	4																				
		EF Lewis 7	1	FC	P	H	6											side/off channel	H	1	0.1	0.3					
				CO	P	H	6																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
		EF Lewis 8A	1	FC	P	H	6											side/off channel	H	14.6	0.1	4.38					
				CO	P	H	6																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				
		EF Lewis 8B	1	FC	P	M	5											side/off channel	H	35.4	0.1	10.62					
				CO	P	M	5																				
				CH	P	H	6																				
				WS	P	M	5																				
				SS	P	L	4																				

Project ID	Project Description	River Mile	Reach / Population								Protection				Assessment	Final Scoring		
			Targeted Reaches	Tier	Species	Pop Class	SRP	Species Reach/Pop Score	Raw Reach /Pop Score	Reach/Pop Score (adjusted) (0-100)	EDT Reach Protection Potential	Protection Rating	Habitat Units	Protection score	Assessment correction	PAR (unadjusted)	PAR Score (adjusted) (0-100)	Benefit Score (0-200)
Protection Projects																		
DE-P 01	Dean Creek land acquisition	0.4-0.9	Dean Cr 1 A	1	CO	P	H	6	14	52	0.36	M	5.6	5.6		5.6	10.9	63
					CH	P	L	4										
					WS	P	L	4										
EF-A 02	Daybreak Pits avulsion risk assessment	7.3 - 9	EF Lewis 6A	1	FC	P	H	6	26	96	0.45	M	2.85	13.9	13.9	13.9	27.1	123
					CO	P	H	6										
					CH	P	H	6										
					WS	P	L	4										
					SS	P	L	4										
			EF Lewis 6B	1	FC	P	H	6			0.46	M	5.4					
					CO	P	H	6										
					CH	P	H	6										
					WS	P	L	4										
					SS	P	L	4										
			EF Lewis 6C	1	FC	P	H	6			0.43	M	12.6					
					CO	P	H	6										
					CH	P	H	6										
					WS	P	L	4										
					SS	P	L	4										

APPENDIX F: PUBLIC AND LCFRB TAC COMMENTS ON DRAFT PLAN

Overview

Comments from the public meetings and from the Lower Columbia Fish Recovery Board (LCFRB) Technical Advisory Committee (TAC) are included in the table below. Responses to the comments and a description of any changes made to the document to address the comments are included in the table. The comments are presented in the tables below which are organized by 1) public comments received, 2) general meeting discussions (questions and answers) and, 3) LCFRB - TAC comments

Public Comments

Commenter	Comment	Response
Keith Isaacson	If habitat restoration is to work, you must have the harvest management on the main stem Columbia. It is not working with any positive effect. Overharvest of salmon and steelhead commercially has dramatically reduced numbers to for escapement.	Habitat restoration is just one of a number of actions that will be required to recover Lower Columbia salmon and steelhead to healthy, harvestable levels. Success will require that actions address habitat protection, estuary conditions, predation, hydropower impacts and harvest and hatchery effects. A detailed discussion of the various factors affecting the recovery of salmon and steelhead is contained in the Lower Columbia Salmon Recovery Plan.
Keith Isaacson	Mining of rock on the east fork of the Lewis is detrimental to habitat restoration.	Past mining practices have altered channel conditions and adversely affected important habitat for salmon and steelhead. This restoration plan identifies several opportunities to improve these degraded habitat conditions.
Rick Malinowski	Nice job of conducting the meeting to prevent public in-put.	Public comments were taken by project staff at the work stations. Public comment forms were available at meetings. These forms could be left with staff or mailed to the LCFRB. Participants at the meetings were also advised that they could submit comments to the LCFRB electronically or by mail.
Sandra Bennett	We had a clear sand and gravel bottom when we first bought our riverfront property. Then we begin to have a buildup of silt and lost all the crawdads & minnows. Two years ago the silt began to wash away (after Storedahl's stopped mining).	Thank you for the information.

Maggie Stone	I am very much interested in restoring salmon and natural habitat to our wild rivers. I live on Dean Creek, which I understand is part of the restoration plan that you are working on. I have been learning about the land from such classes the county has been offering ("Living on the Land" WSU extension service), and am in the process of planning to take out some evasive species (English Ivy and blackberry) and plant natives. RE: Dean Creek What I understand about Dean Creek from the meeting and your website, is that there are numerous ponds and dams on it from landowners, numerous evasive species growing along its banks, and that the creek water splays out and seeps into the ground at the end of its journey to the Lewis River. It is obvious to me that no fish fry that made its way down Dean Creek would survive at the end of the road if there is no creek bed to carry it to the Lewis. I know you know this. But it seems that rebuilding the stream bed would be the only solution. My question is: Are the landowners on either side not willing to allow that to happen? What needs to be done to help this along? I am also concerned about the ponds and dams that could cause warming to the waters. I know that there is a recreational swimming pool on the west side of Dean Creek that you probably know about, but isn't there some state	Work is underway to improve channel and habitat conditions along lower Dean Creek near the mouth (Clark County property). Lower Dean Creek does flow above ground into the East Fork Lewis except for during dry periods. In most years, during the primary migration seasons, juvenile and adult fish are able to migrate through this section. There is private land between J.A. Moore Road and the County land downstream. At this point in time, we do not know the specifics of whether the landowners are willing to participate in restoration efforts. Ponds and dams on the tributaries are believed to create temperature and passage problems and objectives to address these issues are included in the Strategy. The LCFRB has no regulatory authority and attempts to work with interested parties to address these issues. Such dams and ponds frequently fall under the regulatory authority of the Washington Department of Ecology or the Washington Department of Fish and Wildlife. Mining of rock or gravel is a regulatory issue guided by county land use regulations and associated state and federal laws. This habitat strategy is non-regulatory. Its implementation is dependent on volunteer landowners. The strategy attempts to identify restoration measures to address the adverse impact of past mining on fish habitat in several areas. Citizen and community support is critical to the protection and restoration of the East Fork Lewis and its tributaries. We recommend you continue to stay active and advise County and State elected officials of your concerns and what you would like to see happen in the East Fork Lewis watershed. If you are interested in supporting or participating in habitat restoration efforts such as those identified in the strategy, please contact the LCFRB for a list of

	regulations against such things, since it is right on Dean. I read that you don't have authority, but doesn't the state? RE: Storedahl's Determination to mine right next to the Lewis River on the 100 year flood plain. I have kept an eye on this for many years, and when I read an article in The Columbian on Feb. 24 about it, it made me angry. The article was right above the salmon restoration article about the Mar. 3 and 4 meetings; quite a contradiction to put them right together. It said our county commissioners are planning to approve a zone change that will allow Storedahl to mine the flood plain. How can they change the zone of a flood plain to not be a flood plain? It is or it isn't. I am angry that our government could let this slip through a crack of the legal system. I realize that you have a complicated plan for that area of the Lewis, and you may be up against a "hard rock," so if there is anything citizens can do to help, please let me know.	organizations active in the East Fork.

General Meeting Discussion	
Who decided what projects to put in the draft document?	The East Fork Lewis River Work Group determined the projects to be included in the draft strategy document. The Work Group includes representatives from federal and state agencies, local government, the Cowlitz Tribe, local nonprofit organizations (e.g., Fish First, Lower Columbia River Fish Enhancement Group, and Columbia Land Trust) and several interested landowners.

"Sound science" is referenced in the plan; where does it come from? Is it regulatory agencies?	The strategy is based on the best available science and technical information. The consulting team was selected by the Work Group for its knowledge and experience in fish biology, habitat needs and restoration, watershed and river processes, and engineering. The East Fork Lewis has been the subject of many scientific and technical studies and assessments. The Work Group used this available information as a basis for identifying habitat needs and restoration opportunities. Finally, the Work Group members themselves brought a variety of scientific and technical skills to the planning effort.
How are results of a project evaluated?	Currently, the state Salmon Recovery Funding Board (SRFB) and the LCFRB cooperatively monitor projects to ensure they are successfully completed. The SRFB also randomly selects project for effectiveness monitoring. The LCFRB is currently working with federal and state resource agencies, local governments, and project sponsors to develop a more comprehensive monitoring program for the region.
Some groups do their own monitoring work. Does the Fish Recovery Board?	Some project sponsors do attempt to monitor the projects. Project grants rarely include funding to conduct monitoring or evaluation of projects. This is true of grants by state Salmon Recovery Funding Board (SRFB), which funds many of the habitat projects in the Lower Columbia. The LCFRB is currently working with federal and state resource agencies, local governments, and project sponsors to develop a more comprehensive, yet affordable, monitoring program for the region.
Does the Fish Recovery Board decide who they contract with?	Project sponsors are generally free to select their consulting and construction contractors pursuant to the terms and conditions of their grant. For many of the Lower Columbia projects, the state Salmon Recovery Funding Board (SRFB) is the primary granting agency.

	Sponsor and partner qualifications and capabilities are considered by the LCFRB and its Technical Advisory Committee (TAC) in evaluating projects for funding by the SRFB. If the TAC and Board feel that a sponsor or contractor identified in the grant proposal is not qualified to or capable of undertaking the project, the project will not be recommended for funding.

LCFRB TAC Comments	
The temperature data chart references DEQ instead of Ecology---Oregon isn't monitoring temp in WA.	Corrected
The write-up on the Daybreak ponds avulsion study completely misses the work done in the Daybreak HCP and Technical Appendix C. That analysis includes planform, hydrology, sediment transfer, etc. Also, the cost is too low. Storedahl spent several hundred thousand dollars for the analysis. In addition, the Services have approved the avulsion protection and avoidance measures in the HCP and WDFW issued a HPA for the work which will likely be completed this summer.	Conceptual Design project #EF-A-02 (Daybreak Ponds Avulsion Risk Assessment) references the work done in the Daybreak HCP. The East Fork Work Group discussed these efforts and concluded that the HCP analysis should be reviewed, and updated or expanded as appropriate. This is partially due to changes that have occurred to the river channel since the HCP work was conducted. Nevertheless, the EFWG acknowledges that activities related to the HCP are moving forward, and that any work associated with EF-A-02 must take these activities into consideration. The cost estimate for this assessment was developed using professional judgment and takes into consideration the analysis work that has already been performed at the site.
In the objectives section for Segments 1 through 5, I think the plan should be revised in all the Section 8's to change the strategy for LWD to read..."to ensure they remain in place and functional and to withstand a 100-year flood event", instead of the 50-year event as stated. We have had too many 100-year events in the past 5 years or so already and we need to be sure the LWD structures are going to stay.	The design flood of 50-years was removed from the Objectives section. The magnitude of the design flood is handled as a specific design criterion to guide the engineering for a particular project. The magnitude of the design flood may depend on various considerations, including the function of the structures to be placed, nearby infrastructure or property that may be at risk, and the objectives of project stakeholders. In some cases, designing for

	less than a 100-year event may be appropriate, and in other cases, designing for a 100-year event or even greater (i.e. the probable maximum flood) may be necessary.
In the objectives section for Segments 4 through 7, the document does not address objectives or strategies for the following: A. Identification of existing spawning habitat capacity (except for Chum). B. Identification of spawning carrying capacity presently. C. Identification of preservation of key spawning habitat areas (except Chum). D. Identification of key areas to enhance or create spawning areas (except Chum).	In the Objectives section (Appendix A), Segment objectives attempt to focus on the key life history stages and associated habitat attributes for Chinook, chum, coho and steelhead. EDT assisted in evaluating current and potential population performance and habitat capacity. EDT was also used in evaluating the relative importance of life history stages in each segment, but was supplemented by other data or information where available. For example, key spawning areas for all species were identified using WDFW redd surveys. Specific projects opportunities were identified to address spawning as well as other key life history stages for each species.
Spawning habitat availability should be a primary consideration in the plan, and except for Chum, it is missing. Creating or preserving rearing habitat is important, but it goes hand-in-hand with spawning habitat.	Spawning habitat is one of the primary objectives. In order to better highlight the importance of spawning habitat, a new objective that specifically addresses spawning habitat was added to these segments.
I am a little disappointed that the Plan seems to focus an inordinate amount of attention on Chum, to the exclusion of the other salmon species, and it appears to lean heavily toward riparian, fine sediments, LWD and bank stabilization to protect private landowners. There is a distinct lack of focus on instream habitat in vision and scope, and relies too much on EDT data instead of quantifiable field surveys by fish habitat biologists, not just hydrogeomorphologists.	The plan addresses habitat preservation and enhancement for all life-stages for all salmon species. Stabilizing private property is not an objective in the plan and is not an objective of project concepts. Instream habitat is a primary focus of the plan and is a component of numerous projects that have been identified. Field survey data collected by habitat biologists is used to characterize existing conditions and was used to develop the reach-level objectives. EDT and other data sources (provided by multiple technical disciplines) were also used. EDT data is presented at the beginning of the reach-

	level objectives in order to provide context. It is the most comprehensive information that is available on life-stage limiting factors.
Measurement and Monitoring. The Plan does not include any mention or focus on habitat measurement and monitoring to track any progress of effort against plan implementation in the future. If the goals, objectives and strategies are ever expected to work, then there has to be some type of objective before/after measurement to assess whether the goals were indeed met.	We have expanded our monitoring objective in the main body of the plan to reflect these comments. In addition, the LCFRB is completing a Restoration Monitoring Plan as part of the updated Recovery Plan which will be available to all project proponents to provide monitoring guidance and planning.

EF 05

Off-Channel Habitat Enhancement – Conceptual Design

Reach: EF Lewis 8B
River mile: 14
Reference page in main document: 40

Site Description

This site is located on the river left (south side) across from the Lewisville Park baseball field. It is located on Boy Scouts property. There is a small unnamed but perennial tributary that enters the mainstem. The tributary provides cool water input during the summer. Temperatures in the tributary were 10°F cooler than the mainstem at the time of the survey. There were signs of recent beaver dam construction along the tributary. WDFW data shows there is adjacent Chinook and steelhead spawning in the mainstem. Site observations and temperatures suggest suitable groundwater connectivity and tributary inflow for a beneficial off channel project. This project was carried forward to the conceptual design phase ahead of other, higher ranking projects because of its unique opportunity to provide cool water off-channel refuge habitat. The low benefit score is a result of the small size of the project; the benefit per area of off-channel habitat is expected to be high.

Off-channel habitat enhancement area. The small perennial tributary enters from the right side. The mainstem East Fork Lewis River is on the left side (view looking upstream).

Treatment Strategy and Alternatives

Recommended treatments:

- Excavate approximately 10,000 square foot off-channel area connected with the mainstem at summer low flow periods. Off-channel area will be fed by perennial cool-water tributary.
- Add large wood for habitat complexity and cover.
- Conduct riparian restoration throughout project area, especially in areas disturbed by construction activities.

Alternatives:

- The specific extent of off-channel area will be determined through analysis and design.
- Enhancement of tributary spawning habitat should be evaluated and considered.

Example of Constructed Backwater Habitat with Large Wood Cover

Expected Benefits – Limiting Factors Addressed

Physical habitat – Enhanced quantity and quality of off-channel area, habitat complexity and cover, and large woody debris.

Biological – 1) Enhanced cool water refuge for summer rearing of coho and steelhead, and 2) Enhanced winter high flow refuge for coho and steelhead, and 3) Enhanced fry colonization and early-rearing habitat for Chinook (there are adjacent spawning grounds just upstream on the mainstem).

Access and Landownership

Habitat enhancements would be located on private property (Boy Scouts of America property). The most direct access would be through the old Boy Scout camp area and would only require a couple hundred feet of temporary access road.

Data and Analysis Requirements

WDFW steelhead redd survey data shows redds located near the tributary outlet. The effect of the project on steelhead spawning needs to be evaluated. A topographic survey will be needed to determine final excavation volumes and extent. At least one summer season of temperature and dissolved oxygen monitoring should be conducted to characterize the condition of tributary flow and groundwater flow that would be expected to contribute to the backwater area. Flood inundation analysis and a geomorphic assessment will be required to support final designs. Habitat enhancements will be subject to significant potential impact from beavers; these impacts should be addressed as part of project design.

LCFRB Habitat Strategy Summary

EF Lewis 8B						
Tier	**1**					
Length (m)	**8,801**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P	P	P	P	P	
Species Reach Potenial (H,M,L)	M	L	M	M	H	
Restoration Vaue	66%	43%	38%	83%	52%	56%
Preservation Value	34%	57%	62%	17%	48%	44%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	H	M	H	H	H	H
Off channel & side channel habitat	H	M	H	H	H	H
Floodplain function and channel migration processes	H	M	H	H	H	H
Riparian conditions & functions	H	M	M	H	M	H
Water quality	H	M	M	M	L	H
Instream flows	H	M	H	H	H	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	H	M	H	H	M	H


Lewisville Park
East Fork Lewis River
Unnamed perennial tributary
River Mile 14
0 25 50 100 150 200
Feet
N
inter·fluve
Perennial Tributary
Off-Channel Habitat Enhancement Area
2-foot LiDAR contours
Parcel boundaries
Clark County Parcels
*Enhancement features are approximate. Specific location and extent of features will require additional analysis and design
Contour data and 2007 aerial photography provided by Clark County
EF 05
OFF-CHANNEL HABITAT ENHANCEMENT
OVERVIEW AND LOCATOR MAP

Planning-level cost estimate for EF 05

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2009 costs.

Description	Unit	Quantity	Unit Cost	Total Cost	Comment
Mobilization and demobilization	LS	1	$6,000	$6,000	Calculated at 5% of construction sub-total
Temporary access road	LF	200	$40	$8,000	Assumes access can be obtained through Boy Scout Camp area
Excavate & stockpile/dispose	CY	3,000	$15	$45,000	Excavation quantity is based on 10,000 square foot extent with an average excavation depth of 8 ft. Final design criteria and analysis will likely alter these estimates up or down. Assume haul will be less than 1,500 feet. Haul distances greater than 1,500 feet off site on road will substantially increase haul costs.
Large wood purchase and installation	EA	40	$800	$32,000	Assumes 30% delivered with root wads attached. Cost includes placement
Dewatering and sediment control	LS	1	$15,000	$15,000	Assumes water will be encountered throughout construction.
Streambank revegetation	SF	2,000	$1.50	$3,000	Assumes average of 5 feet on each bank for entire length
Riparian revegetation (above bank)	AC	0.2	$15,000	$3,000	Assumes 20 feet revegetation on each side of channel. Includes follow-up maintenance.
Construction oversight	HR	180	$130	$23,400	Assumes 2 weeks of construction oversight, construction staking and associated coordination, 12 hour days, 1.5 staff.
Construction Sub-Total				**$135,400**	
Concept Level Construction Contingency (20%)				$27,080	
Construction Total				**$162,500**	
Project Delivery					Items below are calculated as a percent of the construction sub-total
Permitting (4%)				$5,416	
Detailed Engineering Design (15%)				$20,310	
Contract Administation (5%)				$6,770	
Project Delivery Sub-Total				**$32,500**	
TOTAL ESTIMATE				**$195,000**	rounded to nearest $1,000

General Notes:

Cost includes a 20% construction contingency

Costs assume all materials (wood) is purchased and hauled to the site from a nearby source.

Savings could be gained by reducing the extent of the off-channel area.

Key

LS = Lump sum
CY = Cubic yard
LF = Lineal foot
SF = Square foot
AC = Acre
EA = Each
FF = Face foot (square foot of bank face)
HR = Hours

EF 10

Side-Channel Habitat Enhancement – Conceptual Design

Reach: EF Lewis 8B
River mile: 13 to 13.5
Reference page in main document: 43

Site Description

This site consists of a high flow channel in the river right (north) floodplain area that is not active at summer low flow periods. The existing channel is approximately 2,600 feet long and flows through Lewisville Regional Park. The project area is located on County Park land except at the downstream end where the channel flows through State-owned land. Private property lies just to the west of the channel at the downstream terminus near the junction with the mainstem East Fork Lewis River. The channel enters the mainstem East Fork Lewis near river mile 13. There have been considerable alterations to the channel and surrounding park areas, primarily related to park infrastructure. Two bridges within the park span the channel. Approximately mid-length down the channel is an excavated pond that retains water throughout the summer. Roadways, parking lots, and park amenities are located nearby the channel in several places.

The channel offers a good opportunity to restore summer-active side-channel habitat. At the time of the survey, temperature was 4°F cooler in areas of standing water in the side-channel compared to the mainstem. The channel has gravel and cobble substrate and good riparian cover throughout most of the length. Average gradient is approximately 0.8%. Site observations of standing water during the summer and cool temperatures indicate significant groundwater connectivity.

This project scored high in the project evaluation process due to its benefit to multiple species life-stages and due to its large size.

Existing Conditions

Treatment Strategy and Alternatives

Recommended treatments:

- Excavate within existing channel as necessary to provide year-round surface water connectivity with the mainstem. Utilize existing flood channel and channel scar depressions. It is anticipate that some areas will not require excavation.
- Create and enhance pool-riffle sequences in side-channel.
- Install habitat enhancement features including large woody debris and spawning gravel (if necessary).

Alternatives:

- There may be alternative locations for the side-channel depending on constraints imposed by surrounding park infrastructure. These will be determined with further analysis.
- There may be opportunities to create backwater channels or off-channel wetlands that are connected to the side-channel.

Example of a restored side-channel

Expected Benefits – Limiting Factors Addressed

Physical habitat – 1) Enhanced availability of side-channel and off-channel habitat throughout the year, 2) Increased hyporheic flow connectivity, 3) Enhanced quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris.

Biological – 1) Enhanced winter high flow refuge for coho and steelhead, 2) Enhanced spawning for coho and steelhead, with potential benefits to chum and Chinook spawning, 3) Enhanced quantity and quality of cool-water summer rearing for coho and steelhead, 4) Increased habitat complexity and cover for rearing fish that will provide diverse foraging opportunities and protection from predators.

Access and Landownership

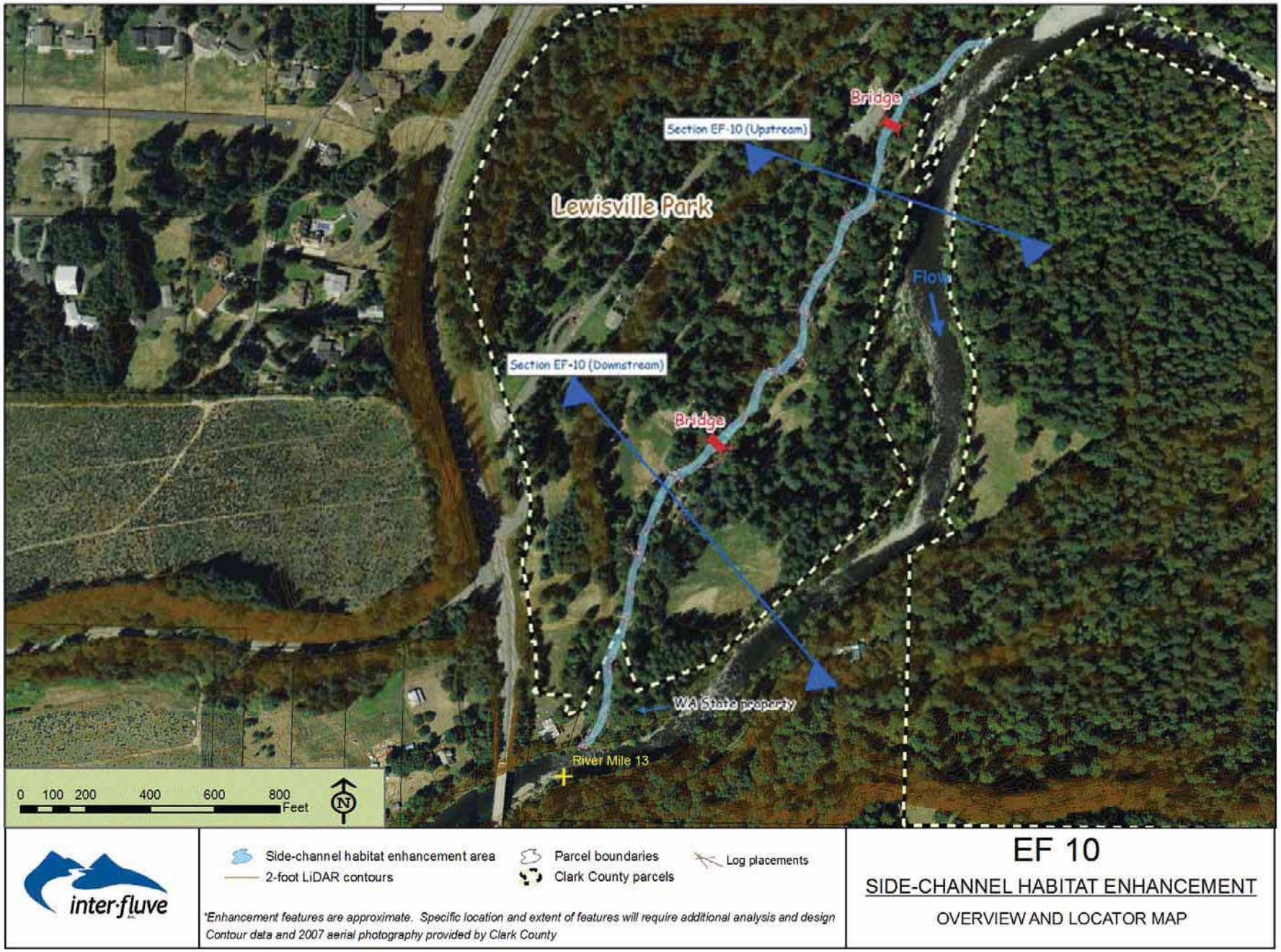
Access can be obtained through Lewisville Park. Property ownership is Clark County and WA State (downstream end). There is private land near the channel at the downstream end. It is possible that the optimal channel outlet location would be located adjacent to this parcel and landowner cooperation may therefore be required for implementation.

Data and Analysis Requirements

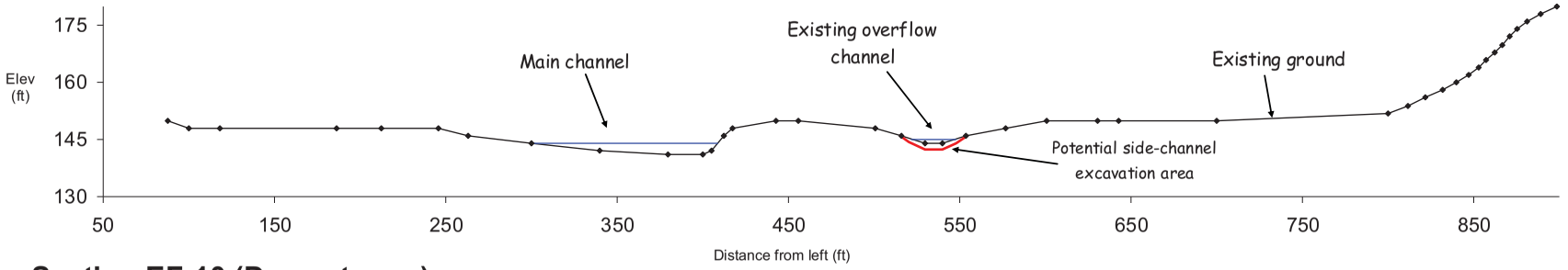
Evaluate effects of reduced flow in mainstem. At least one low-flow season of groundwater monitoring and pump tests are recommended to determine groundwater contribution rates and required excavation extents. Hydraulic analysis, flood inundation analysis, and a geomorphic assessment will be required to support final designs. Habitat enhancements will be subject to significant potential impact from beavers; these impacts should be addressed as part of project design.

LCFRB Habitat Strategy Summary

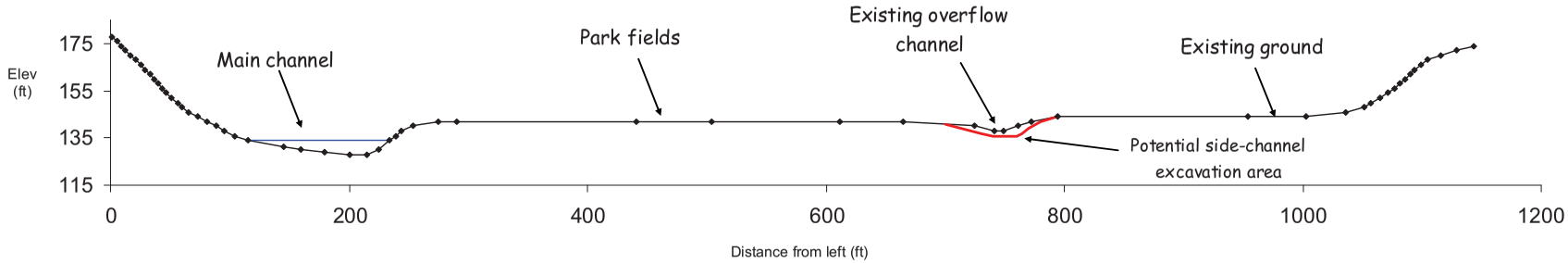
EF Lewis 8B						
Tier	**1**					
Length (m)	**8,801**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P	P	P	P	P	
Species Reach Potenial (H,M,L)	M	L	M	M	H	
Restoration Vaue	66%	43%	38%	83%	52%	56%
Preservation Value	34%	57%	62%	17%	48%	44%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	H	M	H	H	H	H
Off channel & side channel habitat	H	M	H	H	H	H
Floodplain function and channel migration processes	H	M	H	H	H	H
Riparian conditions & functions	H	M	M	H	M	H
Water quality	H	M	M	M	L	H
Instream flows	H	M	H	H	H	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	H	M	H	H	M	H


Bridge
Section EF-10 (Upstream)
Lewisville Park
Flow
Section EF-10 (Downstream)
Bridge
WA State property
River Mile 13
0 100 200 400 600 800
Feet
N
inter·fluve
Side-channel habitat enhancement area
2-foot LiDAR contours
Parcel boundaries
Clark County parcels
Log placements
*Enhancement features are approximate. Specific location and extent of features will require additional analysis and design
Contour data and 2007 aerial photography provided by Clark County
EF 10
SIDE-CHANNEL HABITAT ENHANCEMENT
OVERVIEW AND LOCATOR MAP

Section EF-10 (Upstream)



Section EF-10 (Downstream)



Standard Construction Sequence

Pre-excavation | *Following rough grading* | *Post-implementation* | *5 years following construction*

inter·fluve	*CROSS SECTIONS AND CONSTRUCTION SEQUENCE* ***Notes:*** *Cross-sections are derived from LiDAR contours. Bathymetry is estimated based on site and aerial photograph observations. In some cases, minor corrections are made to LiDAR data that is believed to be representative of vegetation and not the ground surface.*	EF 10 SIDE-CHANNEL HABITAT ENHANCEMENT

Planning-level cost estimate for EF 10

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2009 costs.

Description	Unit	Quantity	Unit Cost	Total Cost	Comment
Mobilization and demobilization	LS	1	$23,000	$23,000	Calculated at 5% of construction sub-total
Temporary access road	LF	500	$40	$20,000	Assumes multiple access points are available through the park
Excavate & stockpile/dispose	CY	5,000	$15	$75,000	Excavation quantity is based on 2 CY per lineal foot (2,500 feet with 3-4 feet of cut). Finished side channel top width with approximately 15 feet. Final design criteria and analysis will likely alter these estimates up or down. Assume haul will be less than 1,500 feet. Haul distances greater than 1,500 feet off site on road will substantially increase haul costs.
Channel earthwork and reshaping	LF	900	$50	$45,000	Assumes one-third of the length receives significant re-grading to create pool and riffle habitat.
Large wood purchased and delivered to site	EA	200	$400	$80,000	Assumes 20% delivered with root wads attached. Frequency of LWD = >20 pieces/100 meters.
Boulder ballast purchased and delivered to site	EA	300	$100	$30,000	Assumes 1.5 - 2 yard boulders. Assumes 1.5 boulders per log.
Wood placement	EA	200	$300	$60,000	Wood placed in small jams and individual placements.
Dewatering and sediment control	LS	1	$25,000	$25,000	Assumes water will be encountered throughout construction.
Streambank revegetation	SF	25,000	$1	$25,000	Assumes average of 5 feet on each bank for entire length
Riparian revegetation (above bank)	AC	2.3	$15,000	$34,500	Assumes 20 feet revegetation on each side of channel. Includes follow-up maintenance.
Construction oversight	HR	540	$130	$70,200	Assumes 6 weeks of construction oversight, construction staking and associated coordination, 12 hour days, 1.5 staff.
Construction Sub-Total				**$487,700**	
Concept Level Construction Contingency (20%)				$97,540	
Construction Total				**$585,200**	
Project Delivery					Items below are calculated as a percent of the construction sub-total
Permitting (4%)				$19,508	
Detailed Engineering Design (15%)				$73,155	
Contract Administation (5%)				$24,385	
Project Delivery Sub-Total				**$117,000**	
TOTAL ESTIMATE				**$702,000**	rounded to nearest $1,000

General Notes:

Cost includes a 20% construction contingency

Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source. Significant savings could be accrued if materials are donated.

Considerable savings could be gained by reducing the total length of the side-channel

Assumes no spawning gravel supplementation. Importing gravels will increase costs.

Costs do not include wetland inventory and impacts analysis

Boulder ballast requirements may be able to be reduced depending on hydraulics analysis

Key

LS = Lump sum
CY = Cubic yard
LF = Lineal foot
SF = Square foot
AC = Acre
EA = Each
FF = Face foot (square foot of bank face)
HR = Hours

EF 12

Instream Habitat Enhancement – Conceptual Design

Reach: EF Lewis 8B
River mile: 10.9 to 11.4
Reference page in main document: 45

Site Description

The meander bend at river mile 11 (see overview photo on page 3) consists of a uniform channel that lacks habitat complexity and in-stream wood structure to support juvenile rearing and adult holding. The frequency and quality of pool habitat is low and there is little to no habitat structure necessary for velocity refuge and rearing cover. Residential development along the south bank limits the ability to fully restore channel migration processes that would create and maintain complex habitats. Adding structural complexity would help to restore habitat conditions within the constraints imposed by surrounding land use.

Portions of adjacent upstream and downstream stream segments, extending from Lewisville Bridge down to Daybreak Bridge, have similar habitat conditions and could also benefit from similar treatments.

This project scored high in the project evaluation process due to its benefit to multiple species life-stages and due to its large size.

Treatment Strategy and Alternatives

Recommended treatments:

- Construct 5-7 meander-bend log jams structures. Ballast logs with boulders, pilings, burial, or attachment to existing trees.
- Add and secure wood on bars to provide floodplain roughness.
- Conduct riparian restoration throughout project area, especially in areas disturbed by construction activities.

Alternatives:

- There are alternatives for log jam size and placement location. These will be determined through analysis and design.
- Similar treatments could be extended into upstream and downstream segments.

Example of Constructed Meander-bend Log Jams

- Construction of this project could potentially be combined with off-channel enhancement at project EF-20 (downstream) and EF-16 (upstream).

Expected Benefits – Limiting Factors Addressed

Physical habitat – Enhanced quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris.

Biological – 1) Enhanced winter high flow refuge for coho and steelhead, 2) Enhanced bank margin habitat for Chinook fry colonization and early rearing, and 3) Increased habitat complexity and cover for rearing fish that will provide diverse foraging opportunities and protection from predators.

Access and Landownership

Habitat enhancements would be located on Clark County property. Private property is located across the river. Access could potentially be obtained from the north across private property or from the east (upstream) or west (downstream) through Clark County property. Access could also potentially be gained from across the river through private property. Any access across private property would require the cooperation of willing landowners. Combining construction of this project with construction of project EF-20 (to the west) should be considered in order to combine access.

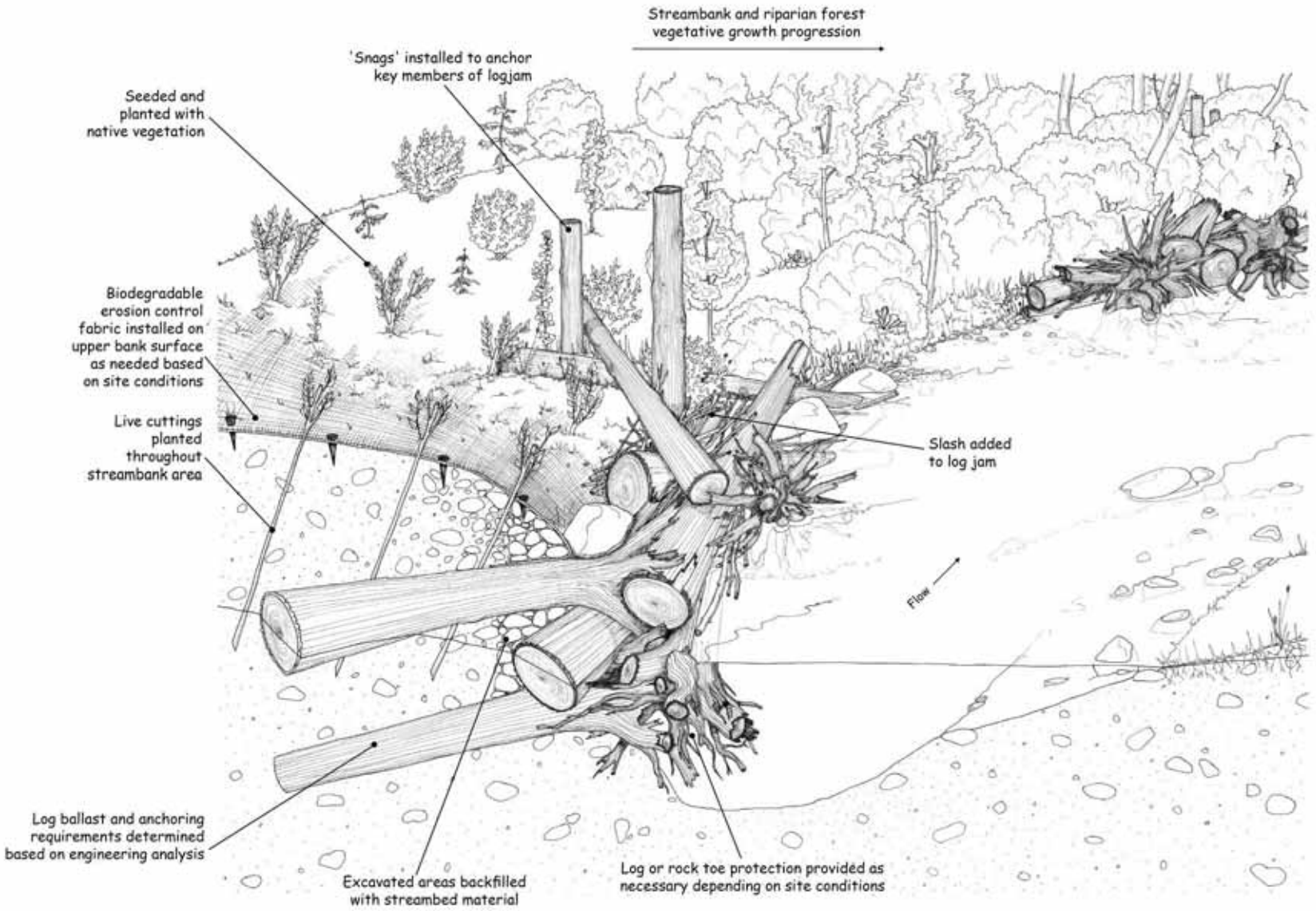
Data and Analysis Requirements

This area is heavily used by river recreationists and is close to adjacent residences. Recreation access, safety, and flood conditions must be addressed in design. This is a FEMA-regulated floodplain and the design must satisfy a No-Rise condition of the base flood. Hydraulic analysis, flood inundation analysis, and a geomorphic assessment will be required to support final designs.

LCFRB Habitat Strategy Summary

EF Lewis 8B						
Tier	**1**					
Length (m)	**8,801**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P	P	P	P	P	
Species Reach Potenial (H,M,L)	M	L	M	M	H	
Restoration Vaue	66%	43%	38%	83%	52%	56%
Preservation Value	34%	57%	62%	17%	48%	44%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	H	M	H	H	H	H
Off channel & side channel habitat	H	M	H	H	H	H
Floodplain function and channel migration processes	H	M	H	H	H	H
Riparian conditions & functions	H	M	M	H	M	H
Water quality	H	M	M	M	L	H
Instream flows	H	M	H	H	H	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	H	M	H	H	M	H


Flow
River Mile 11
0 75 150 300 450 600
Feet
N
inter·fluve
Habitat Enhancement Area
2-foot LiDAR contours
Parcel boundaries
Clark County Parcels
Log placements
*Enhancement features are approximate. Specific location and extent of features will require additional analysis and design
Contour data and 2007 aerial photography provided by Clark County
EF 12
INSTREAM HABITAT ENHANCEMENT
OVEVIEW AND LOCATOR MAP



inter·fluve	*TYPICAL MEANDER-BEND LOG JAM 3-D RENDERING*	EF 12 INSTREAM HABITAT ENHANCEMENT

Planning-level cost estimate for EF 12

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2009 costs.

Description	Unit	Quantity	Unit Cost	Total Cost	Comment/Assumption
Mobilization and demobilization	LS	1	$13,000	$13,000	Calculated at 5% of construction sub-total
Temporary access road	LF	500	$40	$20,000	Assumes one access from private land owner and post construction rehabilitation.
Large wood purchased and delivered to site	EA	150	$500	$75,000	Assumes 30% delivered with root wads attached. Assumes 25 pieces per jam plus floodplain wood.
Boulder ballast purchased and delivered to site	EA	225	$100	$22,500	Assumes 1.5 - 2 yard boulders. Assumes 1.5 boulders per log.
Log jam construction	EA	5	$10,000	$50,000	Wood placed in jams to withstand Lewis River floods. Ballast will be completed through burial, attachment to existing trees, and cable boulder ballast.
Dewatering and sediment control	LS	1	$25,000	$25,000	Assumes water will be encountered during log jam construction.
Revegetation	SF	30,000	$1	$30,000	Assumes 6,000 SF revegetation associated with each log jam.
Construction oversight	HR	270	$130	$35,100	Assumes 3 weeks of construction oversight, construction staking and associated coordination, 12 hour days, 1.5 staff.
Construction Sub-Total				**$270,600**	
Concept Level Construction Contingency (20%)				$54,120	
Construction Total				**$324,700**	
Project Delivery					Items below are calculated as a percent of the construction sub-total
Permitting (4%)				$10,824	
Detailed Engineering Design (15%)				$40,590	
Contract Administation (5%)				$13,530	
Project Delivery Sub-Total				**$64,900**	
TOTAL ESTIMATE				**$390,000**	rounded to nearest $1,000

General Notes:

Cost includes a 20% construction contingency

Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source. Significant savings could be accrued if materials are donated.

Reducing the number of log jams could reduce costs

Key

LS = Lump sum
CY = Cubic yard
LF = Lineal foot
SF = Square foot
AC = Acre
EA = Each
FF = Face foot (square foot of bank face)
HR = Hours

EF 20

Side-Channel and Backwater Habitat Enhancement – Conceptual Design

Reach: EF Lewis 8B
River mile: 10.7 to 11.1
Reference page in main document: 50

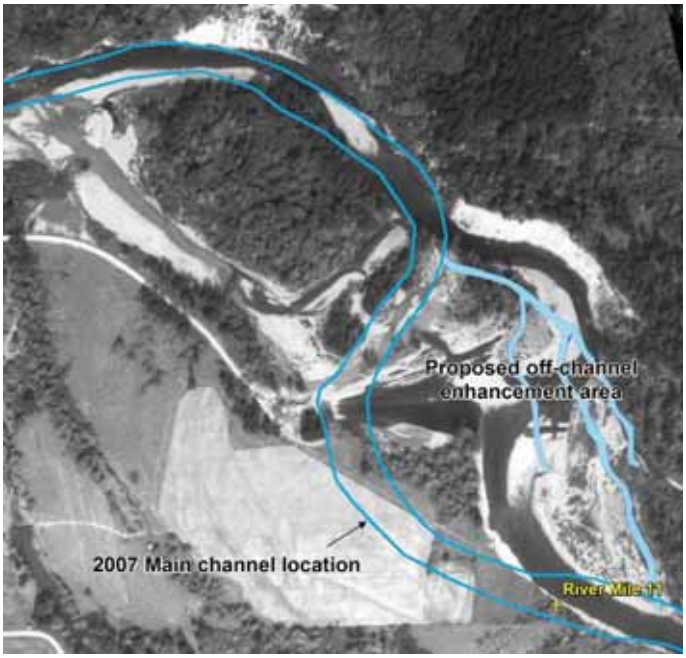
Site Description

This site consists of an old meander scar / flood flow channel in the river right (north) floodplain area that is not active at summer low flow periods. The existing channel scar is approximately 1,500 feet long and joins the mainstem at its downstream end at approximately river mile 10.7 (see overview photo on page 3). The site is located primarily on Clark County property. A complex of historical mainstem meander scrolls are located throughout the floodplain area and offer numerous possibilities for locating side-channel and connected off-channel habitats. This area was the site of extensive river bar gravel mining (scalping) in the early-to-mid 1900s (see 1939 aerial photograph below).

The channel offers a good opportunity to restore summer-active side-channel and off-channel habitat. At the time of the survey, temperature was 6°F cooler in areas of standing water in the side-channel (50°F) compared to the mainstem (56°F). The channel has gravel substrate and good riparian cover throughout its length. Average gradient is approximately 0.6%. Site observations of standing water during the summer and cool temperatures indicate significant groundwater connectivity.

This project scored high in the project evaluation process due to its benefit to multiple species life-stages and due to its large size.

Existing channel, September 2008



1939 aerial photo of project area showing 2007 channel alignment. Note evidence of extensive gravel bar scalping.

Treatment Strategy and Alternatives

Recommended treatments:

- Excavate ~1,500 ft long side-channel connected with the main channel in the summer. Utilize existing flood channel and channel scar depressions.
- Excavate additional off-channel (backwater) habitats connected to the side-channel. Use existing channel scar depressions.
- Create pool-riffle sequences in side-channel. Install habitat enhancement features including large woody debris.

Alternatives:

- Several alternative locations exist for the side-channel and off-channels. These will be determined with further analysis.

Example of restored side-channel

- A long backwater channel (not connected to mainstem at upstream end) could be constructed in lieu of the side-channel if analysis indicates significant impacts to aquatic habitat from flow reductions in mainstem.
- This project could potentially extend further upstream and be combined with off-channel enhancement at project EF-16.

Expected Benefits – Limiting Factors Addressed

Physical habitat – 1) Enhanced availability of side-channel and off-channel habitat throughout the year, 2) Increased hyporheic flow connectivity, 3) Enhanced quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris.

Biological – 1) Enhanced winter high flow refuge for coho and steelhead, 2) Enhanced spawning for coho and steelhead, with potential benefits to chum and Chinook spawning, 3) Enhanced quantity and quality of cool-water summer rearing for coho and steelhead, 4) Increased habitat complexity and cover for rearing fish that will provide diverse foraging opportunities and protection from predators.

Access and Landownership

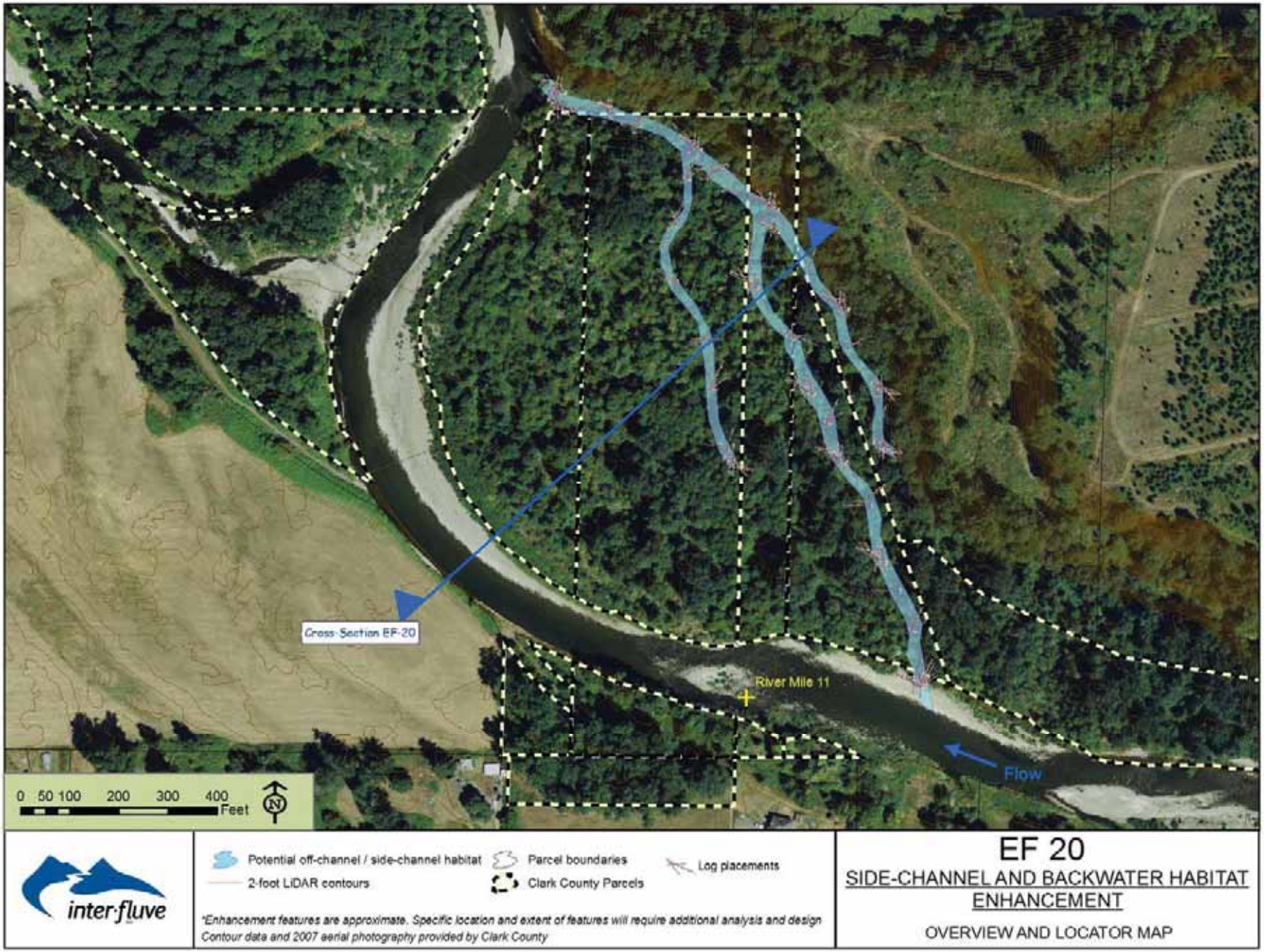
The site is located primarily on Clark County property, with the exception of a portion of the upstream end and a portion of the downstream end, which are located on private land. It is possible to design the project to avoid private property altogether if landowner partnerships cannot be obtained. Access can be obtained from the north through private property (if landowner permission is granted) or from County Property (Daybreak Park) across the mainstem East Fork Lewis.

Data and Analysis Requirements

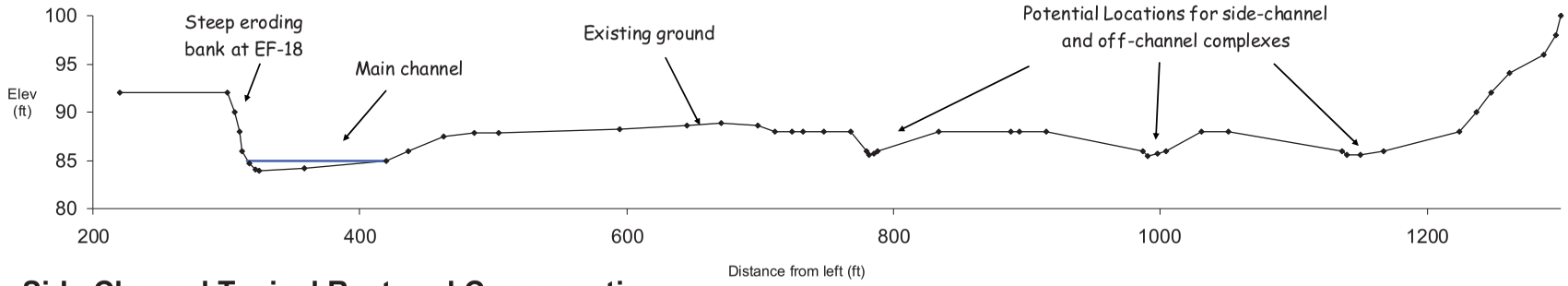
Evaluate effects of reduced flow in mainstem; in particular, ensure there is adequate flow entering the left bank active side-channel throughout the summer. Continued rapid erosion of the unvegetated south bank of the mainstem at project EF-18 should be addressed in order to reduce avulsion risk into the project area. At least one low-flow season of groundwater monitoring and pump tests are recommended to determine groundwater contribution rates and required excavation extents. Hydraulic analysis, flood inundation analysis, and a geomorphic assessment will be required to support final designs. Habitat enhancements will be subject to significant potential impact from beavers; these impacts should be addressed as part of project design.

LCFRB Habitat Strategy Summary

EF Lewis 8B						
Tier	**1**					
Length (m)	**8,801**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P	P	P	P	P	
Species Reach Potenial (H,M,L)	M	L	M	M	H	
Restoration Vaue	66%	43%	38%	83%	52%	56%
Preservation Value	34%	57%	62%	17%	48%	44%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	H	M	H	H	H	H
Off channel & side channel habitat	H	M	H	H	H	H
Floodplain function and channel migration processes	H	M	H	H	H	H
Riparian conditions & functions	H	M	M	H	M	H
Water quality	H	M	M	M	L	H
Instream flows	H	M	H	H	H	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	H	M	H	H	M	H


Cross-Section EF-20
River Mile 11
Flow
0 50 100 200 300 400
Feet
N
inter·fluve
Potential off-channel / side-channel habitat
2-foot LiDAR contours
Parcel boundaries
Clark County Parcels
Log placements
*Enhancement features are approximate. Specific location and extent of features will require additional analysis and design
Contour data and 2007 aerial photography provided by Clark County
EF 20
SIDE-CHANNEL AND BACKWATER HABITAT ENHANCEMENT
OVERVIEW AND LOCATOR MAP

Cross-Section EF-20



Side Channel Typical Restored Cross-section

Standard Construction Sequence

Pre-excavation | *Following rough grading* | *Post-implementation* | *5 years following construction*

CROSS-SECTIONS AND CONSTRUCTION SEQUENCING

Notes:
Cross-section EF-20 is derived from LiDAR contours. Bathymetry is estimated based on site and aerial photograph observations. In some cases, minor corrections are made to LiDAR data that is believed to be representative of vegetation and not the ground surface.

EF 20
SIDE-CHANNEL AND BACKWATER HABITAT ENHANCEMENT

Planning-level cost estimate for EF 20

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2009 costs.

Description	Unit	Quantity	Unit Cost	Total Cost	Comment
Mobilization and demobilization	LS	1	$20,000	$20,000	Calculated at 5% of construction sub-total
Temporary access road	LF	1,000	$40	$40,000	Assumes access from north side and post construction rehabilitation.
Excavate & stockpile/dispose	CY	4,000	$15	$60,000	Excavation quantity is based on 2 CY per lineal foot (2,000 feet with 3-4 feet of cut). Finished side channel top width approximately 15 feet. Final design criteria and analysis will likely alter these estimates up or down. Assumes haul will be less than 1,500 feet. Haul distances greater than 1,500 feet off site on road will substantially increase haul costs.
Channel earthwork and reshaping	LF	700	$50	$35,000	Assumes one-third of the length receives significant re-grading to create pool and riffle habitat.
Large wood purchased and delivered to site	EA	150	$400	$60,000	Assumes 20% delivered with root wads attached. Frequency of LWD = >20 pieces/100 meters.
Boulder ballast purchased and delivered to site	EA	225	$100	$22,500	Assumes 1.5 - 2 yard boulders. Assumes 1.5 boulders per log.
Wood placement	EA	150	$300	$45,000	Wood placed in small jams and individual placements.
Dewatering and sediment control	LS	1	$25,000	$25,000	Assumes water will be encountered throughout construction.
Streambank revegetation	SF	20,000	$1	$20,000	Assumes average of 5 feet on each bank for entire length.
Riparian revegetation (above bank)	AC	1.8	$15,000	$27,000	Assumes 20 feet revegetation on each side of channel. Includes follow-up maintenance.
Construction oversight	HR	450	$130	$58,500	Assumes 5 weeks of construction oversight, construction staking and associated coordination, 12 hour days, 1.5 staff.
Construction Sub-Total				**$413,000**	
Concept Level Construction Contingency (20%)				$82,600	
Construction Total				**$495,600**	
Project Delivery					Items below are calculated as a percent of the construction sub-total
Permitting (4%)				$16,520	
Detailed Engineering Design (15%)				$61,950	
Contract Administation (5%)				$20,650	
Project Delivery Sub-Total				**$99,100**	
TOTAL ESTIMATE				**$595,000**	rounded to nearest $1,000

General Notes:

Cost includes a 20% construction contingency

Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source. Significant savings could be accrued if materials are donated.

Considerable savings could be gained by reducing the total length of the side-channel

Costs do not include wetland inventory and impacts analysis

Boulder ballast requirements may be able to be reduced depending on hydraulics analysis

Key

LS = Lump sum
CY = Cubic yard
LF = Lineal foot
SF = Square foot
AC = Acre
EA = Each
FF = Face foot (square foot of bank face)
HR = Hours

EF 21

Side-Channel Habitat Enhancement – Conceptual Design

Reach: EF Lewis 8A
River mile: 10.3 to 10.8
Reference page in main document: 51

Site Description

This is the large active side-channel on river-left upstream of Daybreak Park (see overview photo on page 3). The outlet is located at approximately East Fork Lewis river mile 10.3. The side-channel is approximately 1,500 feet long and has an average gradient of 0.6%. This side-channel has increased its flow over the last decade and site observations suggest that it conveys approximately 30% of the summer flow. Under existing conditions, portions of the side-channel have good habitat structure and diversity but other areas exhibit uniform channel conditions with very little complexity and wood cover. The channel offers a good opportunity to increase habitat diversity and pool quantity and quality. Apex log jam complexes have been present in various configurations at the channel inlet over the past several years. These jams affect channel conditions at the inlet and likely have a large influence on seasonal flow conditions into the side-channel. There is a small levee at the upstream end on the left bank that may be having an impact on channel location at the side-channel entrance. The project area was the site of extensive river bar gravel mining (scalping) in the early-to-mid 1900s (see 1939 aerial photograph included in Project EF-20 Conceptual Design).

This project scored high in the project evaluation process due to its benefit to multiple species life-stages and due to its large size.

Log jam near side-channel entrance, September 2008

Existing conditions at downstream end of side-channel, September 2008

Treatment Strategy and Alternatives

Recommended treatments:

- Add large wood habitat structures along 1,500 ft long side-channel and connected backwater areas. Place structures to encourage pool-riffle development and habitat complexity.
- Construct bar apex log jam at head of side-channel to encourage continued summer flow into side-channel.
- Remove remnant levee at upstream end of side-channel.

Alternatives:

- There may be opportunities for excavating additional connected backwater habitat to the side-channel.

Example of restored side-channel

Expected Benefits – Limiting Factors Addressed

Physical habitat – 1) Enhanced quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris.

Biological – 1) Enhanced winter high flow refuge for coho and steelhead, 2) Enhanced spawning for coho and steelhead, with potential benefits to chum and Chinook spawning, 3) Enhanced quality of cool-water summer rearing for coho and steelhead, 4) Increased habitat complexity and cover for rearing fish that will provide diverse foraging opportunities and protection from predators.

Access and Landownership

The site is located on Clark County property just upstream of Daybreak Park. Access can be obtained from the park and from an access road on the south side of the project area.

Data and Analysis Requirements

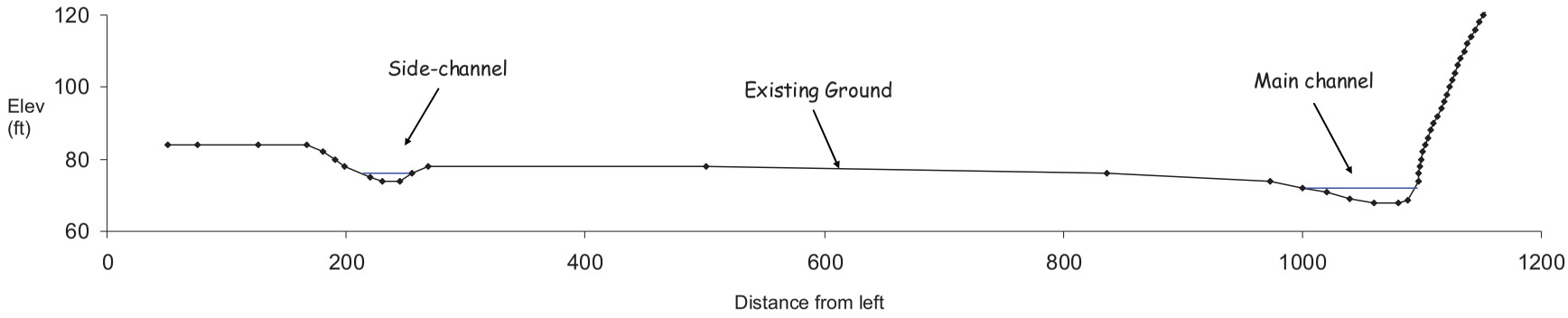
Hydraulic analysis, scour analysis, flood inundation analysis, and a geomorphic assessment will be required to support final designs. Continued rapid erosion of the unvegetated south bank of the mainstem at project EF-18 should be addressed in order to reduce avulsion risk into the EF-20 project area, which could de-water the side-channel at EF-21.

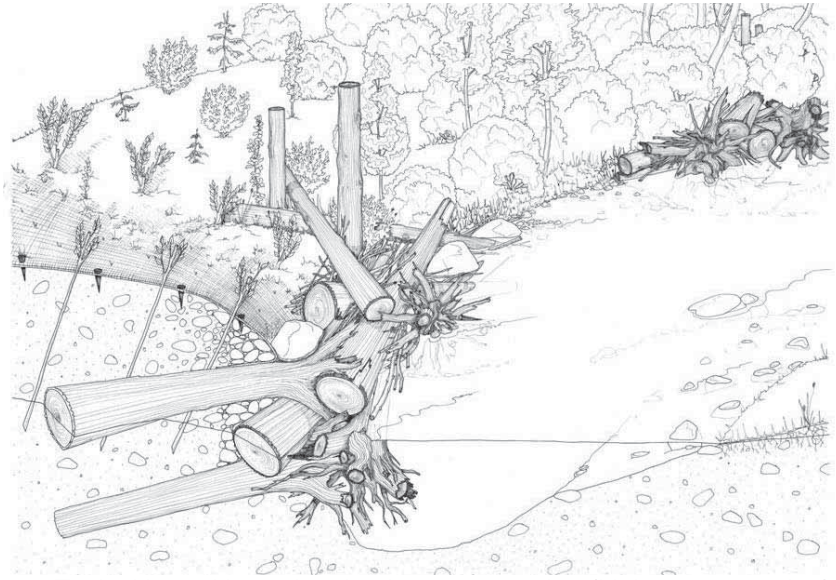
LCFRB Habitat Strategy Summary

EF Lewis 8A						
Tier	**1**					
Length (m)	**2,011**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P	P	P	P	P	
Species Reach Potenial (H,M,L)	M	L	H	H	H	
Restoration Vaue	68%	25%	33%	83%	52%	52%
Preservation Value	32%	75%	67%	17%	48%	48%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	H	L	H	H	H	H
Off channel & side channel habitat	H	M	H	H	H	H
Floodplain function and channel migration processes	H	L	H	H	H	H
Riparian conditions & functions	H	M	M	H	M	H
Water quality	H	M	M	M	L	H
Instream flows	H	M	H	H	H	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	H	M	H	H	M	H


Flow
Cross-Section EF-21
Levee
0 75 150 300 450 600
Feet
N
inter·fluve
Habitat Enhancement Area
2-foot LiDAR contours
Parcel boundaries
Clark County Parcels
Log placements
*Enhancement features are approximate. Specific location and extent of features will require additional analysis and design
Contour data and 2007 aerial photography provided by Clark County
EF 21
SIDE-CHANNEL HABITAT ENHANCEMENT
OVERVIEW AND LOCATOR MAP

Cross-Section EF-21





Typical lateral boundary log jam construction (high energy setting)

Example large wood habitat enhancement in side-channel

inter·fluve	*CROSS-SECTION, 3-D RENDERING, AND SAMPLE PHOTO* ***Notes:*** *Cross-section EF-21 is derived from LiDAR contours. Bathymetry is estimated based on site and aerial photograph observations. In some cases, minor corrections are made to LiDAR data that is believed to be representative of vegetation and not the ground surface.*	EF 21 SIDE-CHANNEL HABITAT ENHANCEMENT

Planning-level cost estimate for EF 21

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2009 costs.

Description	Unit	Quantity	Unit Cost	Total Cost	Comment
Mobilization and demobilization	LS	1	$13,000	$13,000	Calculated at 5% of construction sub-total
Temporary access road	LF	100	$40	$4,000	Assumes access can be obtained from dirt road at south boundary of site.
Large wood purchased and delivered to site	EA	150	$500	$75,000	Assumes 30% delivered with root wads attached. Assumes 25 pieces per jam plus floodplain wood. Frequency of LWD = >30 pieces/100 meters.
Boulder ballast purchased and delivered to site	EA	225	$100	$22,500	Assumes 1.5 - 2 yard boulders. Assumes 1.5 boulders per log.
Log jam construction	EA	6	$10,000	$60,000	Wood placed in jams to withstand Lewis River floods. Ballast will be completed through burial, attachment to existing trees, and cable boulder ballast.
Dewatering and sediment control	LS	1	$25,000	$25,000	Assumes water will be encountered during log jam construction.
Revegetation	SF	36,000	$1	$36,000	Assumes 6,000 SF revegetation associated with each log jam.
Construction oversight	HR	270	$130	$35,100	Assumes 3 weeks of construction oversight, construction staking and associated coordination, 12 hour days, 1.5 staff.
Construction Sub-Total				**$270,600**	
Concept Level Construction Contingency (20%)				$54,120	
Construction Total				**$324,700**	
Project Delivery					Items below are calculated as a percent of the construction sub-total
Permitting (4%)				$10,824	
Detailed Engineering Design (15%)				$40,590	
Contract Administation (5%)				$13,530	
Project Delivery Sub-Total				**$64,900**	
TOTAL ESTIMATE				**$390,000**	rounded to nearest $1,000

General Notes:

Cost includes a 20% construction contingency

Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source. Significant savings could be accrued if materials are donated.

Reducing the number of log jams will reduce costs

Key

LS = Lump sum
CY = Cubic yard
LF = Lineal foot
SF = Square foot
AC = Acre
EA = Each
FF = Face foot (square foot of bank face)
HR = Hours

EF 28

Side-Channel Habitat Enhancement – Conceptual Design

Reach: EF Lewis 8A
River mile: 9.0 to 9.5
Reference page in main document: 55

Site Description

This site consists of a high flow channel in the river right (north) floodplain area that is not active at summer low flow periods. The existing channel is approximately 3,400 feet long and originates on private property upstream of the proposed extent of restoration work at this site. The terminus of the channel (jct with the mainstem) is located at approximately river mile 9 (see overview photo on page 3). A long levee system runs adjacent to this channel for much of its length; it is closest to the channel at the Clark County maintenance yard and upstream. Some of the upstream portion of the channel may have been partially created from excavation for levee material for the adjacent levee. In the downstream portion of the site, a complex of historical mainstem meander scrolls are located throughout the floodplain area and offer numerous possibilities for locating side-channel and connected off-channel habitats. This area was the site of extensive gravel bar mining in the mid 1900s.

Existing conditions

At the time of the survey, temperature was cooler in the upstream portion of the flood channel (52°F) compared to the mainstem (58°F) and the channel downstream. Average gradient is 0.5%. Site observations of standing water during the summer and cool temperatures indicate significant groundwater connectivity.

This site is located in an active channel migration area. A point bar avulsion occurred just downstream of this site in January 2009. Over the past several years, lateral channel migration rates have been high at the West Daybreak site on the opposite side of the river. These conditions, and their implications for potential erosion or avulsion into the project area, must be considered during the analysis phase of this project. In addition, future design of treatment alternatives at the West Daybreak site will influence conditions in the project area. It is imperative that design of this project consider what is planned or implemented at West Daybreak.

Treatment Strategy and Alternatives

Recommended treatments:

- Excavate ~2,300 ft long side-channel connected with the main channel in the summer. Utilize existing flood channel and channel scar depressions.
- Excavate additional off-channel (backwater) habitats connected to the side-channel. Use existing channel scar depressions.
- Create pool-riffle sequences in side-channel. Install habitat enhancement features including large woody debris and spawning gravel.

Example of restored side-channel

Alternatives:

- Several alternative locations exist for the side-channel and off-channels. These will be determined with further analysis.
- A long backwater channel (not connected to mainstem at upstream end) could be constructed in lieu of the side-channel if analysis indicates significant impacts to aquatic habitat from flow reductions in mainstem.
- The project could extend further upstream with participation of the upstream private landowners.

Expected Benefits – Limiting Factors Addressed

Physical habitat – 1) Enhanced availability of side-channel and off-channel habitat throughout the year, 2) Increased hyporheic flow connectivity, 3) Enhanced quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris.

Biological – 1) Enhanced winter high flow refuge for coho and steelhead, 2) Enhanced spawning for coho and steelhead, with potential benefits to chum and Chinook spawning, 3) Enhanced quantity and quality of cool-water summer rearing for coho and steelhead, 4) Increased habitat complexity and cover for rearing fish that will provide diverse foraging opportunities and protection from predators.

Access and Landownership

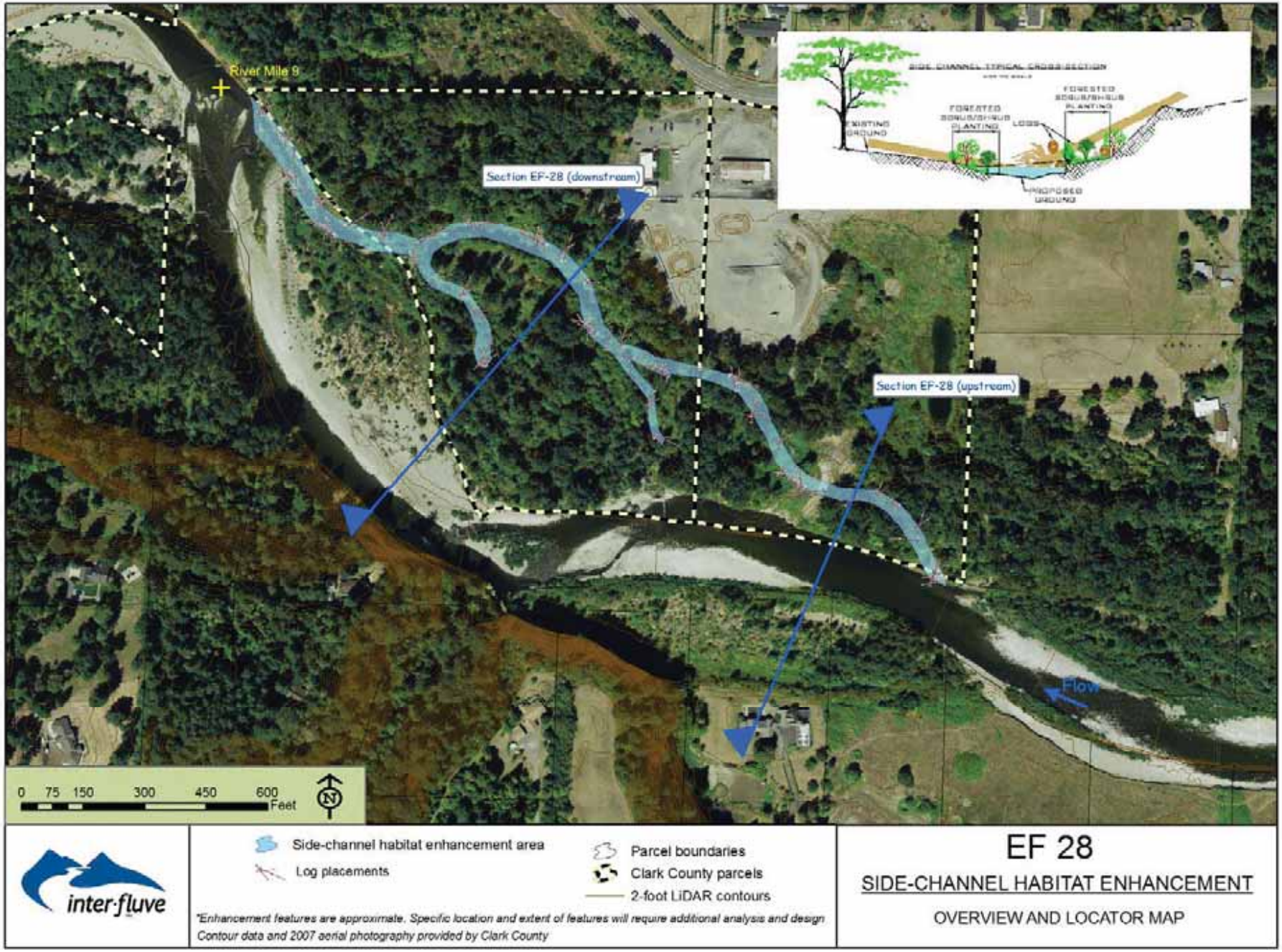
Access can be obtained through numerous locations, including 1) through the County maintenance yard, and 2) across County property from NE 269th Street at several locations. Property ownership is Clark County. There is private land upstream of the site where additional work could occur if there is landowner participation.

Data and Analysis Requirements

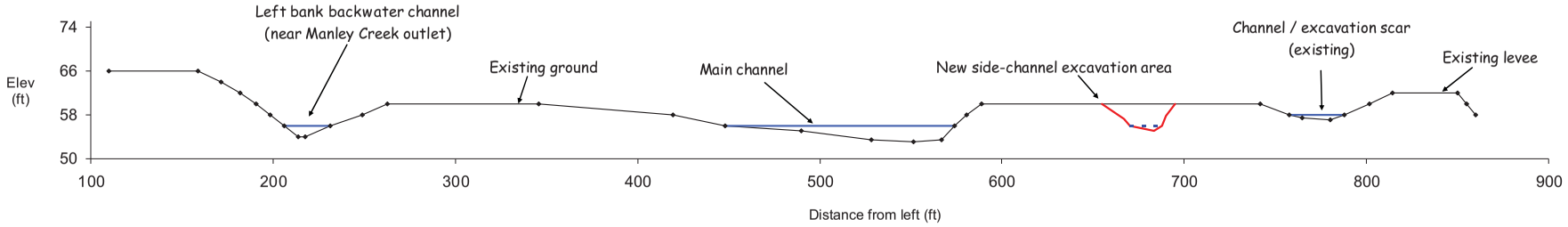
Evaluate effects of reduced flow in mainstem; in particular, ensure there is adequate flow for fish to access Mill Creek during migration periods. At least one low-flow season of groundwater monitoring and pump tests are recommended to determine groundwater contribution rates and required excavation extents. Hydraulic analysis, flood inundation analysis, and a geomorphic assessment will be required to support final designs. Habitat enhancements will be subject to significant potential impact from beavers; these impacts should be addressed as part of project design.

LCFRB Habitat Strategy Summary

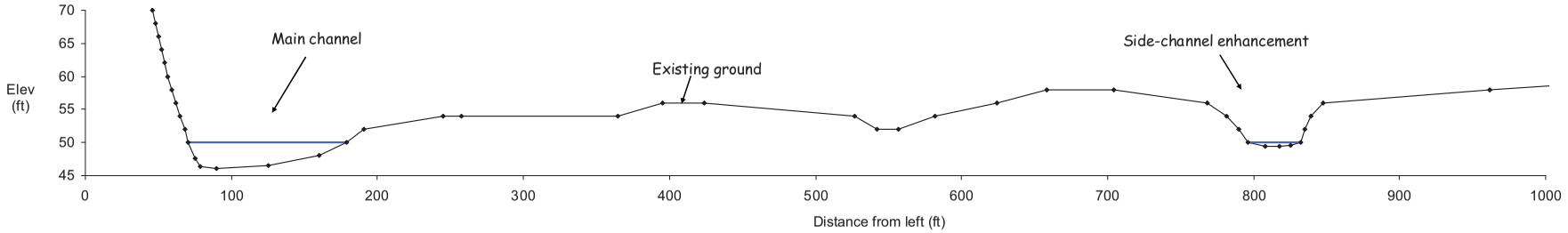
EF Lewis 8A						
Tier	**1**					
Length (m)	**2,011**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P	P	P	P	P	
Species Reach Potenial (H,M,L)	M	L	H	H	H	
Restoration Vaue	68%	25%	33%	83%	52%	52%
Preservation Value	32%	75%	67%	17%	48%	48%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	H	L	H	H	H	H
Off channel & side channel habitat	H	M	H	H	H	H
Floodplain function and channel migration processes	H	L	H	H	H	H
Riparian conditions & functions	H	M	M	H	M	H
Water quality	H	M	M	M	L	H
Instream flows	H	M	H	H	H	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	H	M	H	H	M	H


River Mile 9
Section EF-28 (downstream)
Section EF-28 (upstream)
Flow
0 75 150 300 450 600 Feet
N
inter·fluve
Side-channel habitat enhancement area
Log placements
Parcel boundaries
Clark County parcels
2-foot LiDAR contours
*Enhancement features are approximate. Specific location and extent of features will require additional analysis and design
Contour data and 2007 aerial photography provided by Clark County
EF 28
SIDE-CHANNEL HABITAT ENHANCEMENT
OVERVIEW AND LOCATOR MAP

Section EF-28 (upstream)



Section EF-28 (downstream)



Standard Construction Sequence

Pre-excavation | *Following rough grading* | *Post-implementation* | *5 years following construction*

CROSS-SECTIONS AND TYPICAL CONSTRUCTION SEQUENCE

Notes:
Cross-sections are derived from LiDAR contours. Bathymetry is estimated based on site and aerial photograph observations. In some cases, minor corrections are made to LiDAR data that is believed to be representative of vegetation and not the ground surface.

EF 28

SIDE-CHANNEL HABITAT ENHANCEMENT

Planning-level cost estimate for EF 28

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2009 costs.

Description	Unit	Quantity	Unit Cost	Total Cost	Comment
Mobilization and demobilization	LS	1	$24,000	$24,000	Calculated at 5% of construction sub-total
Temporary access road	LF	1,000	$40	$40,000	Assumes two access points; from the County yard and/or NE 269th Street
Excavate & stockpile/dispose	CY	5,100	$15	$76,500	Assumes active channel width of 20 feet and average excavation depth of 4ft for upstream 700 feet (3 CY per lineal foot) and 2ft for lower 2,000 feet, including connected back channels (1.5 CY per lineal foot). Final design criteria and analysis will likely alter these estimates up or down. Assume haul will be less than 1,500 feet. Haul distances greater than 1,500 feet off site on road will substantially increase haul costs.
Channel earthwork and reshaping	LF	900	$50	$45,000	Assumes one-third of the length receives significant re-grading to create pool and riffle habitat.
Large wood purchased and delivered to site	EA	220	$400	$88,000	Asuumes 20% delivered with root wads attached. Frequency of LWD = >20 pieces/100 meters.
Boulder ballast purchased and delivered to site	EA	330	$100	$33,000	Assumes 1.5 - 2 yard boulders. Assumes 1.5 boulders per log.
Wood placement	EA	220	$300	$66,000	Wood placed in small jams and individual placements.
Streambank revegetation	SF	27,000	$1	$27,000	Assumes average of 5 feet on each bank for entire length.
Riparian revegetation (above bank)	AC	2.5	$15,000	$37,500	Assumes 20 feet revegetation on each side of channel. Includes follow-up maintenance.
Construction oversight	HR	450	$130	$58,500	Assumes 6 weeks of construction oversight, 12 hour days, 1.25 staff.
Construction Sub-Total				**$495,500**	
Concept Level Construction Contingency (20%)				$99,100	
Construction Total				**$594,600**	
Project Delivery					Items below are calculated as a percent of the construction sub-total
Permitting (4%)				$19,820	
Detailed Engineering Design (15%)				$74,325	
Contract Administation (5%)				$24,775	
Project Delivery Sub-Total				**$118,900**	
TOTAL ESTIMATE				**$714,000**	rounded to nearest $1,000

General Notes:

Cost includes a 20% construction contingency
Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source
Considerable savings could be gained by reducing the total length of the side-channel
Boulder ballast requirements may be able to be reduced depending on hydraulics analysis
Assumes no spawning gravel supplementation. Importing gravels will increase costs.

Key

LS = Lump sum
CY = Cubic yard
LF = Lineal foot
SF = Square foot
AC = Acre
EA = Each
FF = Face foot (square foot of bank face)
HR = Hours

EF 41

Riparian Restoration – Conceptual Design

Reach: EF Lewis 5A, 5B
River mile: 5.7 to 7.3
Reference page in main document: 61

Site Description

Riparian and floodplain vegetation along this 1.6 mile stretch of river (see overview map on page 4) has been impacted by past clearing, agricultural activities, stream channel changes, residential and commercial uses, and a proliferation of invasive species. Although there currently are patches of mature floodplain forest, much of the area is devoid of native riparian and floodplain vegetation. Invasive species, including primarily Himalayan blackberry and reed canary grass, dominate many areas and are preventing successional processes necessary for the establishment of climax species. A considerable amount of past planting has occurred in some areas by Clark County, local landowners, and restoration practitioners. Future planting work should build off of these efforts and should be conducted in close collaboration with landowners and other cooperating entities.

Restoration of native riparian, wetland, and floodplain forest communities is critical for the long-term recovery of stream habitat. Habitat in large alluvial river systems like the lower East Fork is heavily influenced by riparian and floodplain vegetation. Under natural conditions, these systems have a patchwork mosaic of vegetation types and ages that provide important natural structure and diversity for aquatic biota and terrestrial wildlife species. Vegetation helps to regulate channel adjustments and flood disturbance through the influence on overbank roughness and streambank stability. Trees recruited from riparian areas provide instream large woody debris that is important for aquatic habitat complexity. Trees also provide shade to cool stream temperatures and also serve important roles in the exchange of nutrients between river and floodplain/wetland areas.

To the extent possible, restoration of native vegetation should occur throughout the existing floodplain and channel migration zone of the river. Covering this extent will ensure that if and when the stream overflows its banks or re-adjusts its location that it will be buffered by mature forest vegetation. However, assuming that riparian restoration efforts will be phased, it will be important to first focus on restoring the following areas: 1) areas in close proximity to the river, 2) areas in and around connected off-channel habitat, and 3) areas with frequent overbank flows where vegetation roughness can moderate the potential for channel avulsion. A site map is attached that highlights a 200 foot riparian buffer that should be considered high priority for restoration. The extent of existing plantings, determined from aerial photo analysis, is also identified.

Typical condition of streambank through project area, with reed canary grass at water level, Himalayan blackberry covering streambanks, and scotchbroom up higher in dry areas.

Special Considerations

Due to rapid channel migration rates in this reach, it is possible that riparian plantings could be lost as a result of channel adjustments and erosion. Planting sites should therefore be prioritized based on the potential for loss. Combining this project with other project opportunities in this reach will alleviate the risk of loss in some areas. This is especially the case for projects EF-34 and EF-40, where there is currently rapid erosion of the unvegetated floodplain terrace and where habitat enhancement work would slow the rates of bank retreat. Other project opportunities in this reach include streambank and in-channel habitat enhancement work at EF-35, EF-36, and EF-37; and off-channel habitat enhancement at EF-38 and EF-39. All of these projects entail some degree of riparian enhancement. Planting activities at these sites should be coordinated with the broader riparian restoration objectives associated with this project.

Treatment Strategy and Alternatives

Recommended treatments:

- Establish a long-term riparian restoration plan in collaboration with Clark County and other landowners.
- Re-establish native riparian and floodplain forest vegetation to provide for long-term natural channel stability, shade, and LWD recruitment.
- Plant streambanks with native early-successional species including willow (*Salix* spp.), cottonwood (*Populus balsamifera*), dogwood (*Cornus stolonifera*), alder (*Alnus rubra*), and others. Plant above-bank areas with native hardwood and conifer species including alder (*Alnus rubra*), ash (*Fraxinus latifolia*), maple (*Acer macrophyllum*), fir (*Pseudotsuga menziesii*), cedar (*Thuja plicata*), and others.
- Focus initially on areas within a 200-foot buffer of the mainstem East Fork Lewis and connected off-channels. Expand efforts throughout the valley floor (channel migration zone and floodplain area) to the extent possible as time, resources, and landowner objectives allow.
- Work with Clark County to continue and expand past and on-going planting efforts.
- Incorporate considerations for waterfowl habitat, wetlands, and habitat for terrestrial species.

Alternatives:

- Available resources and landowner concerns will determine the specific locations of plantings and project phasing.

Expected Benefits – Limiting Factors Addressed

Physical habitat – This project addresses medium- and long-term physical habitat conditions including stream shade, bank stability, and large woody debris recruitment.

Biological – This project addresses medium- and long-term biological habitat conditions including reduction in stream temperature, reduced fine sediment contribution, enhanced channel stability, improved foraging opportunities for rearing fish, and enhanced habitat complexity and cover. All life-stages for all species will benefit from riparian enhancement.

Access and Landownership

Most of the project area to the south and west of the East Fork Lewis River is located on Clark County property. There are a few private parcels in this area. The north and east side of the river is primarily private land. No work will occur on private property without the consent of willing landowners. Access for riparian restoration can be obtained at numerous locations from both sides of the river throughout the project area.

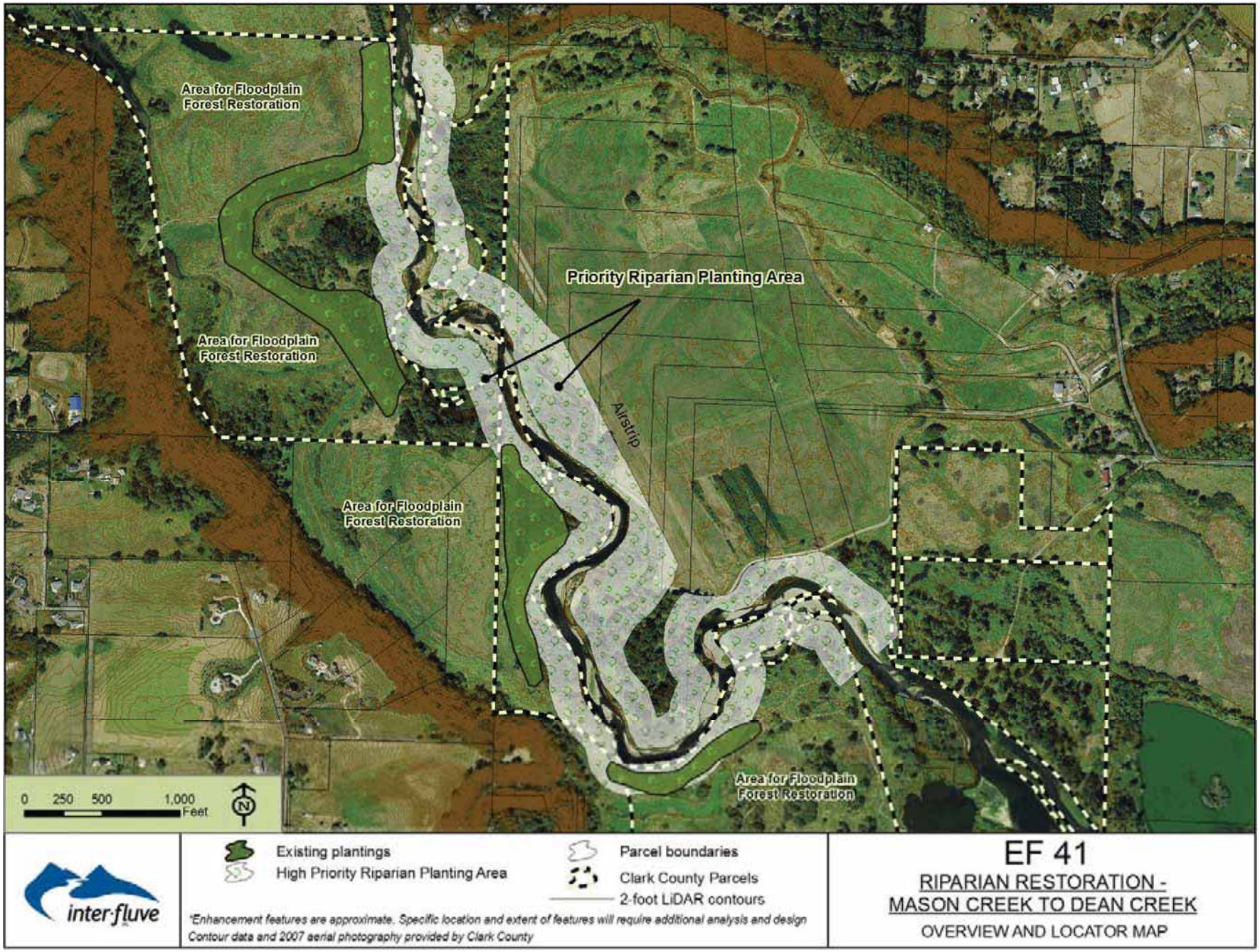
Data and Analysis Requirements

There have already been extensive plantings conducted by Clark County and others within the project area. There are also areas of existing mature forest vegetation. These areas will need to be mapped in order to determine specific locations for riparian plantings. Soil types and seasonal soil moisture conditions will need to be investigated through site evaluations and reference to Natural Resources Conservation Service soil classifications. Irrigation requirements will need to be determined and a method for providing irrigation will need to be developed, if necessary. Locations of future planned restoration activities should be determined in order to ensure that riparian plantings are not later removed by construction activities. Landowner uses and objectives, including future planned uses by Clark County, will need to be addressed as part of the design for the restoration plan.

LCFRB Habitat Strategy Summary

EF Lewis 5A						
Tier	**1**					
Length (m)	**2,076**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P	P	P	P	P	
Species Reach Potenial (H,M,L)	L	L	L	L	H	
Restoration Vaue	57%	27%	28%	50%	56%	44%
Preservation Value	43%	73%	72%	50%	44%	56%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	H	L	M	M	H	H
Off channel & side channel habitat	H	L	M	M	H	H
Floodplain function and channel migration processes	H	L	M	M	H	H
Riparian conditions & functions	H	L	M	M	H	H
Water quality	H	L	L	L	L	H
Instream flows	H	L	M	M	H	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	H	L	M	M	H	H

EF Lewis 5B						
Tier	**1**					
Length (m)	**579**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P	P	P	P	P	
Species Reach Potenial (H,M,L)	L	L	H	H	H	
Restoration Vaue	64%	30%	43%	93%	56%	57%
Preservation Value	36%	70%	57%	7%	44%	43%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	H	L	H	H	H	H
Off channel & side channel habitat	H	M	H	H	H	H
Floodplain function and channel migration processes	H	M	H	H	H	H
Riparian conditions & functions	H	M	H	H	H	H
Water quality	H	M	H	H	L	H
Instream flows	H	L	H	H	H	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	H	L	H	H	H	H


Area for Floodplain Forest Restoration
Priority Riparian Planting Area
Area for Floodplain Forest Restoration
Airstrip
Area for Floodplain Forest Restoration
Area for Floodplain Forest Restoration
0 250 500 1,000 Feet
N
inter·fluve
Existing plantings
High Priority Riparian Planting Area
Parcel boundaries
Clark County Parcels
2-foot LiDAR contours
*Enhancement features are approximate. Specific location and extent of features will require additional analysis and design
Contour data and 2007 aerial photography provided by Clark County
EF 41
RIPARIAN RESTORATION -
MASON CREEK TO DEAN CREEK
OVERVIEW AND LOCATOR MAP

Planning-level cost estimate for EF 41

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2009 costs.

Description	Unit	Quantity	Unit Cost	Total Cost	Comment
Streambank revegetation	SF	85,000	$0.75	$63,750	Assumes average of 10 feet on each bank for half the length of the segment. Economy of scale factored into unit cost.
Riparian revegetation (above bank)	AC	37	$8,000	$296,000	This includes planting within the 200 ft buffer on each side of the stream minus well-forested areas and minus existing plantings and avoiding infrastructure. Includes follow-up maintenance. Economy of scale factored into unit cost.
Implemenation Sub-Total				**$359,750**	
Concept Level Implementation Contingency (10%)				$35,975	
Implementation Total				**$395,700**	
Project Delivery					Items below are calculated as percent of construction sub-total
Permitting (0%)				NA	Assumes minimal to no permitting required
Detailed Design (5%)				$17,988	Includes development of a detailed planting plan and schedule
Contract Administation (5%)				$17,988	
Project Delivery Sub-Total				**$36,000**	
TOTAL ESTIMATE				**$432,000**	rounded to nearest $1,000

General Notes:

Cost includes a 10% implementation contingency

This estimate includes revegetation of a 200 foot buffer on each side of the stream along 1.6 stream miles. Costs could be reduced by reducing the extent of plantings.

Costs do not include plantings beyond the 200 foot buffer

Costs do not include wetland inventory and impacts analysis

Key

LS = Lump sum
CY = Cubic yard
LF = Lineal foot
SF = Square foot
AC = Acre
EA = Each
FF = Face foot (square foot of bank face)
HR = Hours

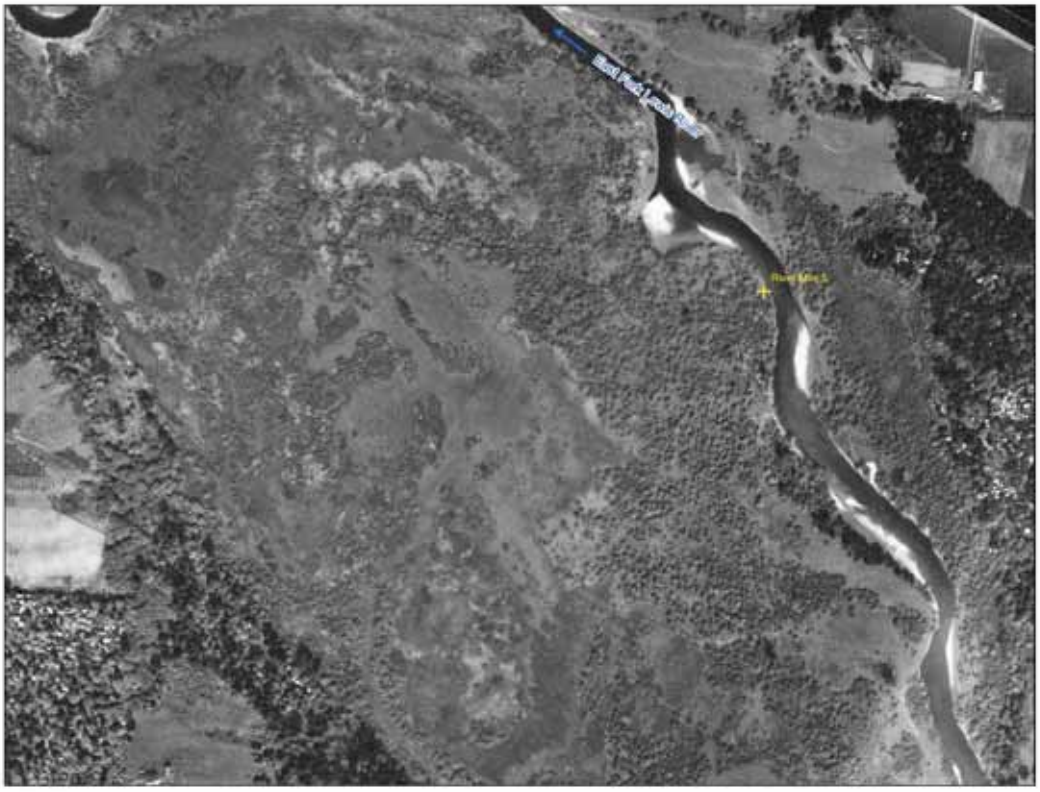
EF 42

Levee and Drainage Ditch Removal – Conceptual Design

Reach: EF Lewis 4B
River mile: 5.1
Reference page in main document: 61

Site Description

This is the levee and drainage ditch network near river mile 5 on the mainstem East Fork Lewis (see aerial overview on page 3). The levee is perpendicular to the river and extends from the west bank of the river across the entire valley floor to the hillslope toe. The levee appears to have been originally constructed primarily from local material, creating a drainage ditch network that drains the floodplain wetlands. The ditch and associated levee system was presumably created to support agriculture/ranching and possibly to provide flood control. The condition of the site in the 1939 can be seen in the aerial photograph below. Current land-use at the site no longer relies upon these improvements and removing the levee and drainage network will provide benefits to floodplain function, aquifer storage capacity, wetland habitat, and channel migration processes. As part of this project, it will be necessary to take into consideration the impacts on waterfowl habitat, wetlands, and habitat for terrestrial species. This project scored high in the project evaluation process due to its potential to benefit multiple species life-stages.



1939 aerial photograph of project area (see page 3 for 2007aerial photograph)

Treatment Strategy and Alternatives

Recommended treatments:

- Remove the levee and drainage network by refilling ditches with levee material. Haul any excess material to the toe of the hillslope or to an off-site disposal area.
- Restore riparian, wetland, and floodplain vegetation in the vicinity of the project area and in any areas disturbed during construction.

Alternatives:

- There may be opportunities to conduct wetland restoration in this area, possibly connecting off-channel wetlands to the mainstem. These opportunities should be investigated as part of project design.

Expected Benefits – Limiting Factors Addressed

Physical habitat – This project will provide enhanced floodplain function, aquifer storage capacity, and channel migration processes.

Biological – Restoration of aquifer storage capacity in the alluvial terrace will prolong inputs of cool groundwater flow into the mainstem as flows recede throughout the summer. Restoration of floodplain function and channel migration processes will restore natural habitat-forming processes. Wetland enhancements will improve conditions for wetland aquatic and terrestrial species.

Access and Landownership

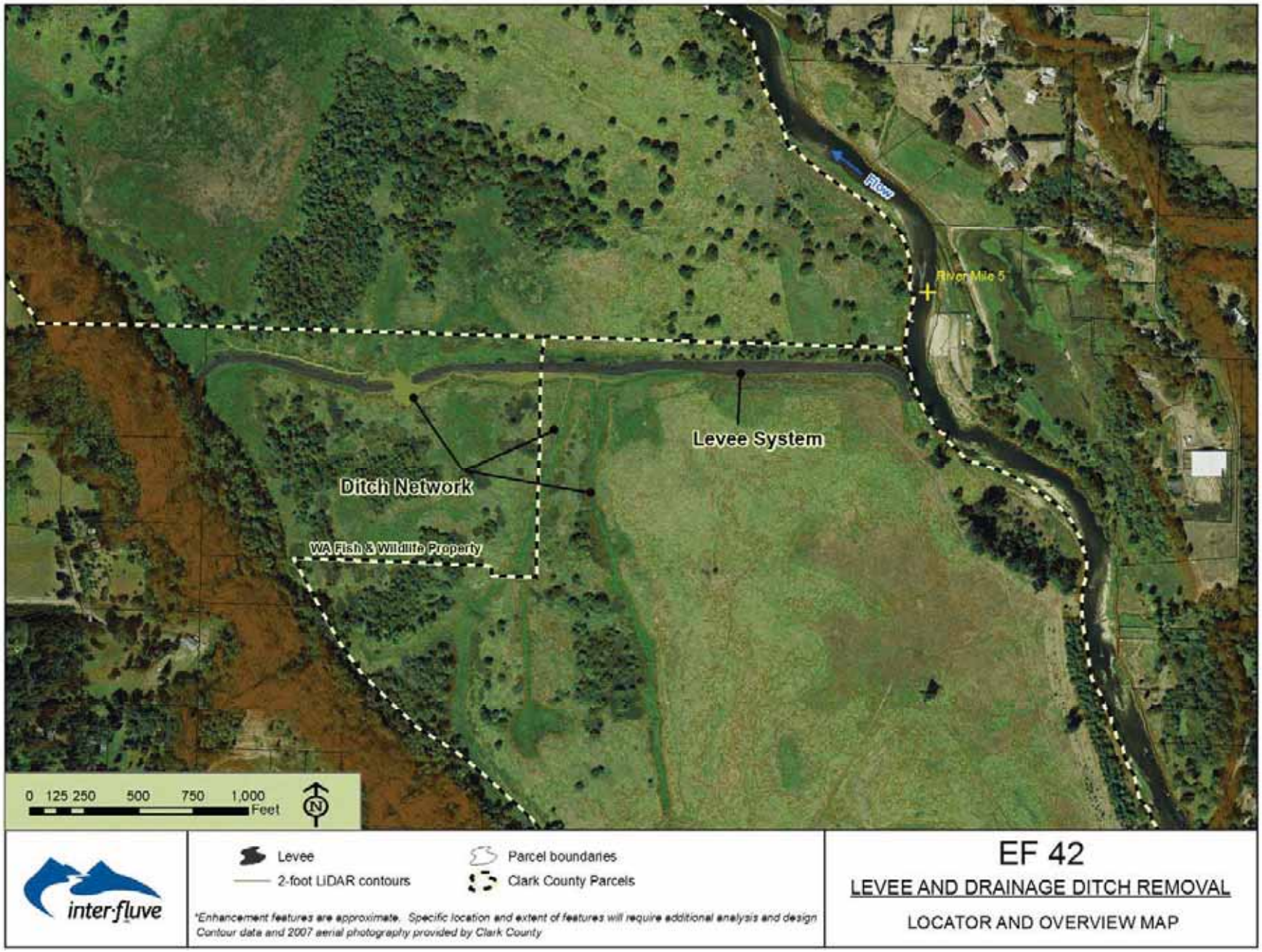
The project area spans Clark County and Washington Department of Fish and Wildlife properties. Access roads approach the site across County property from the north and the south.

Data and Analysis Requirements

A topographic survey will be needed to determine specific levee dimensions and earthwork requirements. This project assumes the levee was constructed of material on-site and that it can be removed by re-filling borrow trench with minimal hauling for disposal. Analysis of levee needs to be conducted to determine the quantity, if any, of non-local rock material. If large rock is found, it may require hauling off-site. Impacts on wetlands and terrestrial habitat should be evaluated.

LCFRB Habitat Strategy Summary

EF Lewis 4B						
Tier	**1**					
Length (m)	**853**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P	P	P	P	P	
Species Reach Potenial (H,M,L)	L	L	L	L	H	
Restoration Vaue	53%	50%	26%	54%	69%	50%
Preservation Value	47%	50%	74%	46%	31%	50%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	H	M	M	M	H	H
Off channel & side channel habitat	H	M	M	M	H	H
Floodplain function and channel migration processes	H	M	M	M	H	H
Riparian conditions & functions	H	M	L	M	H	H
Water quality	L	M	L	L	L	H
Instream flows	H	M	M	M	H	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	H	M	L	M	H	H


Flow
River Mile 5
Levee System
Ditch Network
WA Fish & Wildlife Property
0 125 250 500 750 1,000
Feet
N
inter·fluve
Levee
2-foot LiDAR contours
Parcel boundaries
Clark County Parcels
*Enhancement features are approximate. Specific location and extent of features will require additional analysis and design
Contour data and 2007 aerial photography provided by Clark County
EF 42
LEVEE AND DRAINAGE DITCH REMOVAL
LOCATOR AND OVERVIEW MAP

Planning-level cost estimate for EF 42

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2009 costs.

Description	Unit	Quantity	Unit Cost	Total Cost	Comment
Mobilization and demobilization	LS	1	$5,000	$5,000	Calculated at 5% of construction sub-total.
Doze levee into borrow holes	CY	15,000	$4.50	$67,500	Assumes bulldozed within 200 feet of levee.
Channel earthwork and reshaping	LF	3,500	$4	$14,000	Fine Grading and finish work.
Revegetation	AC	4	$5,000	$20,000	Assumes re-seeding of site and low planting density. Assumes revegetation in disturbed areas only.
Construction oversight	HR	40	$130	$5,200	Assumes 40 hours of total oversite.
Construction Sub-Total				**$111,700**	
Concept Level Construction Contingency (20%)				$22,340	
Construction Total				**$134,000**	
Project Delivery					Items below are calculated as a percent of the construction sub-total
Permitting (4%)				$4,468	
Detailed Engineering Design (15%)				$16,755	
Contract Administation (5%)				$5,585	
Project Delivery Sub-Total				**$26,800**	
TOTAL ESTIMATE				**$161,000**	rounded to nearest $1,000

General Notes:

Cost includes a 20% construction contingency
Assumes 15,000 cubic yards of material is moved
Costs do not include wetland inventory and impacts analysis
Assumes no access road construction is necessary

Key

LS = Lump sum
CY = Cubic yard
LF = Lineal foot
SF = Square foot
AC = Acre
EA = Each
FF = Face foot (square foot of bank face)
HR = Hours

EF-A 01

Ridgefield Pits Alternatives Assessment – Conceptual Design

Reach: EF Lewis 6B, Dyer Cr 1 and 2
River mile: 7.3 - 8.3
Reference page in main document: 73

Assessment Project Description

During the flood of 1996, the East Fork Lewis River avulsed into a series of gravel mine pits (aka Ridgefield Pits) which it continues to occupy. As a result of stream capture, approximately 4,000 lineal feet of key spawning and rearing habitat have been lost and there are significant concerns with respect to other habitat factors including temperature, sediment transport, channel dynamics, and invasive species. Due to historical gravel mining in this area, there is a very large deficit of valley bottom material. The stream now courses through a series of large deep ponds that favor invasive and predatory species. The riparian and floodplain area is severely degraded and overrun with invasive plant species. The purpose of this assessment is to collect information to help evaluate alternatives for re-configuring this reach to enhance habitat. The information gathered will also help clarify opportunities and constraints associated with both active and passive restoration strategies in this area.

The objectives of the Ridgefield Pits Alternatives Assessment are the following:

1) Evaluate alternatives for this reach that will enhance habitat conditions and recover channel function to the extent possible. Alternatives should range from no-action to full reach re-configuration.
2) Develop conceptual designs for restoration alternatives. These might also include designs for restoration alternatives in lower Dyer Creek.
3) Conduct field data collection and technical analyses that are necessary to support the above objectives.

Data Collection and Analysis

The following data collection and analysis activities will be necessary to support the alternatives assessment. These activities have some overlap with data collection and analysis tasks outlined as part of the Daybreak Pits Avulsion Risk Assessment (project #EF-A 02). Conducting these assessments in tandem would reduce the total time and costs.

Site Topographic Survey

- Conduct a topographic survey of the key features of the site. The project area is bounded by the valley wall to the southwest and the Daybreak Pits area to the northeast, and encompasses approximately 200 acres. The survey will need to cover the entire valley bottom in order to conduct hydraulics analysis; however, a detailed topographic survey is not required and LiDAR data will likely be adequate for extending the survey data to areas far from the current river channel. The survey will need to primarily focus on the 200 acres that make up the spatial extent of potential treatments and will need to include key features such as terrace topography, levees, and the dimensions of the Ridgefield Pits. This data will be used to determine cut and fill quantities that may be associated with various treatment alternatives. Cross sections and channel profiles will be needed to support hydraulic analysis. Water surface elevations and the elevation of surface expressions of groundwater should be surveyed in order to calibrate the hydraulic model and to support the analysis. Data from past topographic surveys and available LiDAR data should be incorporated into the survey if these data sources are deemed accurate, up-to-date, and useful for the study.

Hydrology and Hydraulics

- Determine river flow volumes for a range of flood recurrence intervals to be used in the alternatives assessment. Develop flow duration relationships to be used in hydraulic analysis. Much of this information has been compiled as part of past investigations but should be updated with recent flow data.
- A hydraulic model will need to be developed in order to evaluate flow and sediment transport conditions through the reach. Hydraulic modeling will be used to evaluate existing conditions as well as the treatment alternatives that are developed as part of this effort. Hydraulic modeling should build off of existing hydraulics analysis to the extent possible. It is assumed that existing hydraulic models available for the site will require significant revision due to recent channel changes and may therefore have limited utility in this analysis; however, they may be useful for obtaining model parameters.
- Flood inundation extents at a range of flow levels should be mapped throughout the project area and depicted on aerial photo maps.
- Groundwater flow conditions, including the seasonal elevation of water tables and the transmissivity of streambed and terrace deposits should be characterized throughout the site. These data will help determine the required elevations, dimensions, and boundary material composition for treatment alternatives that require construction of new channels through the site. Groundwater analysis will require sampling wells and test pits throughout the floodplain terrace area.

Sediment Transport and Geomorphic Analysis

- Substrate and sediment sampling will be required at multiple locations throughout the site to characterize the erodibility of riverbed, riverbank, and floodplain materials. These data will support incipient motion calculations used to characterize bed and bank mobility conditions for the existing condition and the various restoration alternatives.
- Equilibrium sediment conditions should be characterized to determine trends in sediment aggradation and incision. This will require estimating potential sediment volumes contributed from upstream sources. It is assumed that the volume of upstream-derived sediment needed for the analysis can be estimated without completing a detailed sediment budget for the basin.
- Evaluate the rate of filling of the Ridgefield Pits by comparing post-avulsion pit volumes to current pit volumes and by using sediment budget and transport data. Update existing estimates (WEST 2001) of the time required for the river to naturally fill the pits.
- Estimate the ability of the river to transport sand and larger material through the avulsed reach at a range of flows. Estimate the amount of bed material likely to be trapped within the ponds and determine the likely impact to the stream reach below the pits.
- Historic flooding and channel migration conditions should be characterized. Historic conditions, in combination with existing conditions and land-use, can help to identify treatment alternatives that may be well-suited to the site.
- Build off of existing analyses (e.g. WEST 2001). Include a review of past assumptions and data sources and incorporate newer data.

Aquatic Species Surveys

- Conduct presence/absence surveys for salmon and trout and other important aquatic species, such as western pond turtles and red-legged frogs. Conduct surveys also for invasive and predatory species within the Ridgefield Pits and in upstream and downstream locations.

Temperature Monitoring

- Temperature monitoring should be conducted to determine the temporal and spatial temperature profile of the mainstem river in relationship to the ponds. This assessment overlaps with the Temperature and Groundwater Assessment (EF-A 03) and will be covered under that project if it is carried forward.
- Two loggers will be placed in each pond (top and bottom of the water column) to establish the temperature profile of each captured mine pit. As many as 14 data loggers will be placed throughout the reach to detect changes in temperature related to the captured mine pits. At least 1 temperature logger will collect ambient air temperatures throughout the season.
- The temperature monitoring period will extend from June 1st to October 31st. Logger calibration and deployment will follow WA Department of Ecology temperature monitoring protocol. Logger locations will be geo-referenced using GPS waypoints and aerial photographs, and other notes regarding their specific location.

Evaluation of Treatment Alternatives

Treatment alternatives will be determined as part of the analysis and in consideration of stakeholder objectives. A few of the potential treatment alternatives that might be considered are included below. The alternatives to be evaluated range from no-action to full reach re-configuration. These alternatives will be evaluated as to their impact on channel processes and habitat conditions. There will likely be additional alternatives or combination alternatives that will be developed as part of the analysis.

- No action: This alternative should be considered in the analysis and evaluated with respect to existing and future impacts on aquatic species.
- Habitat enhancement within the existing alignment: This alternative assumes that no major site re-configuration occurs but that existing habitat is enhanced to the extent possible. Enhancement activities may include, but are not limited to: 1) installation of habitat features (e.g. LWD, boulders) in the channel and pond areas, 2) restoration of riparian, floodplain, and wetland vegetation, including control of invasive species, 3) manipulation of connected ponds to maximize rearing conditions, and 4) pumping or otherwise routing cool groundwater flow into the pits to reduce high summer temperatures.
- Fill ponds: Completely or partially fill existing ponds using local and off-site materials. It will be necessary to ensure that materials within the maximum scour-depth of the channel are appropriately-sized to satisfy sediment transport and habitat requirements. Material from other projects, such as levee removals, excavation for wetlands, or excavation for off-channel rearing could potentially be used to fill the pits. Required volumes, sources, and costs should be provided, as well as the potential effects on channel processes and habitat.
- Isolate the pits from the river: This alternative would use fill material to isolate the pits from the existing river channel. The channel would be left more or less in its current location. The river channel itself could be potentially filled to

restore the long profile, or left to refill on its own. For this alternative, it will be necessary to evaluate 1) the effects of continued subsurface connection with the pits, 2) potential for re-avulsion into the pits, and 3) the effect of impacts to flooding and channel migration processes.

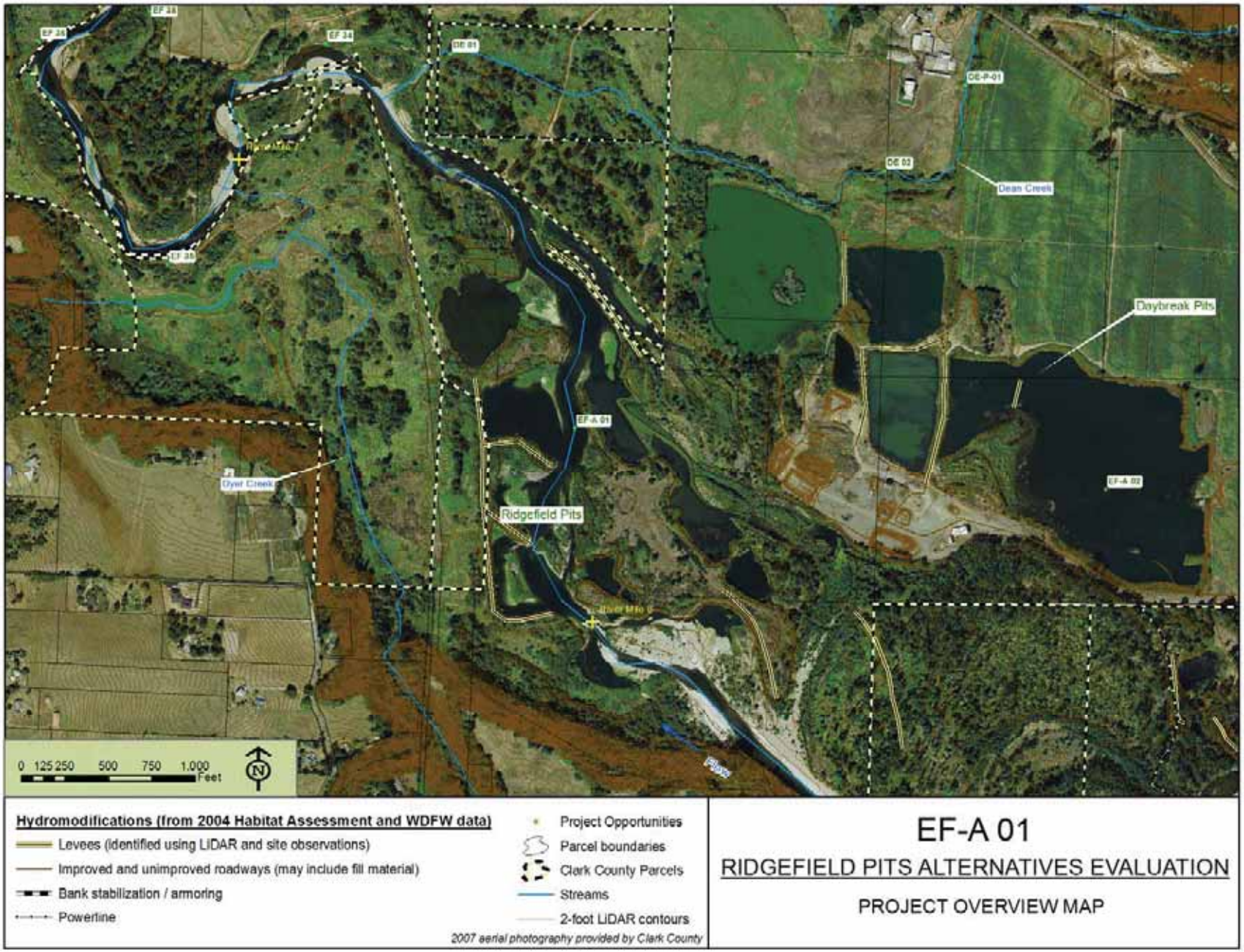
- Re-route the river channel: This alternative would completely re-route the river out of the pits and into a new alignment, either into its pre-1996 channel (to the north) or to the south of the existing channel location. The considerations listed for the previous alternative also apply to this alternative.
- Full site re-configuration: There may be multiple options for site re-configuration that would require less import of material than complete re-filling of the pits. For example, it may be possible to fill the pits with floodplain material to establish a pool-riffle low-flow channel with a frequently inundated 'lowered' floodplain that continues to collect overbank material and re-build grade over time. Such alternatives would require comprehensive hydraulic and geomorphic investigations to determine their likelihood of success and impacts to short-term and long-term habitat conditions.

It is likely that some of the alternatives will have an impact on lower Dyer Creek, which flows through the site at the downstream end (south/west side) of the project area. Potential impacts to Dyer Creek, and any recommended habitat enhancements, should be included in the analysis of each alternative.

A recommended treatment alternative should be developed as part of this evaluation and carried forward to the 30% design level.

Access and Landownership

Access can be obtained at multiple locations throughout the site. Boat access will be required for bathymetric surveys of the mainstem East Fork Lewis River channel through the Ridgefield Pits. This site spans private and Clark County lands. No work will occur without the consent of willing landowners.


EF 33
EF 34
DE 01
DE-P-01
DE 02
Dean Creek
Daybreak Pits
EF-A 01
EF-A 02
Dyer Creek
Ridgefield Pits
0 125 250 500 750 1,000 Feet
N
Hydromodifications (from 2004 Habitat Assessment and WDFW data)
Levees (identified using LIDAR and site observations)
Improved and unimproved roadways (may include fill material)
Bank stabilization / armoring
Powerline
Project Opportunities
Parcel boundaries
Clark County Parcels
Streams
2-foot LIDAR contours
2007 aerial photography provided by Clark County
EF-A 01
RIDGEFIELD PITS ALTERNATIVES EVALUATION
PROJECT OVERVIEW MAP

Planning-level cost estimate for EF-A 01

Note: This is a preliminary cost estimate for planning purposes. Actual costs may vary substantially from these estimates. This estimate is based on assumptions for time requirements and material quantities. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates are based on 2009 costs.

Description	Unit	Quantity	Unit Cost	Total Cost	Comment
Site Topographic Survey	LS	1	$24,000	$24,000	Includes a crew of 3 for 1.5 weeks of surveying. Assumes existing survey data can be used for portions of the site where channel (or other) changes have not occurred.
Data Reduction and Analysis	LS	1	$4,000	$4,000	Includes CAD time and data QA/QC
Hydrology and Hydraulics	LS	1	$15,000	$15,000	Assumes 3 weeks for a hydrologist / engineer. Includes development of a hydraulic model.
Sediment Transport Analysis	LS	1	$15,000	$15,000	Assumes 0.5 week field work for two staff and 2 weeks analysis from an engineer/geomorphologist
Groundwater Monitoring	LS	1	$16,000	$16,000	Assumes 6 groundwater wells are installed and 6 test pits/pump tests are conducted. Includes purchase of data loggers and logger servicing (deployment and retrieval)
Geomorphology Analysis	LS	1	$10,000	$10,000	Assumes 2 weeks for a professional fluvial geomorphologist
Aquatic Species Surveys	LS	1	$14,000	$14,000	Assumes 2 weeks and two staff for field work and data processing
Temperature monitoring	LS	1	$10,000	$10,000	Assumes 14 data loggers. Includes equipment, deployment, retrieval, and data reduction.
Development and Evaluation of Treatment Alternatives	LS	1	$20,000	$20,000	Includes selection of a preferred alternative. Assumes 2 weeks for 2 professional engineers / fluvial geomorphologists
30% Level Design for Preferred Alternative	LS	1	$30,000	$30,000	Assumes CAD and engineering time for 15 design sheets
Implementation Sub-Total				**$158,000**	
Concept Level Implementation Contingency (20%)				$31,600	
Implementation Total				**$189,600**	
Project Delivery					Items below are calculated as a percent of the construction sub-total
Development of final report (15%)				$23,700	
Contract Administation (5%)				$7,900	
Project Delivery Sub-Total				**$31,600**	
TOTAL ESTIMATE				**$221,000**	rounded to nearest $1,000

General Notes:

Cost includes a 20% implementation contingency

All costs are figured on hourly rates of contracted workers. Entities conducting these activities in-house may be able to realize cost savings depending on hourly rates.

Costs do not include meetings with stakeholders, presentations, or multiple revisions of materials

Costs do not include wetland inventory and impacts analysis

Costs do not include any permitting

Time and resource efficiencies can be gained by conducting this project in conjunction with EF-A 02

Key

LS = Lump sum

EF-A 02

Daybreak Pits Avulsion Risk Assessment – Conceptual Design

Reach: EF Lewis 6A, 6B, 6C, 7, 8A
River mile: 7.3 - 9.5
Reference page in main document: 74

Assessment Project Description

The Daybreak Pits are previously-mined floodplain gravel pits located to the north and east of the mainstem East Fork Lewis River between river miles 7.5 and 9.0. The pits pose a potential risk of stream channel avulsion into the pits (i.e. "pit capture") which could result in significant loss of important habitat in both the short and long-term. An avulsion risk assessment at this site was identified as the highest priority action in the lower river by the East Fork Lewis Working Group. Past work to evaluate the risk of pit capture and to identify mitigation alternatives has been conducted by WEST Consultants (2001); however, a more up-to-date and comprehensive analysis is warranted in order to fully characterize avulsion risks and to identify treatment alternatives to address risk. This project will be impacted by work conducted as part of the Storedahl Daybreak Mine Expansion Habitat Conservation Plan. It will be necessary to coordinate this project with these efforts.

The objectives of the Daybreak Pits Avulsion Risk Assessment are the following:

1) Describe potential pit capture scenarios and the levels of risk associated with each scenario.
2) Describe measures to protect against pit capture while also enhancing habitat and river processes.
3) Conduct field data collection and technical analyses that are necessary to support the above investigations.

This project was moved to the top of the ranked project list, above other higher scoring projects, because of its importance to preserving the integrity of the entire lower river. This decision was made by the East Fork Lewis Working Group.

Data Collection and Analysis

The following data collection and analysis activities will be necessary to support this assessment. These activities have some overlap with data collection and analysis tasks outlined as part of the Ridgefield Pits Alternatives Assessment (project #EF-A 01). Conducting these assessments in tandem would reduce the total time and costs.

Site Topographic Survey

- Conduct a topographic survey of the key features of the site. The analysis area encompasses over 700 acres if you consider the entire valley floor throughout this reach; but the entire area does not need a detailed topographic survey. The survey should focus on the channel and any hydraulic flow paths (potential avulsion paths) through the site, as well as the dimensions of levees, roadways, and the existing Daybreak Pits. Cross sections and channel profiles will be needed to support hydraulic analysis. Water surface elevations and the elevation of surface expressions of groundwater should be surveyed in order to calibrate the hydraulic model and to support the analysis. Data from past topographic surveys and available LiDAR data should be incorporated into the survey if these data sources are deemed accurate, up-to-date, and useful for the study.

Hydrology and Hydraulics

- Determine river flow volumes for a range of flood recurrence intervals to be used in the risk assessment. Develop flow duration relationships to be used in hydraulic analysis. Much of this information has been compiled as part of past investigations but should be updated with recent flow data.
- A hydraulic model should be developed in order to evaluate flow velocities, energy gradients, and shear stress along banks. Hydraulic modeling should build off of existing hydraulics analysis to the extent possible. It is assumed that existing hydraulic models available for the site will require significant revision due to recent channel changes and may therefore have limited utility in this analysis; however, they may be useful for obtaining model parameters.
- Flood inundation extents at a range of flow levels should be mapped throughout the project area and depicted on aerial photo maps.

Sediment Transport and Geomorphic Analysis

- Substrate and sediment sampling will be required at multiple locations throughout the site to characterize erodibility of riverbed, riverbank and floodplain materials. These data will support incipient motion calculations used to characterize bed and bank mobility conditions in the mainstem as well as avulsion risk potential in floodplain/overbank areas.
- Characterize equilibrium sediment conditions in the reach to determine trends in sediment aggradation or incision. This will require estimating potential sediment volumes contributed from upstream sources. It is assumed that the volume of upstream-derived sediment needed for the analysis can be estimated without completing a detailed sediment budget for the basin.
- Identify the location of historic flow paths and the past and current channel migration zone. Characterize past and expected future rates of channel migration.

- Evaluate the rate of filling of the Ridgefield Pits and identify how pit filling will affect channel dynamics and erosion/avulsion potential within the reach.
- Evaluate the effects of a potential future pit capture on local, upstream, and downstream beneficial uses. This will require an analysis of the potential extent of upstream headcut progression in the main channel if a pit capture were to occur and the length of time it would take for the pits to naturally fill with riverbed material. This analysis should build off of existing assessment work conducted by WEST (2001).
- Build off of existing analyses (e.g. WEST 2001). Include a review of past assumptions and data sources and incorporate newer data.

Aquatic Species Surveys

- Conduct presence/absence surveys within abandoned ponds for salmon and trout and other important aquatic species, such as western pond turtles and red-legged frogs, to support project planning and impacts analysis.

Identification of Risk of Pit Capture

The data and site analyses will be used to identify potential pit capture scenarios and their associated levels of risk. Potential erosion sites and avulsion paths will be described and identified on aerial photo maps. Cross-sections and profiles will be included that portray site topography, elevation of flood flow paths, and significant landscape features. Risk of pit capture scenarios will be based on the hydraulics, sediment, and geomorphology analyses and will be framed in terms of flood recurrence and duration potential, with considerations for changes in the level of risk given potential future channel adjustment.

Evaluation of Treatment Alternatives

Treatment alternatives will be determined as part of the analysis and in consideration of stakeholder objectives. A few of the potential treatment alternatives that might be considered are included below:

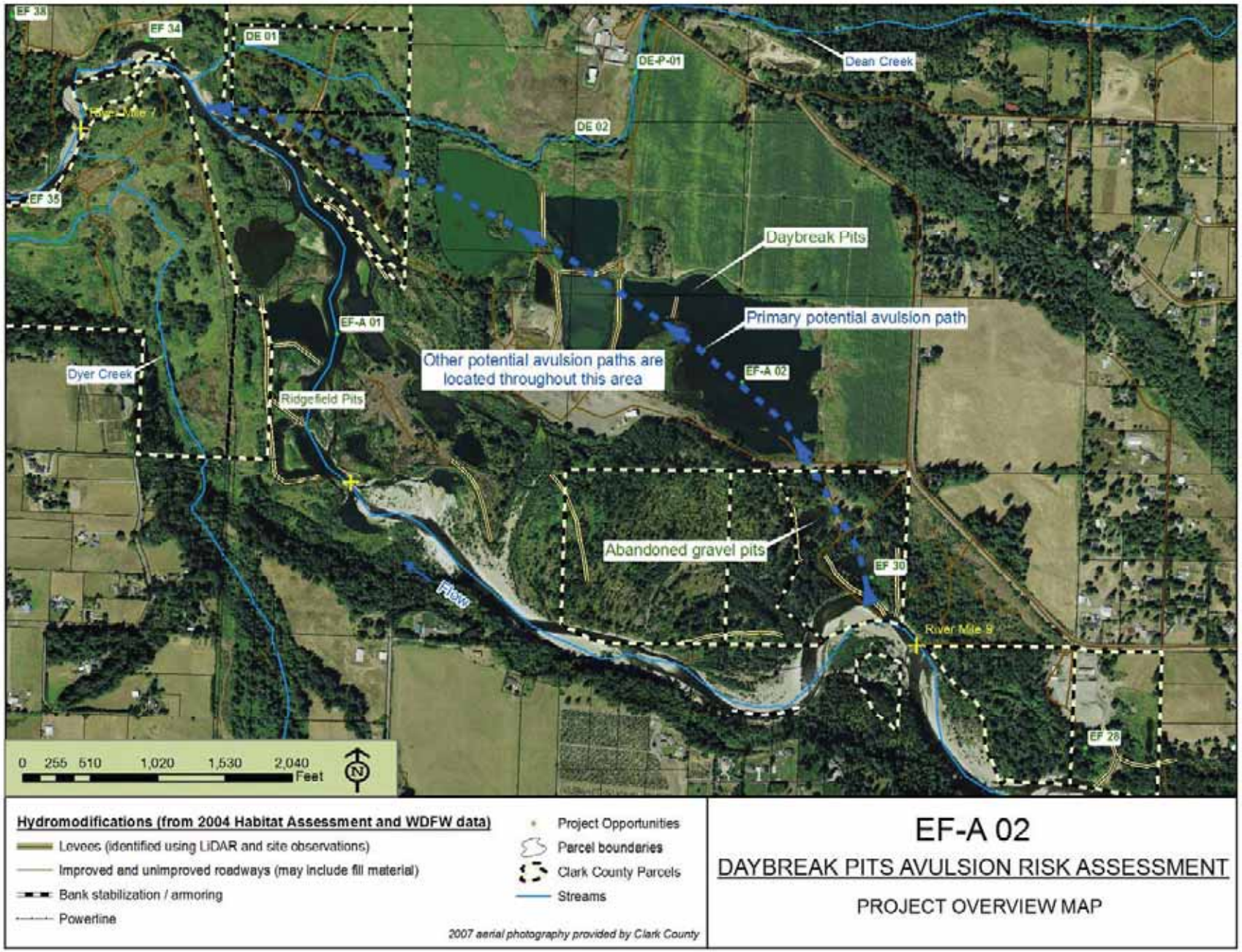
- No action: This alternative should be considered in the analysis. A no action alternative should only be recommended if the risk analysis shows very little risk of pit avulsion.
- Defined CMZ: This alternative includes establishing a channel migration zone with a northeast boundary defined by levees and other features that will ensure the prevention of pit capture but will allow the river to migrate and flood within a defined CMZ.
- Channel avulsion control: This alternative would include techniques for increasing floodplain roughness along overbank flow paths in order to reduce shear stresses and to reduce the risk of headcutting that would initiate an avulsion. Techniques might also include the containment and control of overbank flows into well-defined and stabilized flow paths that are resistant to erosion/avulsion.
- Control of lateral migration: This alternative would be considered if lateral channel migration potential shows a risk of erosion into the pits. Lateral erosion can be controlled by a number of different channel and bank treatments using natural and artificial materials.
- Other: There are other sub-treatments that may be combined with the strategies listed above or utilized on their own to control risk of pit capture, reduce impacts in the case of pit capture, and/or to improve habitat conditions. These include removal of remnant levees in the floodplain and filling of the pits to reduce the impacts of an avulsion if it were to occur. It is anticipated that there will be other treatments that are identified and evaluated as part of the assessment.

Treatment alternatives will need to consider any actions that are taken to restore the Ridgefield Pits reach. Treatment alternatives are likely to impact lower Dean Creek. The impact on the lower Dean Creek channel and habitat conditions needs to be considered as part of the assessment.

A recommended treatment alternative should be developed as part of this evaluation and carried forward to the 30% design level.

Access and Landownership

Access can be obtained at multiple locations throughout the site. Boat access will be required for bathymetric surveys of the mainstem East Fork Lewis River channel and the Daybreak Pits. This site spans private and Clark County lands. No work will occur without the consent of willing landowners.


EF 33
EF 34
DE 01
DE-P-01
Dean Creek
DE 02
EF 35
Daybreak Pits
Primary potential avulsion path
EF-A 01
Other potential avulsion paths are located throughout this area
EF-A 02
Dyer Creek
Ridgefield Pits
Abandoned gravel pits
EF 30
Flow
River Mile 9
EF 28
0 255 510 1,020 1,530 2,040 Feet
N
Hydromodifications (from 2004 Habitat Assessment and WDFW data)
Levees (identified using LiDAR and site observations)
Improved and unimproved roadways (may include fill material)
Bank stabilization / armoring
Powerline
Project Opportunities
Parcel boundaries
Clark County Parcels
Streams
2007 aerial photography provided by Clark County
EF-A 02
DAYBREAK PITS AVULSION RISK ASSESSMENT
PROJECT OVERVIEW MAP

Planning-level cost estimate for EF-A 02

Note: This is a preliminary cost estimate for planning purposes. Actual costs may vary substantially from these estimates. This estimate is based on assumptions for time requirements and material quantities. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates are based on 2009 costs.

Description	Unit	Quantity	Unit Cost	Total Cost	Comment
Site Topographic Survey	LS	1	$36,000	$36,000	Includes a crew of 3 for 2 weeks of surveying. Assumes existing survey data can be used for portions of the site where channel (or other) changes have not occurred.
Data reduction and analysis	LS	1	$5,000	$5,000	Includes CAD time and data QA/QC
Hydrology and Hydraulics	LS	1	$20,000	$20,000	Assumes 4 weeks for a hydrologist / engineer. Includes development of a hydraulic model.
Sediment Transport Analysis	LS	1	$20,000	$20,000	Assumes 1 week field work for two staff and 2 weeks analysis from an engineer/geomorphologist
Geomorphology Analysis	LS	1	$10,000	$10,000	Assumes 2 weeks for a professional fluvial geomorphologist
Aquatic Species Surveys	LS	1	$7,000	$7,000	Assumes 1 week and two staff for field work and data processing
Identification of Risk of Pit Capture	LS	1	$10,000	$10,000	Includes synthesis of data to characterize risk of pit capture scenarios. Assume 2 weeks for a professional engineer / geomorphologist
Development and Evaluation of Treatment Alternatives	LS	1	$20,000	$20,000	Includes selection of a preferred alternative. Assumes 2 weeks for 2 professional engineers / fluvial geomorphologists
30% Level Design for Preferred Alternative	LS	1	$30,000	$30,000	Assumes CAD and engineering time for 15 design sheets
Implementation Sub-Total				**$158,000**	
Concept Level Implementation Contingency (20%)				$31,600	
Implementation Total				**$189,600**	
Project Delivery					Items below are calculated as a percent of the construction sub-total
Development of final report (15%)				$23,700	
Contract Administation (5%)				$7,900	
Project Delivery Sub-Total				**$31,600**	
TOTAL ESTIMATE				**$221,000**	rounded to nearest $1,000

General Notes:

Cost includes a 20% implementation contingency

All costs are figured on hourly rates of contracted workers. Entities conducting these activities in-house may be able to realize cost savings depending on hourly rates.

Costs do not include meetings with stakeholders, presentations, or multiple revisions of materials

Costs do not include wetland inventory and impacts analysis

Costs do not include any permitting

Time and resource efficiencies can be gained by conducting this project in conjunction with EF-A 01

Key

LS = Lump sum

EF-A 03

Temperature and Groundwater Assessment – Conceptual Design

Reach: Lower mainstem EF Lewis and tributaries
River mile: 0.0 to 14.5
Reference page in main document: 75

Assessment Project Description

This conceptual study design describes stream temperature and groundwater monitoring and assessment activities that will support the identification and development of stream habitat enhancement efforts within the Lower East Fork Lewis River Basin. This project was moved forward to the conceptual design phase in front of other higher scoring projects because of its relevance to project planning in the basin (East Fork Lewis Working Group decision).

Summer temperatures in the mainstem East Fork Lewis are known to exceed the preferred range for salmon and trout. Although temperature assessment work has been conducted in the lower EF Lewis River as part of the WA Department of Ecology TMDL study, and other monitoring efforts, additional information is needed to support the development of restoration actions within the lower river. Specifically, there is a need to comprehensively describe the spatial and temporal distribution of the mainstem river temperature profile and the influence that cold/warm water sources have on the overall river temperature. Data is also needed to detect and describe potential sources for cold water refuge habitat in the lower river that may provide critical rearing conditions during periods of near-lethal water temperatures.

In combination with stream temperature assessment, groundwater monitoring is also necessary to help identify and prioritize potential habitat restoration areas that receive inputs of cool groundwater / hyporheic flow throughout the summer. These areas may include abandoned wall-based channels, old meander scars, or floodplain wetlands. Groundwater assessment should focus on areas where topographic, hydrologic, and geomorphic conditions suggest the potential for groundwater-fed off-channel areas. Monitoring will involve the installation of groundwater monitoring wells used to track water table elevations and groundwater temperatures throughout the dry period.

Implementation of this temperature and groundwater assessment is not an absolute requirement for restoration project advancement; however, this information will enhance the ability to compare project cost/benefit; and for projects that are carried forward, it will provide a robust dataset to be used in project design.

Species and Life Stages Addressed:

Steelhead, coho - summer rearing. All species and all freshwater life-stages affected to some degree

Limiting Factors Addressed:

Temperature, key habitat quantity, habitat diversity

Assessment Design & Data Collection

Baseline Temperature Monitoring

The objective of the baseline monitoring is to describe the spatial and temporal distribution of the mainstem river temperature profile and the influence that cold/warm water sources have (if any) on the overall river temperature. The results of this assessment can be used to pinpoint areas of cool water input that might be targeted for habitat enhancements or areas of warm water input that should be the target of temperature restoration efforts.

Temperature logger installed to monitor a cold water habitat site

- Deploy continuous electronic temperature data loggers (i.e. HOBO) throughout the Lower East Fork Lewis River to describe the temporal and spatial temperature profile of the Lower River (RM 0.0 – RM 15.0).
- Build off of existing data collected by agencies and restoration practitioners.
- Survey period should extend from June 1st to October 31st. Logger calibration and deployment should follow WA Dept of Ecology temperature monitoring protocol and should include monthly data downloads to QA/QC equipment and reduce data loss.
- Data loggers should be installed at regular intervals in the mainstem (e.g. every mile) in thermally mixed waters. Loggers should be placed in order to determine tributary temperature influence (if any) on mainstem temperatures. A logger should be installed at the base of each tributary; and in the larger tributaries, a logger should be placed upstream where the tributary enters the East Fork valley bottom and experiences a change in channel and vegetation conditions. Logger locations should also be placed to correspond to locations used in the past for the TMDL or other monitoring efforts. The estimated number of temperature loggers required for mainstem, tributary, and off-channel monitoring is approximately 50. This does not include extensive sampling in the tributaries. See attached figures for initial recommended logger locations.
- Additional temperature information should be collected in the Ridgefield Pits reach to support restoration planning in that

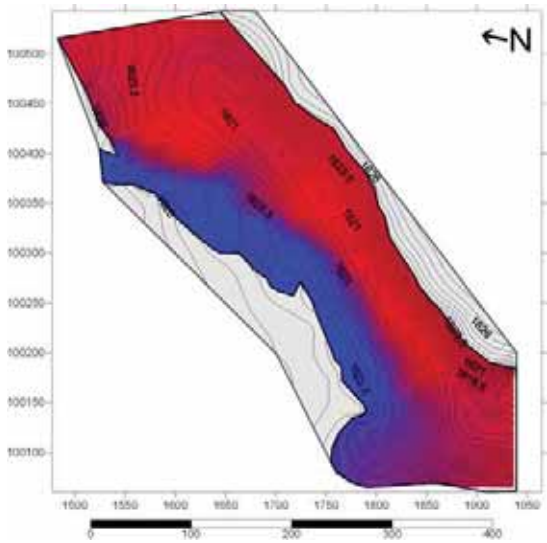
reach. Two loggers should be placed in each pond (one near the surface and the other near the bottom) to establish the temperature profile of each captured mine pit. At least 14 loggers should be placed throughout the reach in the mainstem river to detect changes in temperature related to the captured mine pits.

- Logger locations should be geo-referenced using GPS waypoints and aerial photographs, and other notes regarding their specific location.
- At least 2 temperature loggers should be used to collect ambient air temperatures throughout the season.
- An alternative assessment option is to conduct a thermal imaging flight (i.e. FLIR) for the mainstem East Fork Lewis. This alternative has been considered in the past by WA Department of Ecology. A thermal imaging assessment could provide useful information on the spatial variation of surface temperatures. This alternative warrants further consideration.

Detection and Monitoring of Thermal Refuge and Groundwater Sources

The objective of this portion of the assessment is to identify and describe persistent cold water refugia throughout the project area. Initial reconnaissance surveys are conducted throughout the mainstem and off-channel areas. Once a potential cold water location is identified, temperature loggers are installed.

- Reconnaissance level cold water habitat detection surveys can be conducted using a digital or calibrated handheld thermometer (accuracy of $\pm 0.3^{o}C$). Any habitat feature with a temperature of $2.0^{o}C$ colder than the mainstem temperature should be flagged for further investigation.
- Reconnaissance surveys should be conducted at all the existing significant off-channel areas and on the mainstem, especially where topographic features suggest the potential for spring inflow (e.g. where topo lines denote depressions).
- Reconnaissance surveys need to be conducted during the warmest part of the day (12:00-4:00 pm) and during the warmest period of the year (July – August).
- Continuous data loggers should be deployed at sites identified during the reconnaissance survey to monitor for cold water persistence over the balance of the survey season. GPS coordinates should be collected to map the site. Additional habitat features such as shade measurement, water quality (D.O., pH, and mineral content) should also be collected depending on site conditions.



Example of cool patch location in off-channel area

Groundwater / Hyporheic Flow Monitoring

Multiple sites have been identified for potential enhancement along the lower mainstem that may provide off-channel rearing and temperature refuge for steelhead, coho, and Chinook. These include wall-based channels, abandoned side-channels, flood overflow channels, previous main channel locations, and floodplain wetlands. For many of these sites, observations suggest there is suitable groundwater connectivity; however, specific water table depths, temperatures, water quality, and seasonal groundwater flow rates are unknown. Monitoring at these sites will help to identify suitable enhancement project locations and will support project design. In particular, information on groundwater table elevations and flow rates will help to determine the depth of required excavation for off-channel creation projects and will help determine the need for other design features such as groundwater collection galleries.

- Recommended sites for groundwater monitoring are included in the attached figures. A total of 20 well locations are included at a total of 9 sites. These sites should be considered a preliminary list of sites that may be amended depending on more detailed site investigations and depending on the potential for future project work at the site.
- Sampling should target low water periods, typically July through September.
- Sampling can be conducted using electronic continuous data recorders to record water table elevation (stage) as well as temperature. At most sites, two or more wells should be used, one nearer the main channel (e.g. beginning of the backwater channel/scar) and one at the more distant end of paleo-channel features or wetlands. Additional wells will be needed for large sites. Multiple wells at a site helps to portray a complete picture of water table elevations and also allows for the calculation of groundwater flow rates / substrate transmissivity.
- Groundwater wells will typically require an excavator or backhoe to install, but in some sites they may be able to be installed using hand tools. Access conditions may limit the ability to install wells at some sites.
- The electronic data recorders should be downloaded once during mid-sampling season and given QA/QC review in order to reduce data loss.

- Water quality parameters for dissolved oxygen, mineral content, and pH can also be collected at sites that are fed by groundwater but that have little surface flow influence in order to detect potential water quality concerns that would affect aquatic biota.
- Logger locations should be geo-referenced using GPS waypoints and aerial photographs, and other notes regarding their specific location.

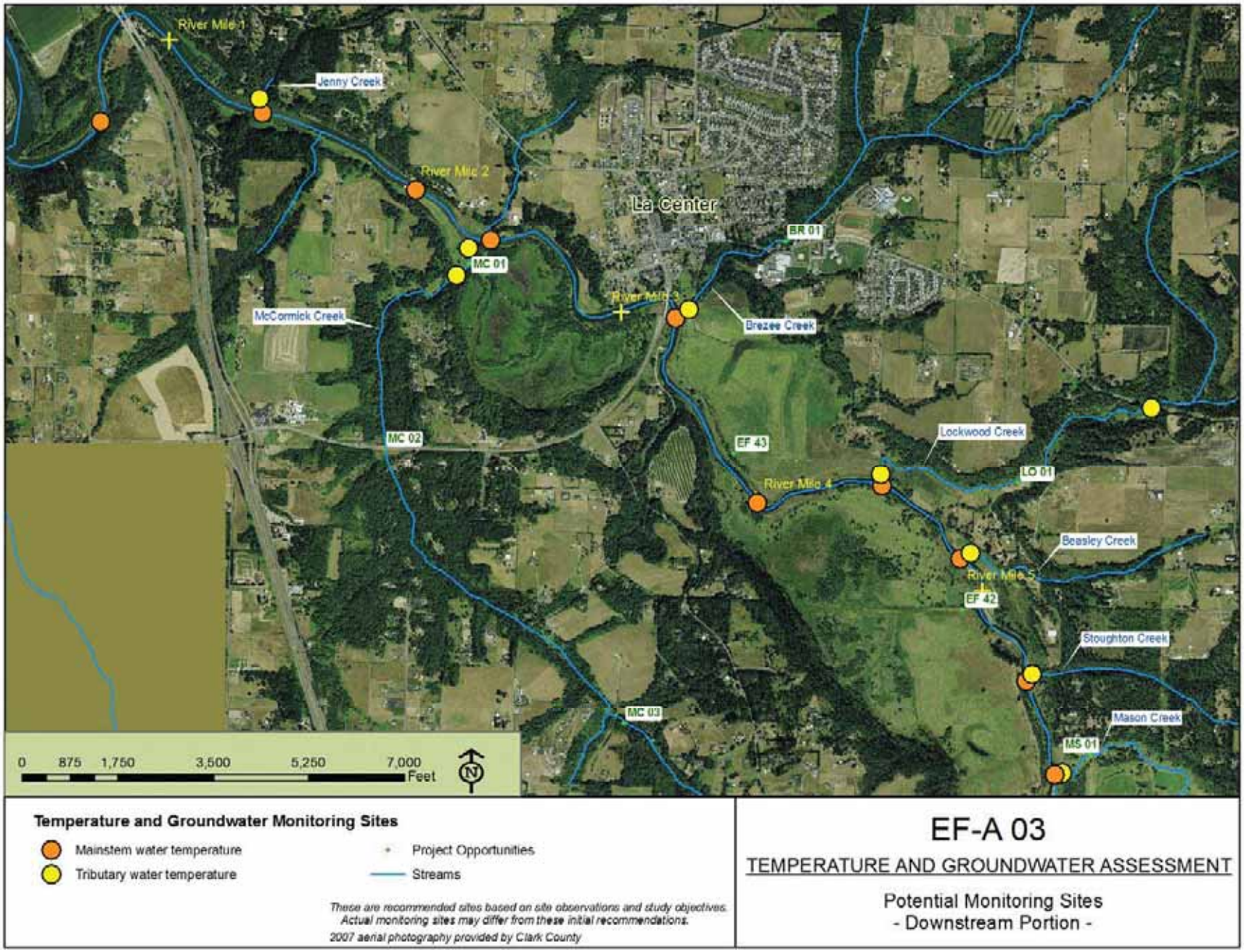
Access and Landownership

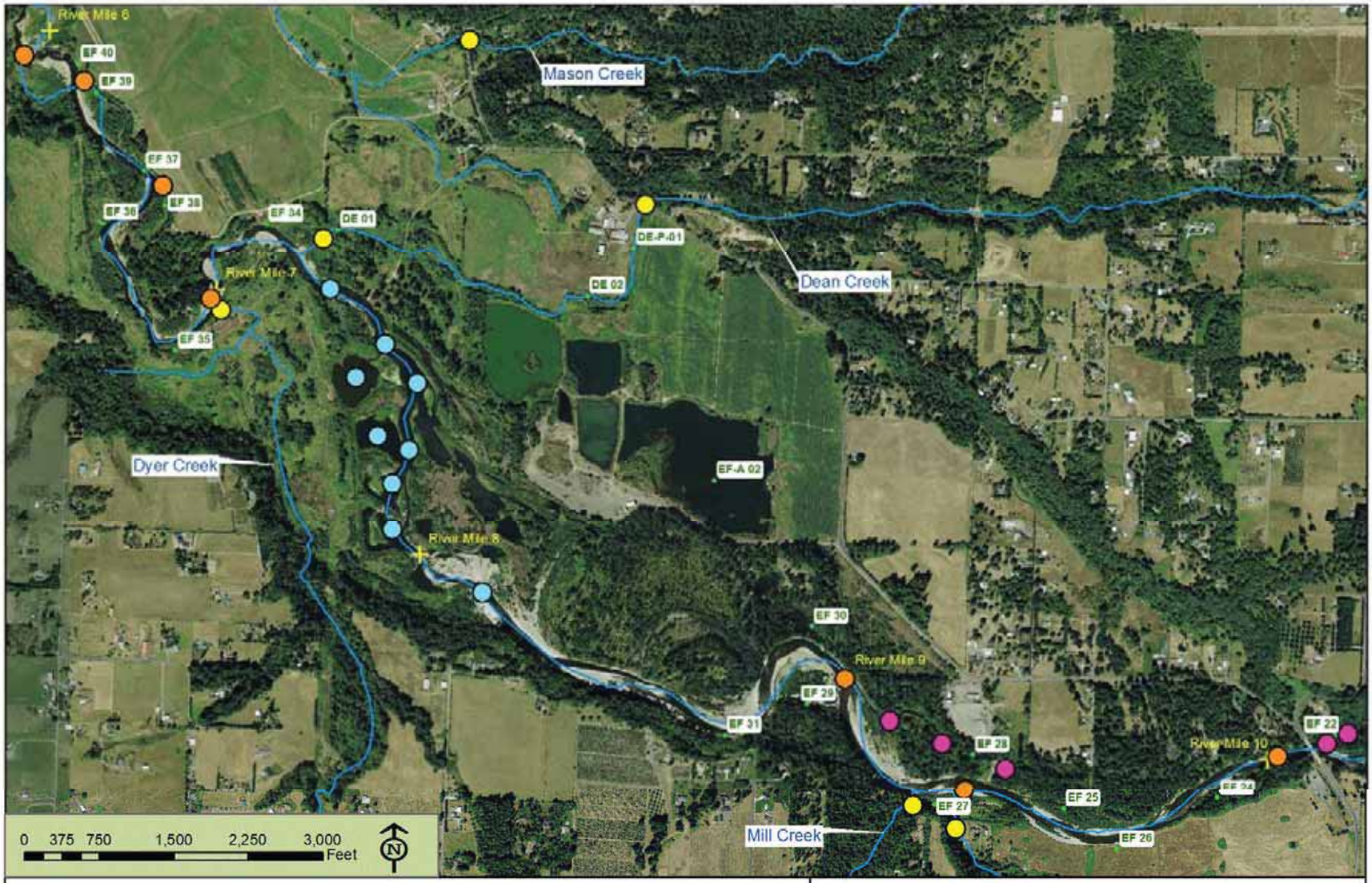
Some potential monitoring sites are located on private lands. No temperature or groundwater monitoring work will be conducted without full landowner willingness.

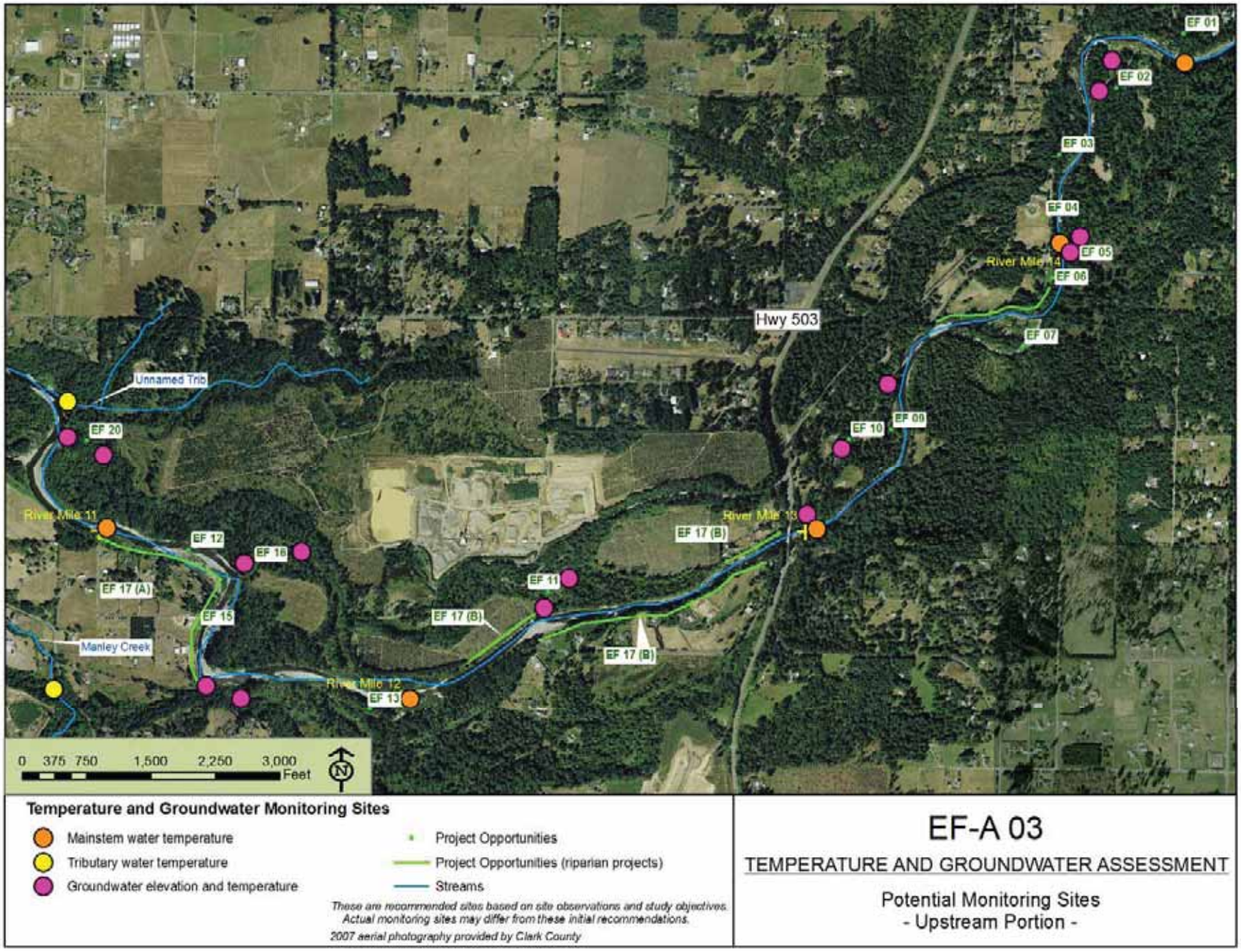
Data and Analysis Requirements

Temperature Analysis: Temperature data should be stored in a computer database and GPS locations should be downloaded into a Geographical Information System (GPS) and overlaid onto digital aerial photographs. Prior to analysis, data from each logger will require QA/QC to identify and remove any anomalous data. Data analysis should include calculation of the maximum 7-day maximum (max 7DMAX) and maximum 7-day average (max 7DAVG) for the period of monitoring, as well as other metrics as determined as part of the study. Results should include a detailed description of the temperature profile (maximum and average) throughout the sampling season in both the mainstem and off-channel sites and identification of persistent cold water sites.

Groundwater Analysis: Well data should be stored in a computer database and GPS locations should be downloaded into ArcGIS and overlaid onto digital aerial photographs. Prior to analysis, data from each logger will require QA/QC to identify and remove any anomalous data. Data analysis will determine water table elevations, thermal profiles at the site, low-season flow volumes and residence time of water traveling through the project area.


River Mile 1
Jenny Creek
River Mile 2
La Center
BR 01
MC 01
McCormick Creek
River Mile 3
Brezee Creek
MC 02
EF 43
Lockwood Creek
LO 01
River Mile 4
Beasley Creek
River Mile 5
EF 42
Stoughton Creek
MC 03
Mason Creek
MS 01
0 875 1,750 3,500 5,250 7,000 Feet
N
Temperature and Groundwater Monitoring Sites
Mainstem water temperature
Tributary water temperature
Project Opportunities
Streams
These are recommended sites based on site observations and study objectives. Actual monitoring sites may differ from these initial recommendations.
2007 aerial photography provided by Clark County
EF-A 03
TEMPERATURE AND GROUNDWATER ASSESSMENT
Potential Monitoring Sites
- Downstream Portion -


River Mile 6
EF 40
EF 39
Mason Creek
EF 37
EF 38
EF 36
EF 34
DE 01
DE-P-01
River Mile 7
DE 02
Dean Creek
EF 35
Dyer Creek
EF-A 02
River Mile 8
EF 30
River Mile 9
EF 29
EF 31
EF 28
EF 22
River Mile 10
EF 27
EF 25
EF 24
EF 26
Mill Creek
0 375 750 1,500 2,250 3,000 Feet
N
Temperature and Groundwater Monitoring Sites
Mainstem water temperature
Tributary water temperature
Groundwater elevation and temperature
Ridgefield Pits focus area
Project Opportunities
Streams
These are recommended sites based on site observations and study objectives.
Actual monitoring sites may differ from these initial recommendations.
2007 aerial photography provided by Clark County
EF-A 03
TEMPERATURE AND GROUNDWATER ASSESSMENT
Potential Monitoring Sites
- Middle Portion -


EF 01
EF 02
EF 03
EF 04
EF 05
EF 06
EF 07
EF 08
EF 10
EF 11
EF 12
EF 13
EF 15
EF 16
EF 17 (A)
EF 17 (B)
EF 17 (B)
EF 17 (B)
EF 20
Hwy 503
River Mile 14
River Mile 13
River Mile 12
River Mile 11
Unnamed Trib
Manley Creek
0 375 750 1,500 2,250 3,000
Feet
N
Temperature and Groundwater Monitoring Sites
Mainstem water temperature
Tributary water temperature
Groundwater elevation and temperature
Project Opportunities
Project Opportunities (riparian projects)
Streams
These are recommended sites based on site observations and study objectives.
Actual monitoring sites may differ from these initial recommendations.
2007 aerial photography provided by Clark County
EF-A 03
TEMPERATURE AND GROUNDWATER ASSESSMENT
Potential Monitoring Sites
- Upstream Portion -

Planning-level cost estimate for EF-A 03

Note: This is a preliminary cost estimate for planning purposes. Actual costs may vary substantially from these estimates. This estimate is based on assumptions for time requirements and material quantities. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates are based on 2009 costs.

Description	Unit	Quantity	Unit Cost	Total Cost	Comment
Monitoring Design Development	LS	1	$5,000	$5,000	Includes preparation of detailed sampling plan and schedule
Baseline sampling: temperature logger purchase	EA	50	$150	$7,500	Includes mainstem and tributary surface water temperature sites
Baseline sampling: logger deployment supplies and prep	EA	50	$25	$1,250	Includes time and materials for preparing deployments
Baseline sampling: temperature logger servicing	LS	1	$18,000	$18,000	Assumes 3 site visits to each of 50 locations for 1) deployment, 2) mid-season download and QA/QC, 3) retrieval. (contracted wages)
Cold water refugia sampling: temperature logger purchase	EA	15	$150	$2,250	Assumes monitoring of 15 cold water refugia sites
Cold water refugia sampling: field reconnaissance	LS	1	$7,500	$7,500	Does not include tributary surveys (mainstem and connected off-channels only). (contracted wages)
Cold water refugia sampling: temperature logger servicing	LS	1	$1,500	$1,500	Only retrieval. Assumes deployment covered in reconnaissance.
Groundwater monitoring: logger purchase	EA	20	$600	$12,000	Used in wells for monitoring water table elevation and water temperature
Groundwater monitoring: well materials	EA	20	$100	$2,000	PVC, accessories, and tools for construction
Groundwater monitoring: well construction	EA	10	$3,000	$30,000	Assumes 10 sites with 2 wells per site. Assumes a small excavator or backhoe is used to dig wells. Assumes easy access conditions.
Groundwater monitoring: logger servicing	LS	1	$6,000	$6,000	Assumes 3 site visits to each of 20 locations for 1) deployment, 2) mid-season download and QA/QC, 3) retrieval. (contracted wages)
Data reduction and analysis	LS	1	$5,000	$5,000	Includes data entry, QA/QC, and basic data analysis
Implementation Sub-Total				**$98,000**	
Concept Level Implementation Contingency (20%)				$19,600	
Implementation Total				**$117,600**	
Project Delivery					Items below are calculated as a percent of the construction sub-total
Development of final report (15%)				$14,700	
Contract Administation (5%)				$4,900	
Project Delivery Sub-Total				**$19,600**	
TOTAL ESTIMATE				**$137,000**	rounded to nearest $1,000

General Notes:

Cost includes a 20% implementation contingency

This estimate assumes only basic data analysis and reporting is conducted. In-depth analysis and correlation of data with environmental variables is not included.

This estimate does not include water quality monitoring of parameters other than water level and temperature.

Assumes an excavator or backhoe is necessary to dig wells into gravel/cobble substrate. Savings could be gained if wells can be dug with hand tools.

Reducing the number of sites will reduce costs

Key

LS = Lump sum

EA = Each

MN 02

Manley Creek Habitat Enhancement – Conceptual Design

Reach: Manley Creek 1B - 1C
River mile: 0.2 to 0.75
Reference page in main document: 69

Site Description

This site is located on lower Manley Creek below 259th Street. This reach follows the south margin of the EF Lewis floodplain located between EF Lewis river miles 9.5 and 10. The site is located on County property (Lower Daybreak). There is a concurrent master planning effort for this site that will have to be considered when developing proposed treatments in this reach. It is estimated that historically Manley Creek entered the EF Lewis further upstream from its present location, although the exact location of the historical alignment is unknown. The lower section of the creek was likely realigned against the valley wall to accommodate agriculture / grazing uses. The current channel alignment has been relatively unchanged at least since the 1939 aerial photograph series.

Beaver pond complexes in lower section of MN 02.

Vegetative conditions along Manley Creek in the reach aligned with the valley wall include a relatively intact riparian canopy and a mix of native and invasive understory species. In this reach, instream habitat structure is lacking though several beaver dam complexes are present which lend habitat complexity. It is likely that the presence of the beaver dam complexes in combination with road crossings (culverts) and previous damned ponds have limited incision in Manley Creek. In the upper section of the project reach, the channel alignment departs from the valley wall and has been significantly impacted by prior land use practices including a road crossing. Riparian vegetation and habitat conditions are severely degraded, lacking canopy trees and dominated by invasive reed canary grass and Himalayan blackberry. Instream habitat quality is poor due to highly simplified channel conditions that lack structure and cover. Current average channel slope for this site is 0.3%.

This site offers a good opportunity to restore a low gradient tributary that will potentially provide suitable channel habitat for a range of life history needs (spawning, rearing, high flow refugia) for coho, steelhead and chum (potential). This project scored high in the project evaluation process due to its benefit to multiple species life-stages and due to its large size. Although the project is located in a Tier 2 reach, the project was ranked as a Tier 1 reach due to its potential to benefit fish originating in downstream Tier 1 reaches (i.e. Lower Manley and the mainstem EF Lewis).

Treatment Strategy and Alternatives

Recommended treatments:

- Select grading and channel realignment in the upper portion (1,500 ft) of the reach. Create pool-riffle sequences. Install habitat enhancement features including large woody debris.
- Enhance habitat conditions in the lower section of the project reach through supplemental addition of large woody debris.
- Remove or retrofit the existing road crossing in the upper section of the reach if consistent with future use of the property.
- Control invasive species and restore native riparian habitat.

Alternatives:

- There are numerous channel re-alignment alternatives that could be considered in order to accomplish restoration objectives and to accommodate future land-use at the site.
- Connected backwater channels could be constructed along the southern side of the channel in order to enhance off-channel rearing habitat and to collect cool springflow from the valley-wall.
- It would be possible to only treat a portion of the project reach (e.g. the upstream portion that is most degraded) or to phase treatments over time as available resources allow.

Examples of typical restored channels

Expected Benefits – Limiting Factors Addressed

Physical habitat – 1) Enhanced quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris, 2) Enhanced availability of tributary habitat throughout the year, 3) Enhanced stream shading, 4) Enhanced channel stability.

Biological – 1) Enhanced winter high flow refuge for coho and steelhead, 2) Enhanced spawning for coho and steelhead, with potential benefits to chum spawning, 3) Enhanced quantity and quality of cool-water summer rearing for coho and steelhead, 4) Increased habitat complexity and cover for rearing fish that will provide diverse foraging opportunities and protection from predators, 5) Improved fish passage conditions.

Access and Landownership

The property is currently owned by Columbia Land Trust, with a memorandum of understanding with Clark County that the property will eventually be transferred to County ownership. Projects need to be consistent with the County's master planning process at this site. Projects need to take into consideration the future of the house that is located at the site, bank erosion, flood damage protection, and the relationship with potential future recreation facilities. Mitigation credits should be pursued. Additional funding sources may be available. Access can be obtained from 259th Street at the upstream end and from the existing access road that enters the west end of the site off of 259th Street. The project will need to be developed in conjunction with the park master planning process at this site and the proposed bank stabilization project (West Daybreak) on the mainstem EF Lewis.

Data and Analysis Requirements

Detailed site survey, hydraulic analysis, flood inundation analysis, and a geomorphic assessment will be required to support final designs. Effects of past and potential future inputs of fine sediment originating from the TEBO mine should be evaluated as to the potential impact on habitat conditions in the project reach. Prior to habitat enhancement work, there needs to be assurance that no significant future inputs of fine sediment will occur. Habitat enhancements will be subject to significant potential impact from beavers; these impacts should be addressed as part of project design.

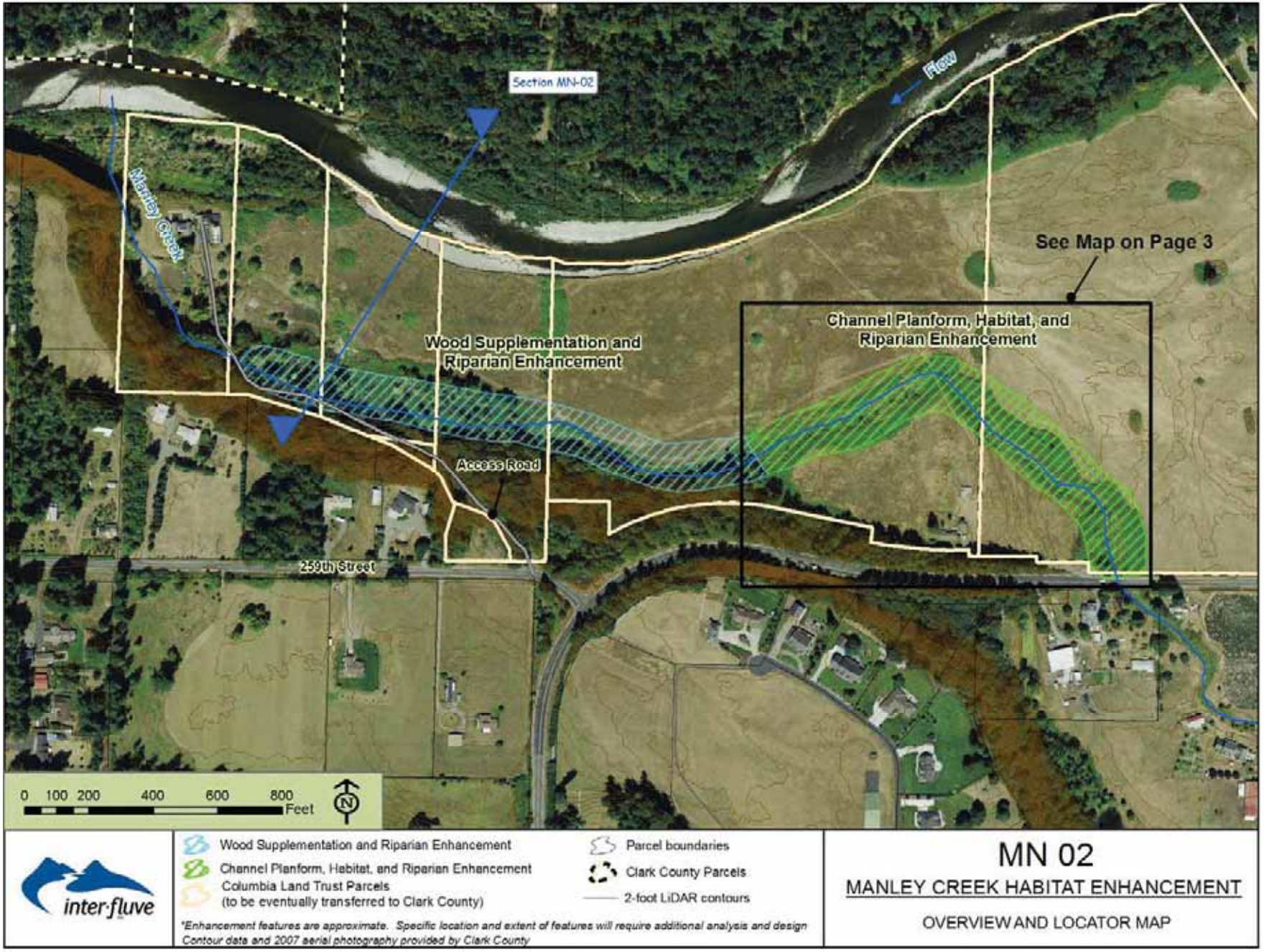
LCFRB Habitat Strategy Summary

Manley Cr 1B						
Tier	**2**					
Length (m)	**708**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P			P	P	
Species Reach Potenial (H,M,L)	L			M	L	
Restoration Vaue	30%			91%	72%	64%
Preservation Value	70%			9%	28%	36%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	M	-	-	H	M	H
Off channel & side channel habitat	M	-	-	H	M	H
Floodplain function and channel migration processes	M	-	-	H	M	H
Riparian conditions & functions	M	-	-	H	M	H
Water quality	M	-	-	M	L	H
Instream flows	M	-	-	H	M	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	M	-	-	H	H	H

Manley 1C						
Tier	**2**					
Length (m)	**676**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P			P	P	
Species Reach Potenial (H,M,L)	L			M	L	
Restoration Vaue	27%			92%	72%	64%
Preservation Value	73%			8%	28%	36%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	M	-	-	H	H	H
Off channel & side channel habitat	M	-	-	H	H	H
Floodplain function and channel migration processes	M	-	-	H	H	H
Riparian conditions & functions	M	-	-	H	H	H
Water quality	M	-	-	M	M	H
Instream flows	M	-	-	H	H	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	M	-	-	H	H	H

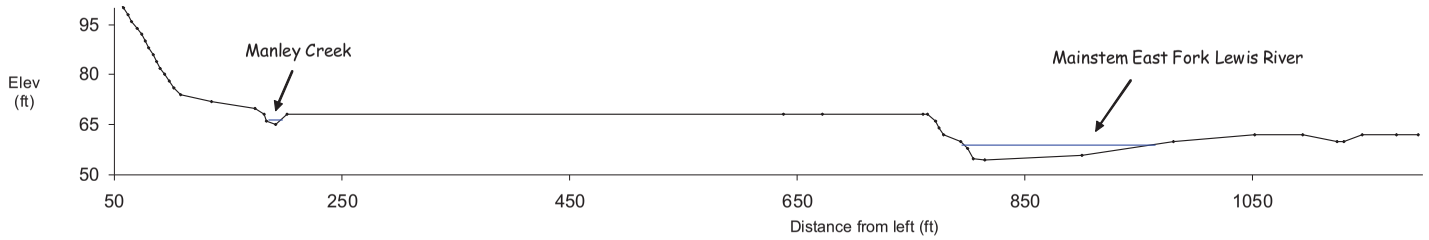
Manley 1A						
Tier	**1**					
Length (m)	**241**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P			P	P	
Species Reach Potenial (H,M,L)	L			H	L	
Restoration Vaue	40%			92%	72%	68%
Preservation Value	60%			8%	28%	32%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	M	-	-	H	M	H
Off channel & side channel habitat	H	-	-	H	M	H
Floodplain function and channel migration processes	M	-	-	H	M	H
Riparian conditions & functions	H	-	-	H	M	H
Water quality	H	-	-	H	L	H
Instream flows	H	-	-	H	M	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	H	-	-	H	H	H

Note: Manley Creek 1A is included due to the benefit of this project for rearing for fish that originate in Manley 1A . This project was ranked as a Tier 1 reach in order to reflect this benefit.

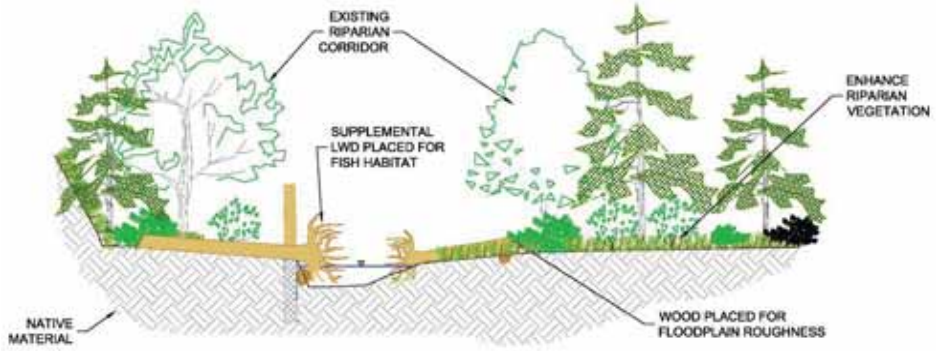

Section MN-02
Flow
Manley Creek
See Map on Page 3
Wood Supplementation and Riparian Enhancement
Channel Planform, Habitat, and Riparian Enhancement
Access Road
259th Street
0 100 200 400 600 800 Feet
N
inter·fluve
Wood Supplementation and Riparian Enhancement
Channel Planform, Habitat, and Riparian Enhancement
Columbia Land Trust Parcels
(to be eventually transferred to Clark County)
Parcel boundaries
Clark County Parcels
2-foot LiDAR contours
*Enhancement features are approximate. Specific location and extent of features will require additional analysis and design
Contour data and 2007 aerial photography provided by Clark County
MN 02
MANLEY CREEK HABITAT ENHANCEMENT
OVERVIEW AND LOCATOR MAP


Approximate extent of floodplain, channel, and riparian enhancements
0 25 50 100 150 200
Feet
N
inter·fluve
Stream channel location
Extent of floodplain and riparian enhancements
Bar formation
Log placements
*Enhancement features are approximate. Specific location and extent of features will require additional analysis and design
Contour data and 2007 aerial photography provided by Clark County
MN 02
MANLEY CREEK HABITAT ENHANCEMENT
DETAIL OF HABITAT ENHANCEMENTS

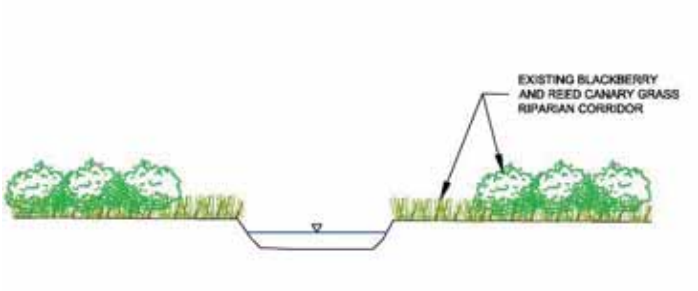
Cross-Section MN-02



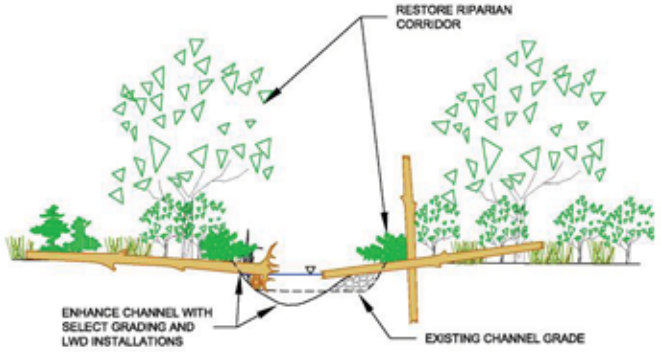
Typical Enhancement Section View– Lower Reach



Typical Existing Condition Section View– Upper Reach



Typical Enhancement Section View– Upper Reach



inter·fluve	*CROSS-SECTIONS AND TYPICALS* ***Notes:*** *Cross-section MN-02 is derived from LiDAR contours. Bathymetry is estimated based on site and aerial photograph observations. In some cases, minor corrections are made to LiDAR data that is believed to be representative of vegetation and not the ground surface.*	MN-02 INSTREAM HABITAT ENHANCEMENT

Planning-level cost estimate for MN 02

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2009 costs.

Description	Unit	Quantity	Unit Cost	Total Cost	Comment
Mobilization and demobilization	LS	1	$13,000	$13,000	Calculated at 5% of construction sub-total
Channel earthwork and reshaping	LF	1,000	$40	$40,000	Assumes two-thirds of upstream portion of project area receives channel re-grading improvements
Large wood purchased and delivered to site	EA	150	$400	$60,000	Assumes 20% delivered with root wads attached. Frequency of LWD = >20 pieces/100 meters in upstream portion and supplementation at >10 pieces/100 meters in downstream portion.
Wood placement	EA	150	$300	$45,000	Wood placed in small jams and individual placements
Dewatering and sediment control	LS	1	$25,000	$25,000	Assumes water will be encountered throughout construction.
Streambank revegetation	SF	22,500	$1	$22,500	Assumes average of 5 feet on each bank for upper portion and 5 feet on one bank for lower portion.
Riparian revegetation (above bank)	AC	2	$15,000	$30,000	Assumes 20 feet revegetation on each side of channel for upstream portion and on only 1 side for downstream portion. Includes follow-up maintenance.
Construction oversight	HR	270	$130	$35,100	Assumes 3 weeks of construction oversight, construction staking and associated coordination, 12 hour days, 1.5 staff.
Construction Sub-Total				**$270,600**	
Concept Level Construction Contingency (20%)				$54,120	
Construction Total				**$324,700**	
Project Delivery					Items below are calculated as a percent of the construction sub-total
Permitting (4%)				$10,824	
Detailed Engineering Design (15%)				$40,590	
Contract Administation (5%)				$13,530	
Project Delivery Sub-Total				**$64,900**	
TOTAL ESTIMATE				**$390,000**	rounded to nearest $1,000

General Notes:

Cost includes a 20% construction contingency
Costs assume all materials (wood) is purchased and hauled to the site from a nearby source.
Savings could be gained by reducing the total length of treatments.
Assumes wood ballast is provided through burial. Cost will increase if boulder ballast is required.
Costs do not include wetland inventory and impacts analysis

Key

LS = Lump sum
CY = Cubic yard
LF = Lineal foot
SF = Square foot
AC = Acre
EA = Each
FF = Face foot (square foot of bank face)
HR = Hours

MS 01

Mason Creek Habitat Enhancement – Conceptual Design

Reach: Mason Creek 1; EF Lewis 4C, EF Lewis 5A
River mile: 0 to 1
Reference page in main document: 71

Site Description

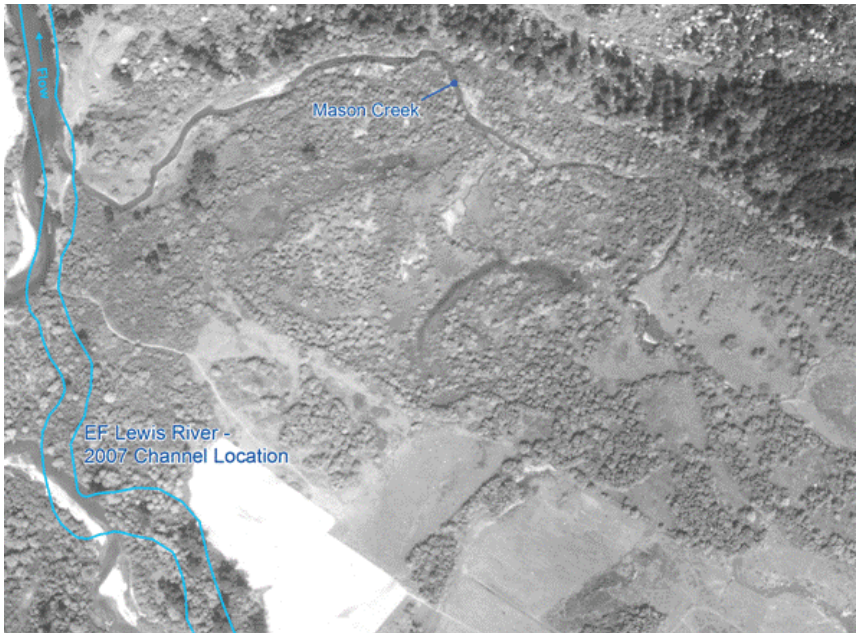
This site is associated with the lower mile of Mason Creek (see overview photo on page 5), aligned along the north (river right) margin of the East Fork floodplain located between EF Lewis river miles 5.5 and 7. The site is located on private property and is located just below a significant slope break that results as the tributary drainage emerges into the EF Lewis valley. The upper section of the reach is located on the tributary depositional fan. The channel occupied a range of positions in the upper section historically, with alignment shifts and avulsions occurring in response to deposition events associated with major floods. In this area, the historical photos also suggest losing channel conditions associated with the slope break and tributary fan setting. In contrast, the lower section of the reach appears to have been a gaining reach historically. The historic photos suggest water lost upstream by the EF Lewis was captured by this channel in the lower section along the valley wall as the valley constricts. Additionally, the lower section has historically also captured cool water originating from springs in the northwest wall of the EF Lewis valley.

Presently, Mason Creek is incised and degraded, resulting from response to prior incision and base level lowering in the main stem EF Lewis (due to dredging for navigation) and past channel and floodplain manipulation associated with adjacent land use. Mason Creek is characterized by a lack of instream habitat structure, lack of floodplain connectivity, excessive fine sediment, and degraded riparian corridor. Stream water temperature may also be a concern although more data is necessary. Several remnant oxbow wetlands were historically present adjacent to Mason Creek on the EF Lewis floodplain. These wetlands are in a degraded condition due to drainage by ditching and lowered groundwater table. Current average channel slope in this reach of Mason Creek is 0.2%.

This site offers a good opportunity to restore a low gradient tributary that will potentially provide suitable main- and side-channel habitat for a range of life history needs (spawning, rearing, high flow refugia) for coho, steelhead and chum (potential). An integrated restoration approach will provide water quality benefits by developing cold water refuge and addressing fine sediment limitations.

This project scored high in the project evaluation process due to its benefit to multiple species life-stages and due to its large size. Although the project is located in a Tier 2 reach, the project was ranked as a Tier 1 reach due to its potential to benefit fish originating in the mainstem East Fork Lewis (i.e. to serve as off-channel habitat for mainstem rearing fish).

General location of Mason Creek. View looking downstream towards East Fork Lewis River at approximately RM 0.3 on Mason Creek.



1939 aerial photo of project area showing 2007 channel alignment. Note evidence of gaining condition in lower reach.

Treatment Strategy and Alternatives

Recommended treatments:

- Select grading and channel realignment to create an incipient flood terrace and speed post-incision channel recovery.
- Excavate connected backwater channels to the north of the main channel to provide off-channel habitat and capture cool groundwater originating from the valley wall.
- Create pool-riffle sequences in main channel. Install habitat enhancement features including large woody debris.
- Use excavated material to fill ditches draining remnant oxbow wetlands.
- Control invasive species and restore native riparian habitat.

Alternatives:

- It would be possible to only treat a portion of the project reach (i.e. the upstream portion not affected by backwater conditions) or to phase treatments over time as available resources allow.
- An additional alternative involves further enhancing the remnant oxbow wetlands to receive and store wet season overbank flows (see aerial photo overlay on page 7). This project would enhance wetland values and endeavor to enhance local groundwater recharge and hyporheic flow to the mainstem EF Lewis, thereby providing additional cooling benefit. However, significant additional data collection and analyses would be required to confirm the viability of this alternative (see below).

Examples of typical restored channels

Expected Benefits – Limiting Factors Addressed

Physical habitat – 1) Enhanced quantity and quality of habitat features including pools and riffles, bank complexity and cover, and instream woody debris, 2) Enhanced availability of side-channel and off-channel habitat throughout the year, 3) Cold water refuge, 4) Enhanced stream shading.

Biological – 1) Enhanced winter high flow refuge for coho and steelhead, 2) Enhanced spawning for coho, with potential benefits to chum, winter steelhead, and Chinook spawning, 3) Enhanced quantity and quality of cool-water summer rearing for coho and steelhead, 4) Increased habitat complexity and cover for rearing fish that will provide diverse foraging opportunities and protection from predators.

Access and Landownership

The site is located on private land and crosses multiple parcels. Preliminary indications suggest that landowners may be amenable to a restoration project on their land. Access can be easily obtained at multiple locations along the project reach. Considerations must be given to the power transmission right of way that is located in the project area. Coordination with the utility will be necessary.

Data and Analysis Requirements

Mapping and select subsurface exploration is recommended to determine sources of groundwater input along the north valley wall and to locate backwater channels to collect cold groundwater. Detailed site survey, hydraulic analysis, flood inundation analysis, and a geomorphic assessment will be required to support final designs. In addition, the identified wetland and mainstem hyporheic exchange enhancement alternative would require a range of analyses to confirm viability, including evaluation of potential heating of ponded water in the wetland area, groundwater monitoring and modeling to assess subsurface flow conditions and anticipated degree of cooling, and evaluation of requirements related to fish exclusion and potential stranding. Habitat enhancements will be subject to significant potential impact from beavers; these impacts should be addressed as part of project design.

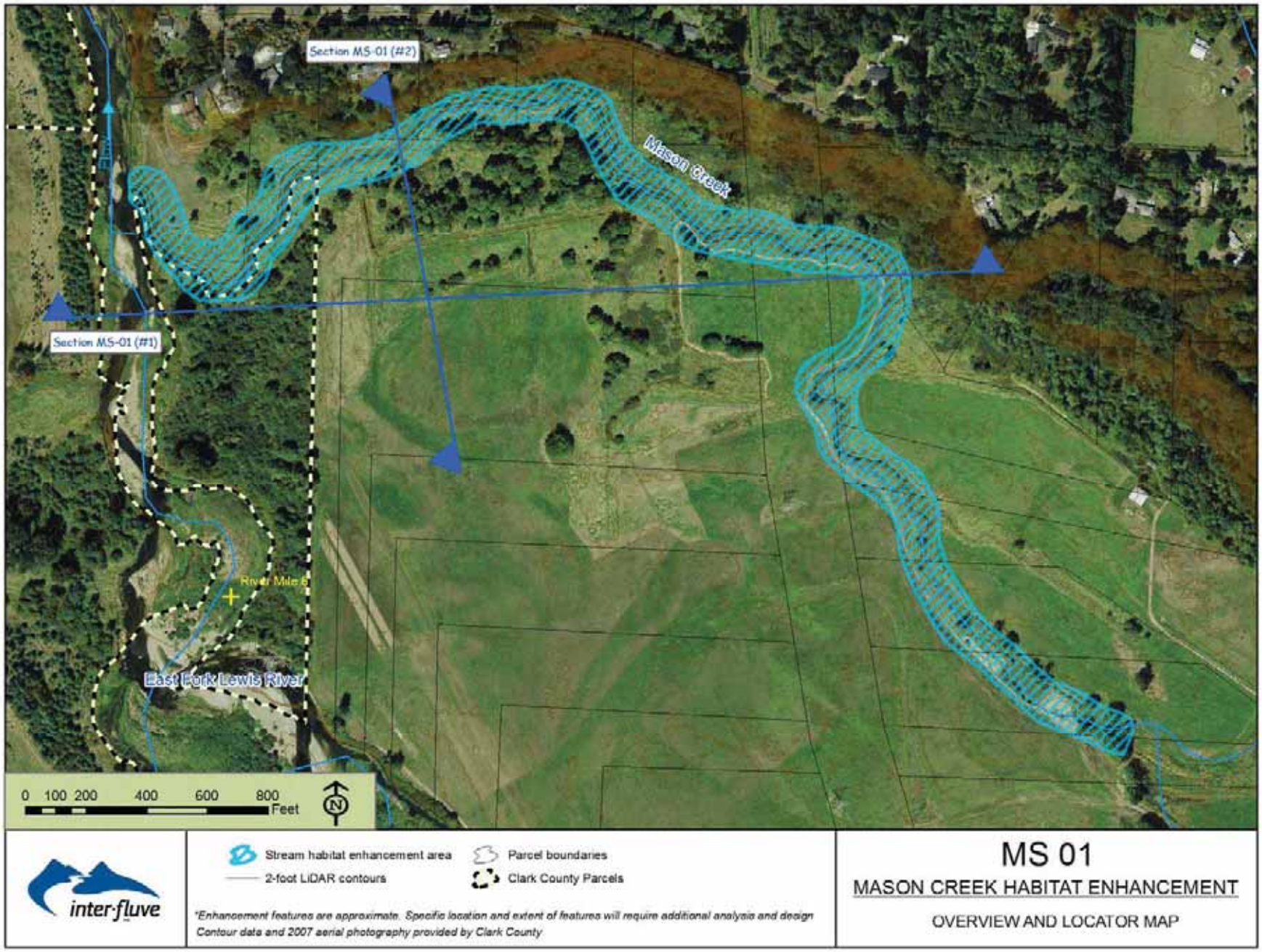
LCFRB Habitat Strategy Summary

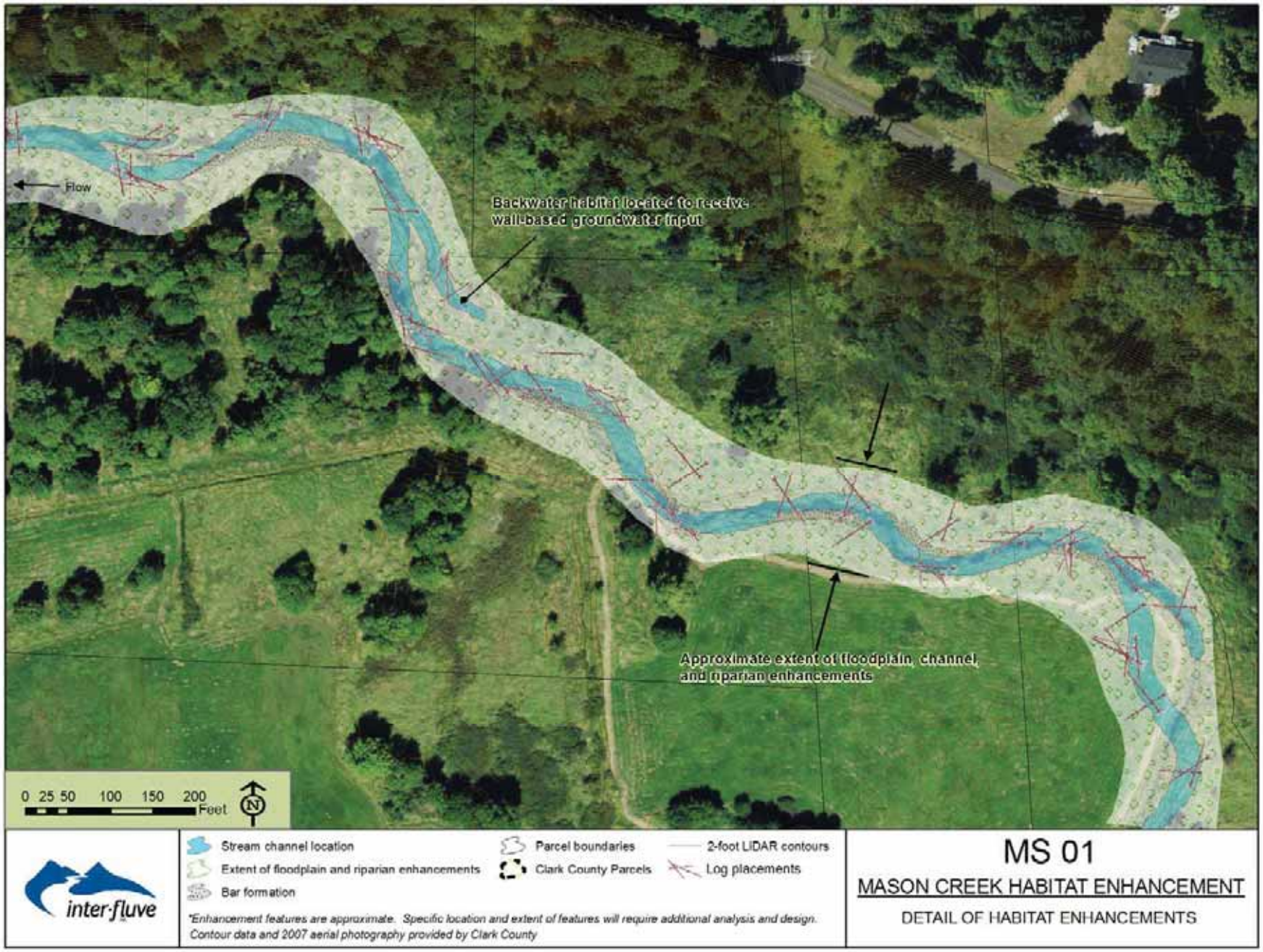
Mason Cr 1						
Tier	**2**					
Length (m)	**1,609**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P			P	P	
Species Reach Potenial (H,M,L)	L			M	L	
Restoration Vaue	75%			87%	53%	72%
Preservation Value	25%			13%	47%	28%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	H	-	-	H	M	H
Off channel & side channel habitat	H	-	-	H	M	H
Floodplain function and channel migration processes	H	-	-	H	M	H
Riparian conditions & functions	H	-	-	H	M	H
Water quality	M	-	-	H	L	H
Instream flows	M	-	-	H	L	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	H	-	-	H	M	H

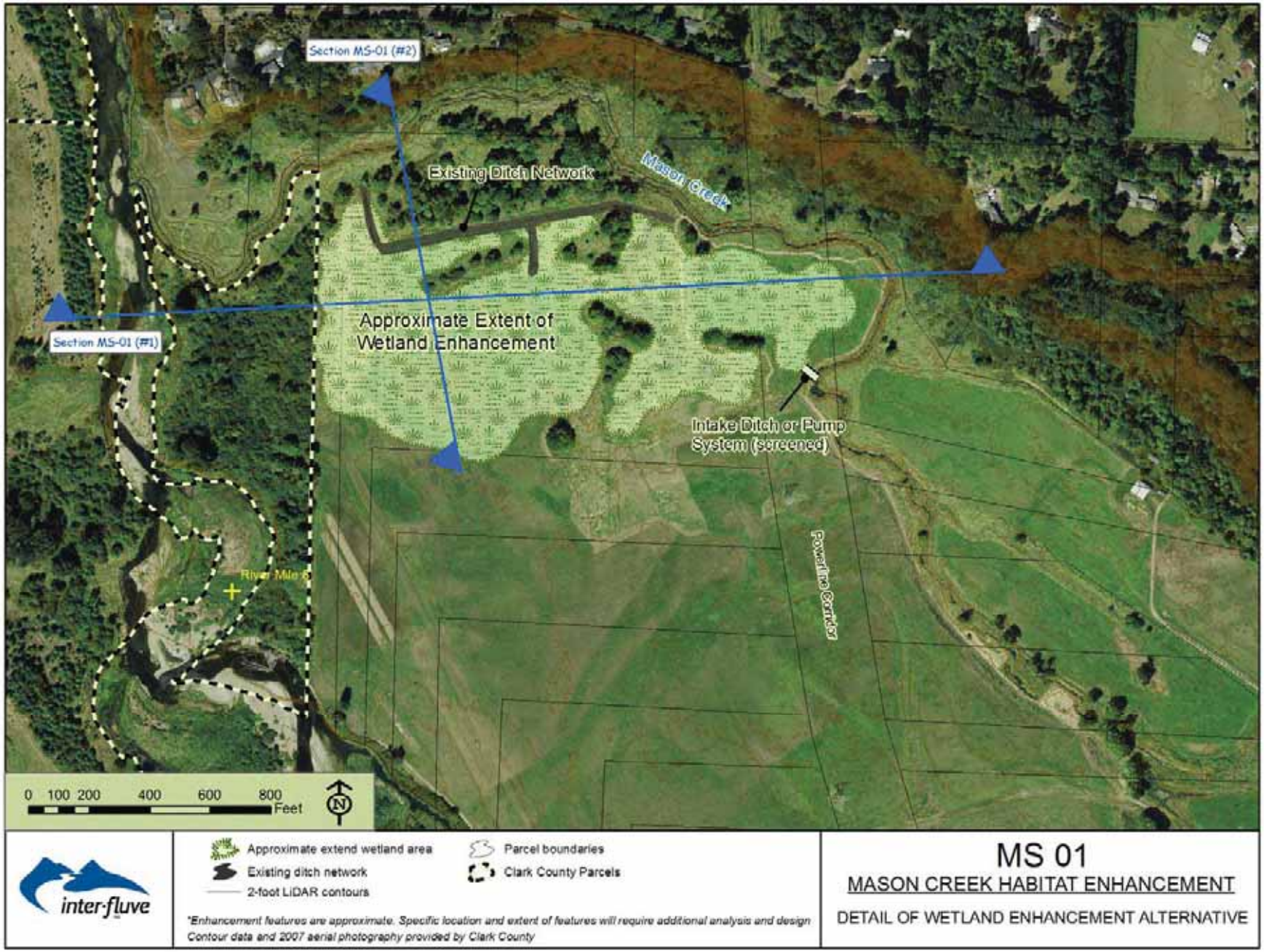
EF Lewis 4c						
Tier	**1**					
Length (m)	**563**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P	P	p	P	P	
Species Reach Potenial (H,M,L)	L	L	L	L	H	
Restoration Vaue	62%	55%	25%	50%	69%	53%
Preservation Value	38%	45%	75%	50%	31%	47%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	H	M	M	M	H	H
Off channel & side channel habitat	H	M	M	M	H	H
Floodplain function and channel migration processes	H	M	M	M	H	H
Riparian conditions & functions	H	M	L	L	H	H
Water quality	M	L	L	L	L	M
Instream flows	H	M	M	M	H	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	H	M	L	L	H	H

EF Lewis 5A						
Tier	**1**					
Length (m)	**2,076**					
Population	**WSTH**	**SSTH**	**FCH**	**Coho**	**Chum**	**Multi Species**
Recovery Plan Priority	P	P	P	P	P	
Species Reach Potenial (H,M,L)	L	L	L	L	H	
Restoration Vaue	57%	27%	28%	50%	56%	44%
Preservation Value	43%	73%	72%	50%	44%	56%
Access to blocked habitats	-	-	-	-	-	L
Stream channel habitat structure & bank stability	H	L	M	M	H	H
Off channel & side channel habitat	H	L	M	M	H	H
Floodplain function and channel migration processes	H	L	M	M	H	H
Riparian conditions & functions	H	L	M	M	H	H
Water quality	H	L	L	L	L	H
Instream flows	H	L	M	M	H	H
Regulated stream management for habitat functions	-	-	-	-	-	L
Watershed conditions & hillslope processes	H	L	M	M	H	H

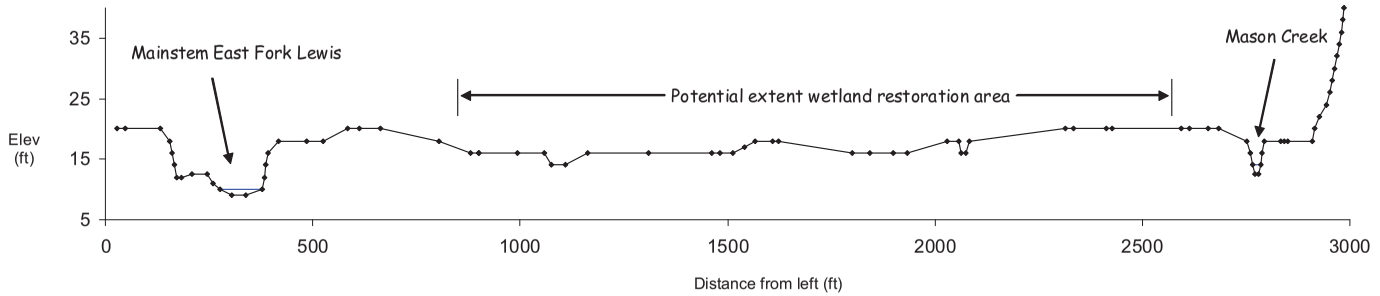
Note: EF Lewis 4C and 5A are included due to the benefit of this project for off-channel rearing for fish that originate in the mainstem. This project was ranked as a Tier 1 reach in order to reflect this benefit.


Section MS-01 (#2)
Mason Creek
Section MS-01 (#1)
River Mile 6
East Fork Lewis River
0 100 200 400 600 800
Feet
N
inter·fluve
Stream habitat enhancement area
2-foot LiDAR contours
Parcel boundaries
Clark County Parcels
*Enhancement features are approximate. Specific location and extent of features will require additional analysis and design
Contour data and 2007 aerial photography provided by Clark County
MS 01
MASON CREEK HABITAT ENHANCEMENT
OVERVIEW AND LOCATOR MAP

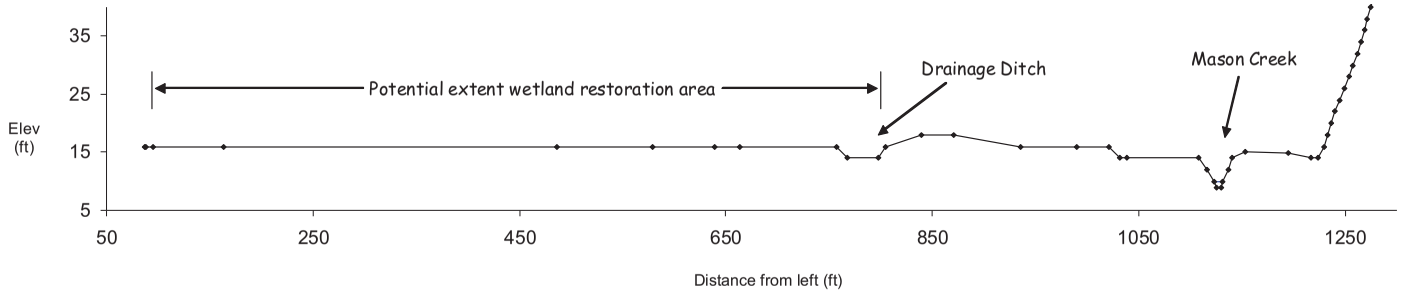

Flow
Backwater habitat located to receive wall-based groundwater input
Approximate extent of floodplain, channel, and riparian enhancements
0 25 50 100 150 200 Feet
N
inter·fluve
Stream channel location
Extent of floodplain and riparian enhancements
Bar formation
Parcel boundaries
Clark County Parcels
2-foot LIDAR contours
Log placements
*Enhancement features are approximate. Specific location and extent of features will require additional analysis and design.
Contour data and 2007 aerial photography provided by Clark County
MS 01
MASON CREEK HABITAT ENHANCEMENT
DETAIL OF HABITAT ENHANCEMENTS


Section MS-01 (#2)
Existing Ditch Network
Mason Creek
Approximate Extent of Wetland Enhancement
Section MS-01 (#1)
Intake Ditch or Pump System (screened)
Powerline Corridor
River Mile 5
0 100 200 400 600 800 Feet
N
inter·fluve
Approximate extend wetland area
Existing ditch network
2-foot LiDAR contours
Parcel boundaries
Clark County Parcels
*Enhancement features are approximate. Specific location and extent of features will require additional analysis and design
Contour data and 2007 aerial photography provided by Clark County
MS 01
MASON CREEK HABITAT ENHANCEMENT
DETAIL OF WETLAND ENHANCEMENT ALTERNATIVE

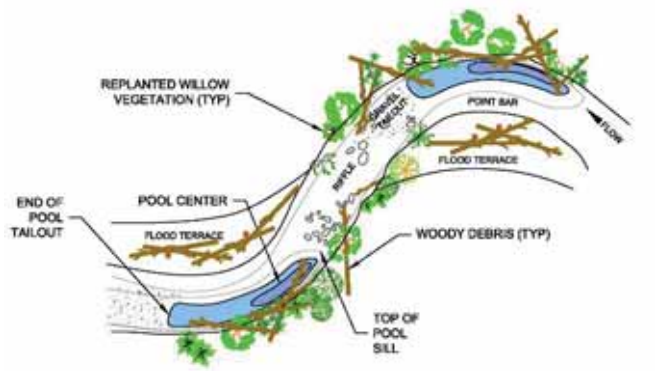
Cross-Section 1: MS-01



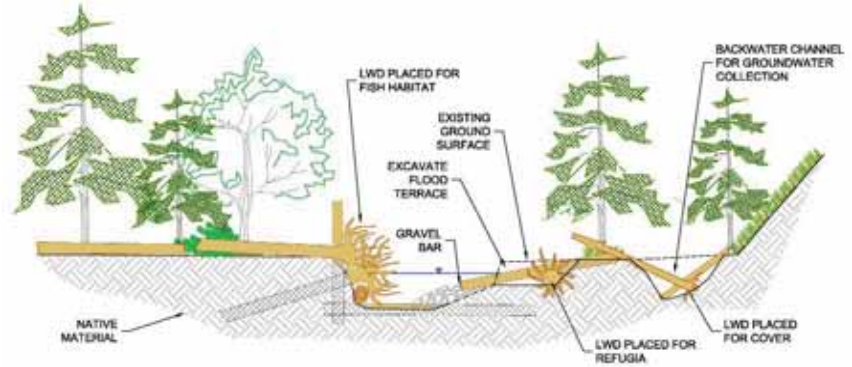
Cross-Section 2: MS-01



Typical Restored Channel – Plan View



Typical Restored Channel – Section View



CROSS-SECTIONS AND TYPICALS

Notes:
Cross-sections for MS-01 are derived from LiDAR contours. Bathymetry is estimated based on site and aerial photograph observations. In some cases, minor corrections are made to LiDAR data that is believed to be representative of vegetation and not the ground surface.

MS 01

INSTREAM HABITAT ENHANCEMENT

Planning-level cost estimate for MS 01

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2009 costs.

Description	Unit	Quantity	Unit Cost	Total Cost	Comment
Mobilization and demobilization	LS	1	$22,000	$22,000	Calculated at 5% of construction sub-total
Channel earthwork and reshaping	LF	1,300	$40	$52,000	Assumes one-third of the upstream portion of project area receives channel re-grading improvements
Large wood purchased and delivered to site	EA	325	$400	$130,000	Assumes 20% delivered with root wads attached. Frequency of LWD = ~20 pieces/100 meters.
Wood placement	EA	325	$300	$97,500	Wood placed in small jams and individual placements
Dewatering and sediment control	LS	1	$25,000	$25,000	Assumes water will be encountered throughout construction.
Streambank revegetation	SF	55,000	$0.75	$41,250	Assumes average of 5 feet on each bank for entire length. Economy of scale factored into unit cost.
Riparian revegetation (above bank)	AC	5	$10,000	$50,000	Assumes 20 feet revegetation on each side of channel. Includes follow-up maintenance. Economy of scale factored into unit cost.
Construction oversight	HR	360	$130	$46,800	Assumes 4 weeks of construction oversight, construction staking and associated coordination, 12 hour days, 1.5 staff.
Construction Sub-Total				**$464,550**	
Concept Level Construction Contingency (20%)				$92,910	
Construction Total				**$557,500**	
Project Delivery					Items below are calculated as a percent of the construction sub-total
Permitting (4%)				$18,582	
Detailed Engineering Design (15%)				$69,683	
Contract Administation (5%)				$23,228	
Project Delivery Sub-Total				**$111,500**	
TOTAL ESTIMATE				**$669,000**	rounded to nearest $1,000

General Notes:

Cost includes a 20% construction contingency
Costs assume all materials (wood) is purchased and hauled to the site from a nearby source.
Total length of treatment is over 1 mile long. Savings could be gained by reducing the total length of treatments.
Assumes wood ballast is provided through burial. Cost will increase if boulder ballast is required.
Costs do not include wetland inventory and impacts analysis
Costs do not include wetland restoration

Key

LS = Lump sum
CY = Cubic yard
LF = Lineal foot
SF = Square foot
AC = Acre
EA = Each
FF = Face foot (square foot of bank face)
HR = Hours