LEWIS RIVER – EAGLE ISLAND

PROJECT IDENTIFICATION AND DESIGN

December 2009

Prepared for:

Lower Columbia Fish Recovery Board
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Introduction and Overview

The Eagle Island Project Identification and Design Project identifies and designs restoration projects with the goal of improving overall habitat values in the Eagle Island area of the North Fork Lewis River, Washington. The NF Lewis River provides habitat for Chinook, coho, steelhead, and chum, all listed as threatened under the federal Endangered Species Act (ESA). The combined effects of the hydropower system, development, and instream activities have resulted in a severe loss of off-channel habitat in the lower river.

The stream reaches that include Eagle Island, located at approximately river mile 12, have been identified as high priority areas for salmon recovery within the Lower Columbia region. This island is one of the few areas in the North Fork Lewis system that provides a variety of natural conditions, including some of the best rearing habitat in the system. The Eagle Island property was purchased by Clark County in 2000 with the goal of protecting this habitat in perpetuity. Ownership of the property is in the process of being transferred to the Washington State Department of Fish and Wildlife. Studies of channel conditions and anecdotal evidence indicate that conditions have changed in and around the island, including colonization by invasive plant species, disconnection of side channels, and increased sediment deposition in existing off-channel areas.

This project evaluates the current conditions within the Eagle Island reaches, builds on previously-completed studies, and develops 30% designs for three high priority project alternatives to improve the long-term function of off-channel habitat on and around the Eagle Island property. The highest priority alternative is further developed to the 90% design level.

Interaction with Technical Oversight Group

This project has been completed in coordination with a Technical Oversight Group (TOG) made up of local technical stakeholders involved in aquatic habitat management in the Eagle Island area. Each step of this study has been conducted in coordination with the TOG and the TOG has provided reviews of each of the technical memos produced as part of this effort.

TOG members include:

Participant	**Affiliation**
Eli Asher	Lower Columbia Fish Recovery Board
Donna Bighouse	WA Dept of Fish and Wildlife
Brian Calkins	WA Dept of Fish and Wildlife
Bill Dygert	Consultant
Pat Lee	Clark County
Ron Roler	WA Dept of Fish and Wildlife
Rudy Salakory	Cowlitz Indian Tribe
Frank Shrier	PacifiCorp Energy

Data Review / Existing Conditions

Existing data was reviewed, compiled, and summarized from a number of sources in order to establish the technical foundation for project identification and design. The primary materials consulted for this task include past reports, available GIS data, WDFW habitat data, and data developed as part of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan. This information is provided in Technical Memo #1 that is included in this report.

Project Identification and Prioritization

Project Identification

Selection of potential projects was based on a consideration of habitat limiting factors, species-specific life history requirements, geomorphic and hydraulic conditions, and riparian vegetation conditions. Projects were derived through a number of methods, including the following:

1. Review and adaptation of existing restoration project enhancement recommendations from the Lewis River LWD Study (Interfluve 2008##)
2. Office-based analysis of aerial photography and LiDAR data
3. Site visit via foot and boat on August 12, 2009

The design team identified a total of 14 potential fish habitat enhancement projects in the Eagle Island reaches. See Technical Memo #2 for a list and description of each of the project opportunities.

Project Prioritization

Project prioritization was conducted through discussions with the TOG regarding the merits and special circumstances of individual projects. The TOG originally considered using the LCFRB TAC method of project prioritization but decided that this methodology would not adequately differentiate between project opportunities, since the LCFRB scoring criteria are designed to compare various types of projects in a regional fish recovery context, and not within a single river reach.

One major consideration in prioritizing projects is the potential abandonment of the North Channel, which has been moving progressively closer to cutting off based on the aerial photo record. As a result, projects within the North Channel were not considered high priority due to their potential abandonment. Construction of a large bar apex jam at the head of the island was considered as an approach to encourage continued flow into the North Channel; however, upon further investigation, the design team determined that insufficient information exists to ensure that such a project would accomplish the intended objectives. In response to this uncertainty, the design team developed a conceptual study design to evaluate the potential for North Channel abandonment and to identify appropriate solutions. The conceptual study design is included as Appendix A of this report.

The TOG selected three high priority projects to move forward to 30% design. These projects were selected based on the above considerations as well as other factors including landownership and habitat benefit. One of the three projects was selected as the top priority project to move forward to 90% design. The top ranked projects are included in Table 1. See Technical Memo #3 for more detailed discussions of the projects, including their anticipated habitat benefits.

Table 1. High priority projects selected for 30% design. Project #3 was further developed to 90% design.

Project ID	Location	Treatment Type
Project #3 (aka Site A)	River left (south) side of the south channel 250 meters downstream of the upstream end of Eagle Island	Enhancement of existing side-channel habitat. Enhancement of channel dynamics LWD enhancement Riparian enhancement
Project #4 and #6 (aka Site B)	River right bank near the upstream end of the south channel; RM 11.3.	Enhancement of existing backwater habitat Enhancement of channel dynamics LWD enhancement Riparian enhancement
Project #8 (aka Site C)	River right bank 1,100 meters from the upstream end of Eagle Island.	Enhancement of existing side-channel habitat Enhancement of channel dynamics LWD enhancement Riparian enhancement

Project Design

Led by a Professional Engineer, the design team developed 30% designs for the three projects in Table 1. The 30% designs are included as Attachments to this report. Technical Memo #3 is the preliminary design report that accompanies these designs. Original draft designs were revised based on input from the TOG. The 30% design for Site A was revised and further developed, resulting in the attached 90% design. This design was also revised based on comments from the TOG on the draft design. Cost estimates for Sites B and C are included in Technical Memo #3. The cost estimate for Site A is included in Technical Memo #4.

Report Organization

This report consists of the Technical Memos that were developed throughout the course of this project. These include the following:

Technical Memo #1: Existing Conditions
Technical Memo #2: Preliminary Project Opportunities
Technical Memo #3: Preliminary Design Report (for 30% designs)
Technical Memo #4: Final Design Report (for 90% design at Site A)

The 30% designs for Sites B and C, and the 90% designs for Site A, are included as attachments to this report. The assessment needs for the North Channel abandonment evaluation are included in Appendix A.

References

Interfluve, Cramer Fish Sciences, and Fox Environmental Services. 2008. Lewis River LWD Study. Prepared for PacifiCorp, Portland, OR.

EAGLE ISLAND PROJECT IDENTIFICATION AND DESIGN

Tech Memo 1: Existing Conditions

To: Lower Columbia Fish Recovery Board and Eagle Island Technical Oversight Group (TOG)

From: Interfluve and Stillwater Sciences

Primary Author: Gardner Johnston, Interfluve

Original Draft Date: 7/29/2009

Revision Date: 12/03/2009

Description: This Technical Memorandum describes existing conditions within the Eagle Island area on the North Fork Lewis River.

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EXISTING CONDITIONS

Existing habitat and fish population conditions for the Eagle Island area are summarized below. Existing conditions were obtained from past studies, experience working in the basin, and communication with WDFW research biologists.

Lower Columbia Recovery Plan

The Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan (Recovery Plan, LCFRB 2004b) identifies fish population objectives, reach priorities, limiting factors, and recommended recovery measures within the lower North Fork Lewis River Basin. The basin supports 6 salmon and steelhead populations (Table 1). The North Fork Lewis fall Chinook population is one of the healthiest populations in the region and is considered a high priority for recovery to a high level of population viability (LCFRB 2004b). Current population status and Recovery Plan objectives for North Fork Lewis River populations are included in Table 1.

Table 1. Viability status of lower North Fork Lewis populations and the biological objectives from the Recovery Plan. Table is reproduced directly from the Recovery Plan (LCFRB 2004b).

	ESA	Hatchery	Current		Objective	
Species	Status	Component	Viability	Numbers	Viability	Numbers
Fall Chinook	Threatened	No	Med+	3,200-18,000	High+[P]	6,500-16,600
Spring Chinook	Threatened	Yes	Very low	200-1,000	High[P]	2,200
Chum	Threatened	No	Very low	<150	High[P,X]	1,100
Winter Steelhead	Threatened	Yes	Low	Unknown	Medium[C]	300
Summer Steelhead	Threatened	Yes	Very low	Unknown	Very low[S]	150
Coho	Proposed	Yes	Very low	Unknown	Medium[C]	300

P = primary population in recovery scenario
C = contributing population in recovery scenario
S = stabilizing population in recovery scenario
X = subset of larger population

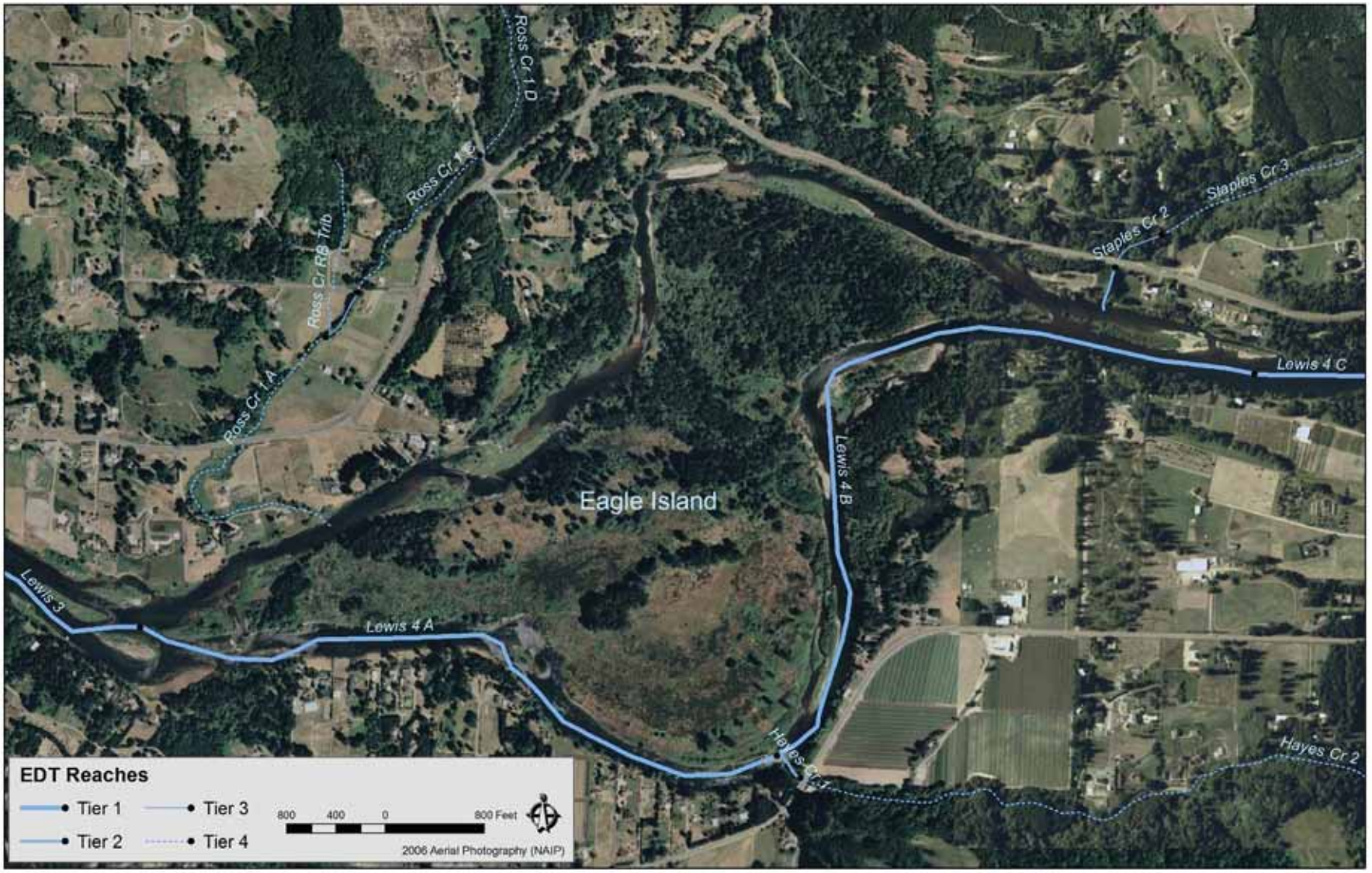


Figure 1. Aerial photo map of Eagle Island Reaches and nearby tributary reaches and their Recovery Plan designations.

The reaches within the study area include Lewis 4A and Lewis 4B. Both of these reaches are rated as Tier 1 reaches according to the Recovery Plan (see Figure 1). Tier 1 reaches represent the highest priority reaches for one or more primary populations. Reaches Lewis 4A and 4B support fall Chinook, coho, winter steelhead, and chum at various life-stages. Limiting factors in the reaches include sediment load, flow conditions, quantity of key habitat, and habitat diversity. The species-specific life-stage limiting factors in the Eagle Island reaches are summarized in Table 2.

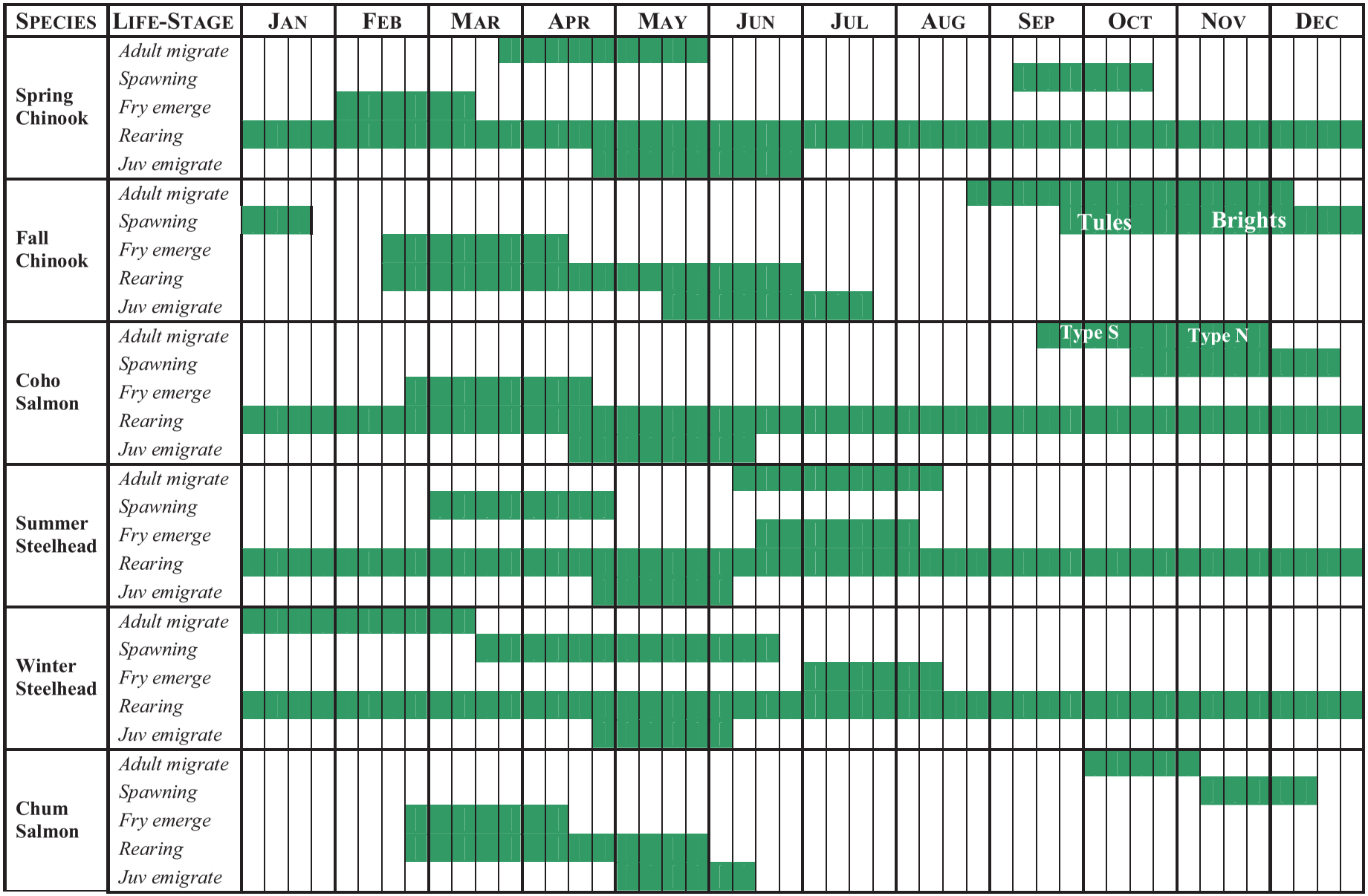
Table 2. Species life-stages and limiting factors for Reaches 4A and 4B (Eagle Island) on the North Fork Lewis River. Information is from the EDT Consumer Report diagrams.

Species Present	Life Stage (primary limiting)	Limiting Factor (primary)	Relevant Months
Coho	Egg incubation	Sediment load, flow	Oct-May
	0-age active rearing	Key habitat quantity, habitat diversity	Mar-Oct
Winter Steelhead	1-age active rearing	Habitat diversity	Mar-Oct
	Egg incubation	Sediment load	Mar-Jul
	Fry colonization	Habitat diversity	May-Jul
Fall Chinook	Egg incubation	Sediment load	Nov-May
	Spawning	Flow, habitat diversity	Oct-Nov
Chum	Prespawning holding	Key habitat quantity, habitat diversity	Oct-Jan
	Spawning	Habitat diversity, flow	Oct-Jan

Fish Use and Distribution

The lower North Fork Lewis Basin is used by 6 populations of salmon and steelhead, including fall and spring Chinook, winter and summer steelhead, coho, and chum. A periodicity chart with timing of life-history stages is included in Table 3. The fall Chinook run consists of an early-spawning "tule" run as well as a late-spawning "bright" run. Fall Chinook make extensive use of the lower mainstem for spawning. The highest concentrations of Chinook spawning occur within the 5 mile reach downstream of Merwin Dam; however, Chinook spawning also occurs within the Eagle Island reaches. Winter steelhead make limited use of the mainstem for spawning; some winter steelhead spawning occurs in the Eagle Island reaches. Steelhead primarily use the mainstem for juvenile rearing. Coho also make limited use of the mainstem for spawning. Coho primarily spawn in mainstem tributaries and use the mainstem and connected off-channel areas for rearing. Chum, whose numbers are very limited in the system (see Table 1), use the mainstem for migration, adult holding, and spawning. Summer steelhead and spring Chinook make only limited use of the lower mainstem, primarily using these lower reaches as a migration corridor to access upstream spawning grounds.

Table 3. Periodicity chart for salmon and steelhead species in the Lewis River Basin (PacifiCorp and Cowlitz PUD 2003). Chart reproduced from Interfluve et al. (2008) with edits based on conversations with WDFW staff (Steve Vanderploeg and Shane Hawkins, WDFW, personal communication).



SPECIES	LIFE-STAGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Bull Trout	*Adult migrate*						■	■	■	■			
	Spawning		■	■					■	■	■		
	Fryemerge		■	■									
	Rearing	■	■	■	■	■	■	■	■	■	■	■	■
	Juv emigrate					■	■						

WDFW conducts annual escapement surveys (adult counts and redd counts) and annual juvenile surveys (seining) for salmon and steelhead. These data enhance our understanding of species-specific lifestage use of habitats throughout the study area and provide useful information for identification of appropriate habitat enhancement projects.

Annual escapement estimates are made for hatchery and wild returns based on adult counts, carcass surveys, coded wire tag recoveries, and redd surveys. Monitoring has been focused on the upper reaches between Merwin Dam and the hatchery, where the vast majority of the spawning occurs. Chinook escapement monitoring began in the late 1970s and early 1980s and extends to the present. Counts are made of live fish observations, carcasses, and redds. Data are grouped according to four index reaches between the hatchery and Merwin Dam. Although the majority of Chinook spawning occurs in these upstream reaches, Chinook spawning has also been observed in the Eagle Island channels, primarily in the upstream 3-400 yards of the north and south channels (Shane Hawkins, WDFW, personal communication). Eagle Island spawners tend to be fall 'bright' Chinook that spawn towards the later end of the run (i.e. December and January).

Annual steelhead redd counts have also been conducted throughout the mainstem Lewis for the past 2 years (Steve Vanderploeg, WDFW, personal communication). Steelhead spawning occurs throughout the lower mainstem as far downstream as Woodland, WA. A GPS point is taken at each redd location. The locations of surveyed steelhead redds in 2008 and 2009 in the Eagle Island area are identified in Figure 2.

Juvenile seining sets are performed throughout the mainstem each year beginning in May and extending into July. The following observations have been made over the years based on seining surveys (Shane Hawkins, WDFW, personal communication). Most of the juvenile rearing occurs downstream of the canyon reach and appears to be correlated with the availability of suitable channel-margin rearing habitat. Flow levels and habitat features such as bank slope tend to have a large influence on selection of rearing sites. Once juveniles become established at a particular bank site or backwater habitat area, they tend to remain in those areas until they begin their smolt migrations. The spatial distribution and habitat associations of juvenile salmonids are difficult to evaluate because much of the data that is collected is dependent on where effective seining sets can be conducted. Areas with woody debris or high complexity tend to be difficult areas for sampling. The majority of the captured fish are Chinook fry, with coho, trout, and chum fry making up smaller percentages of the catch (see Table 4). Larger fish, including trout parr and age-1 coho and Chinook, are occasionally captured or observed during surveys.

The spatial distribution of the juvenile catch is presented below in Table 5. A map is provided of the individual sampling sites that are presented in the table (Figure 3). These data give a general idea of the spatial distribution of juvenile rearing throughout the study reach. It should be noted, however, that sampling effort is not necessarily equal among sites and that sampling sites are partially dependent on where effective seining can be conducted. In general, a significant amount of rearing occurs within the Eagle Island channels. Nearly 40% of the juveniles are captured within the north or south channels and an additional 26% are captured at the top end of the island where the channels split.

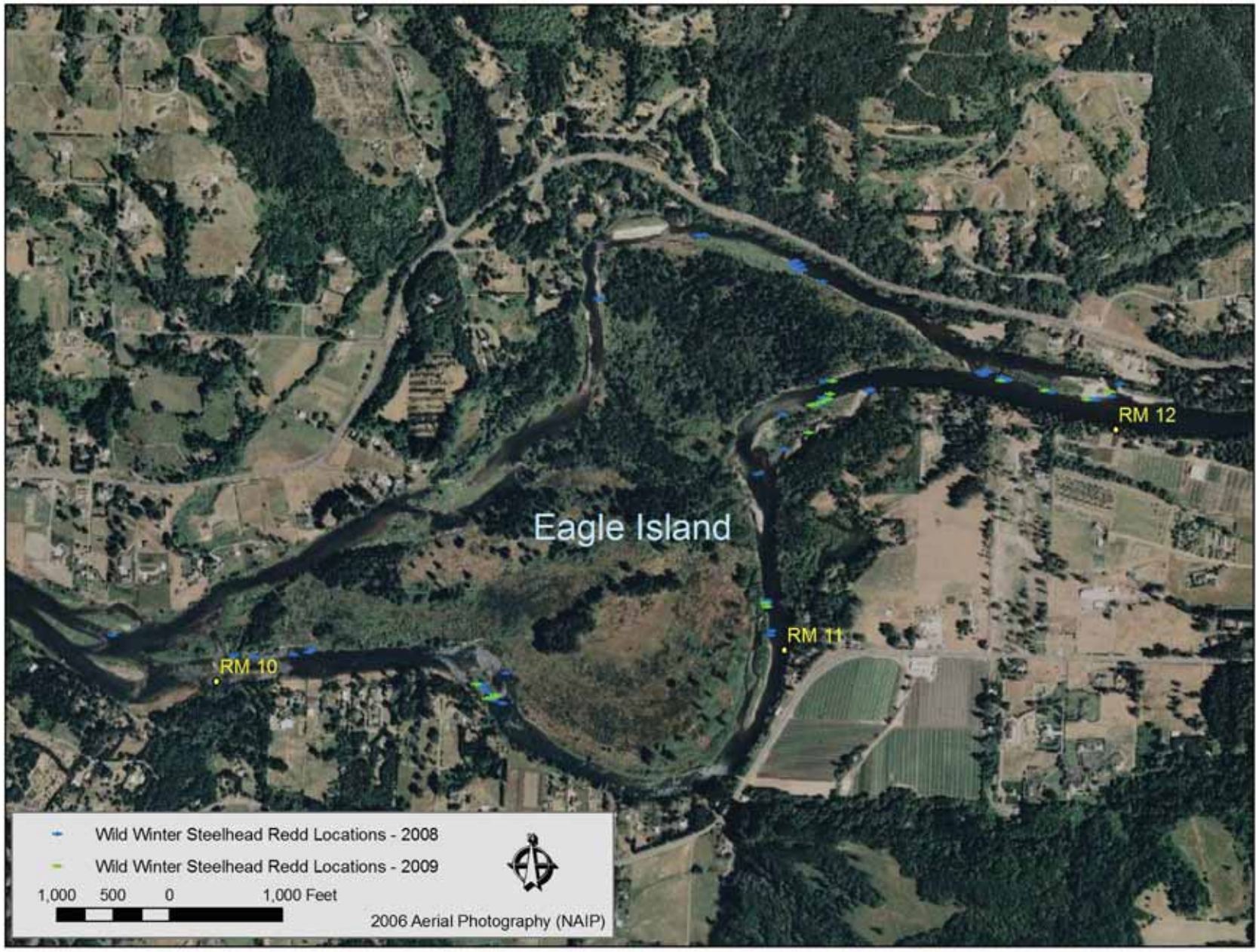


Figure 2. Wild winter steelhead redd locations. Unpublished data from WDFW (2009).

Table 4. Catch distribution by species for years 1978 – 2006. WDFW, unpublished data.

Species	Average	Range
Chinook	90.1%	67.5% - 99.6%
Coho	9.5%	0.3% - 32%
Trout	0.4%	0% - 1.8%
Chum	0.01%	0% - 0.2%

Table 5. Spatial distribution of juvenile catch data in the Eagle Island area and in upstream and downstream locations. Data is from 1983 – 2006. Seining site numbers correspond to the map in Figure 3. (WDFW, unpublished data).

	Above Island	Top of Island	North Channel	South Channel	Below Island	Totals
Seining Site	*1 - 20*	*21 - 27*	*29 - 50*	*28 & 51 - 63*	*64 - 85*	
Average Catch	50,867	52,539	42,613	32,442	25,034	203,495
Average %	25%	26%	21%	16%	12%	100%

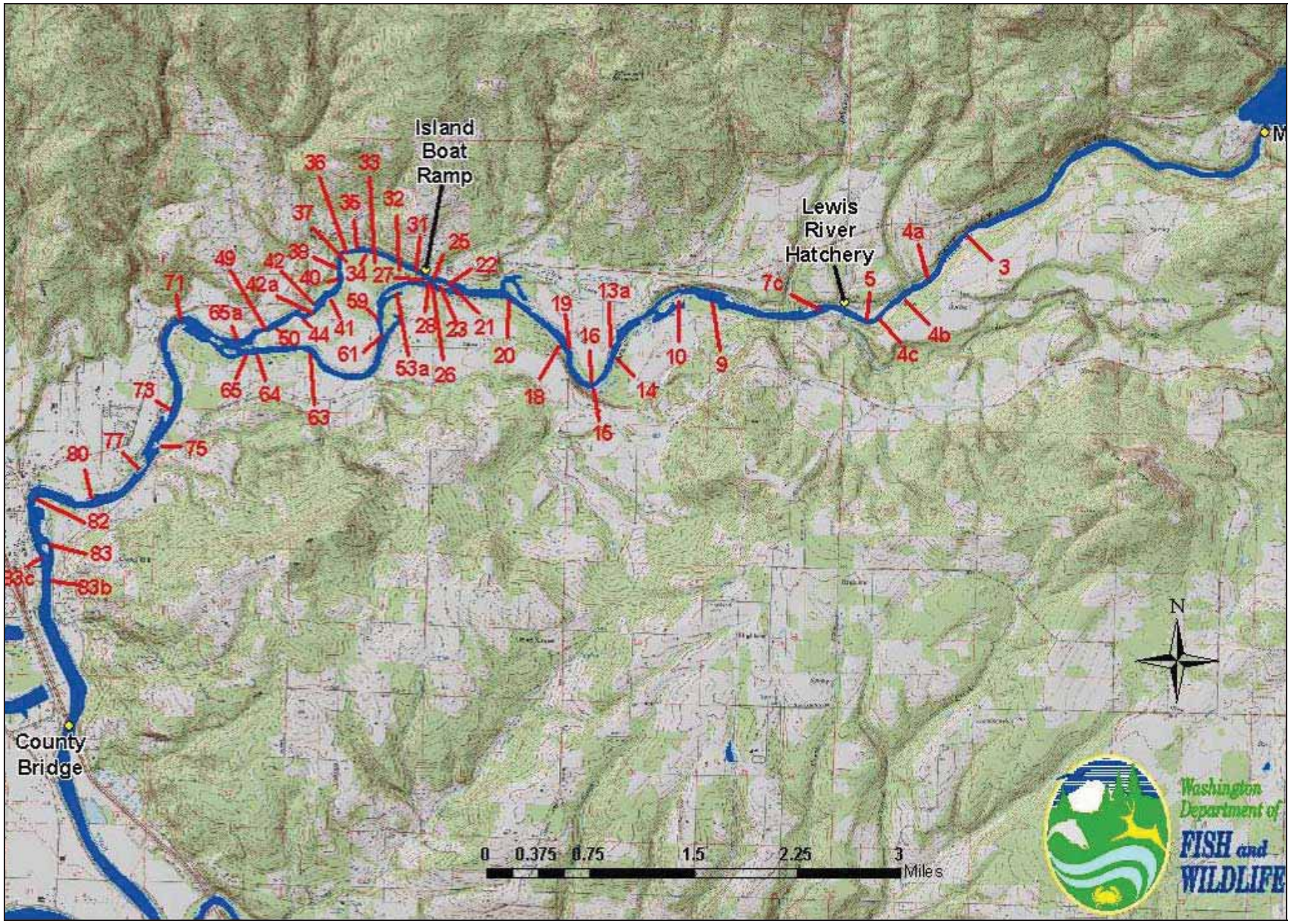


Figure 3. Map of juvenile seining sites (WDFW).

Habitat and Geomorphology

Hydrologic Conditions

The PacifiCorp hydroelectric projects on the Lewis River are operated to produce power, manage peak (flood) flows, augment late summer flows, and minimize rapid water-level fluctuations in the lower river (BioAnalysts, et al. 2003). The net effect of the project is to dampen the range of flow fluctuations, therefore winter flood flows are lower and summer low flows are higher than under pre-project conditions (Figure 4 and Figure 5). Section 6.2.4 of the 2004 Settlement Agreement sets the minimum flows for below Merwin Dam (RM 19) for ten separate time periods (Table 6). Due to these minimum flow requirements and due to flow releases in the fall in preparation for winter rains, flows during the late summer and fall are typically higher than baseflow under pre-project conditions. In addition, flows during the spring are lower than under pre-project conditions as the reservoirs are filled for the summer recreation season. Under pre-project conditions the hydrograph as measured at the Ariel gage (USGS #14220500) (RM 18.5) had a spikier shape than at present. Under post-dam conditions, the operation of the turbines at Merwin Dam gives the hydrograph a more stepped shape during peak flows, unless the reservoir is filled. When reservoirs are filled, peak flows have a similar spike shape under pre- and with-project conditions as water is spilled at the dams (BioAnalysts, et al. 2003).

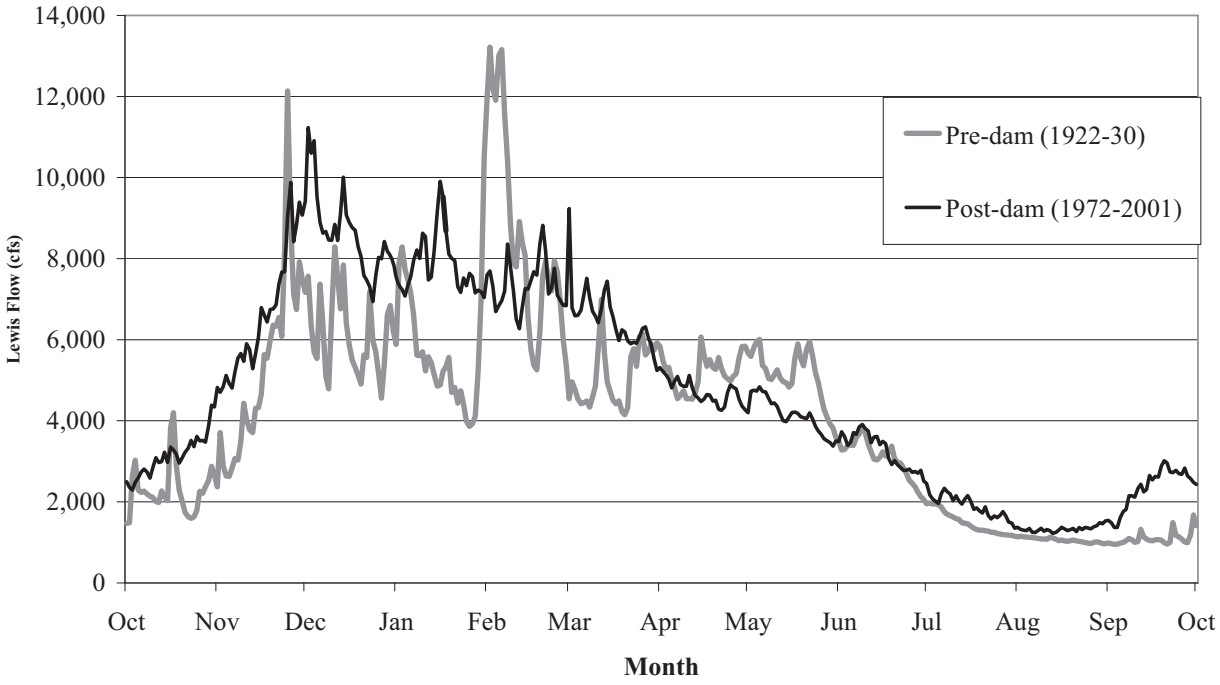


Figure 4. Lower Lewis River flow pre- and post-Merwin Dam (1931). Hydro-regulation has decreased flows in the spring and increased flows in the summer and fall. USGS Gage #14220500; Lewis River at Ariel, Wash. Figure reproduced from the Recovery Plan (LCFRB 2004).

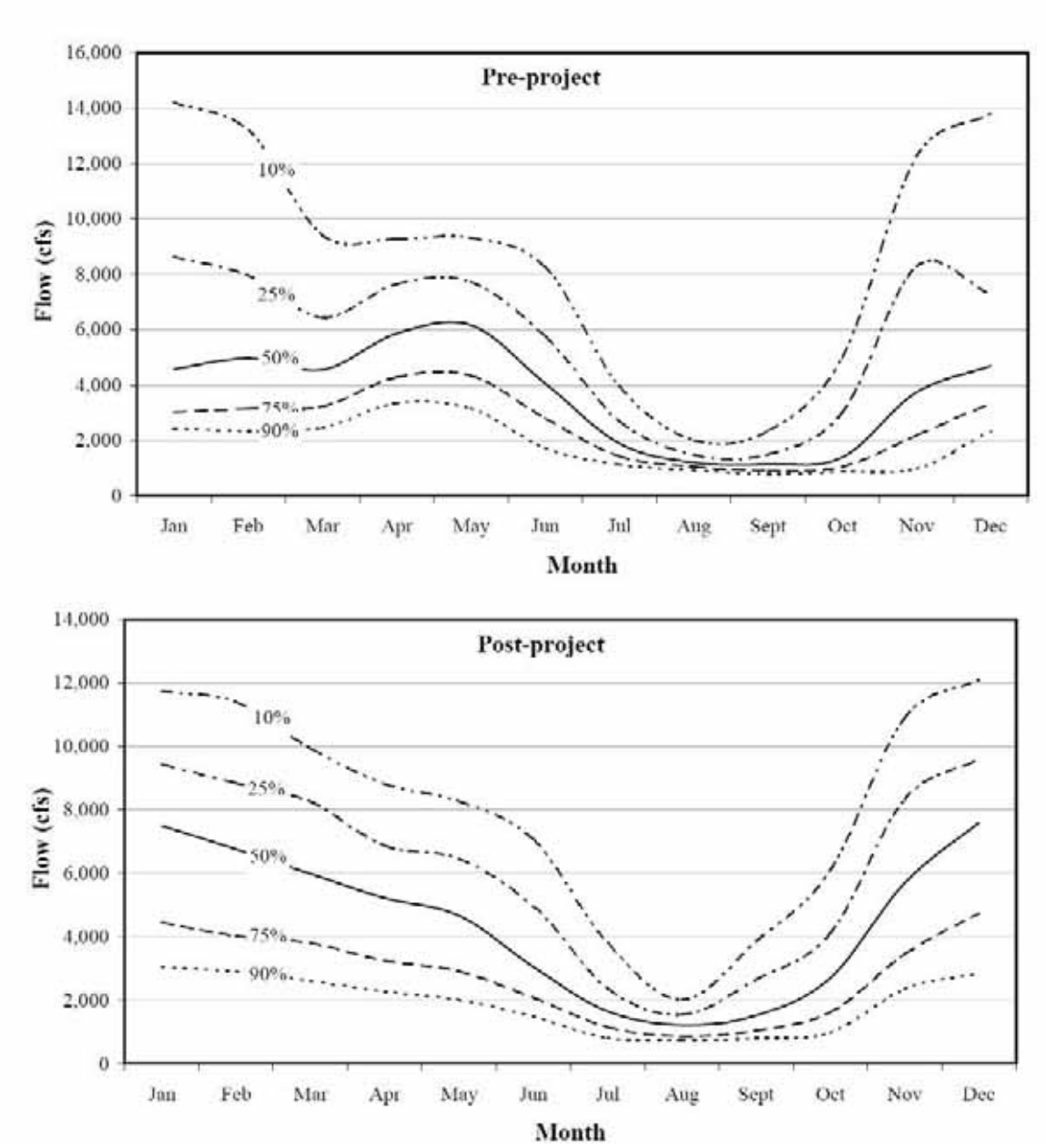


Figure 5. Daily flow exceedance curve for Lewis River at Ariel (below Merwin Dam, USGS Gage 14220500). Pre-project is from 1909 through 1930 and post-project is from 1932 through 1998. Daily flow from 1910 through 1923 was estimated based on Lewis River flow at USGS Gage 14219500 near Amboy. This figure is a copy of Figure 2.2-9 WTS 2 in BioAnalysts, et al. (2003).

Table 6. Minimum flow requirements in the Lewis River below Merwin Dam (based on text from the 2004 Settlement Agreement)

Time Period	Minimum Flow Requirement
July 31 through October 15	1,200 cfs
October 16 through October 31	2,500 cfs
November 1 through December 15	4,200 cfs
December 16 through March 1	2,000 cfs

Time Period	Minimum Flow Requirement
March 2 through March 15	2,200 cfs
March 16 through March 30	2,500 cfs
March 31 through June 30	2,700 cfs
July 1 through July 10	2,300 cfs
July 11 through July 20	1,900 cfs
July 21 through July 30	1,500 cfs

Channel Conditions

In the context of Eagle Island restoration prioritization, the most important factor contributing to the contemporary channel morphology in the Lewis River below Merwin Dam is the flood history of the river since the construction of Merwin Dam. The flood of 1933 was of particular importance because it was the flood of record and had disproportionate geomorphic consequences relative to the smaller floods since that time. Secondary to the flood history is the distinctive geomorphic setting of each of the two main reaches of the river downstream of Merwin Dam. The nature of each of the reaches gives rise to distinct habitat features that are of importance to aquatic biota. Finally, human intervention and infrastructure, particularly in the vicinity of Eagle Island in the lower reach of the river, have had an influence on channel planform and geomorphic function.

In December 1933, a flood that peaked at approximately 129,000 cfs occurred; this is the highest discharge on record at the USGS Lewis River at Ariel gage (14220500). This flood had a profound impact on channel morphology and spawning habitat in the Lewis River below Merwin Dam, which had been in place for less than two years at the time. The channel condition today is the combined legacy of the effect of Merwin Dam on sediment supply, the 1933 flood, and the hydrologic regime since 1933. The most notable impacts of the flood were sediment mobilization, reorganization and resurfacing of point bars, and removal of riparian vegetation throughout the Lewis River below Merwin Dam.

In addition to mobilizing point bars, the flood resulted in channel avulsions or meander-bend cutoffs in several locations in the lower reach where the river overtopped its banks. In the 1938 aerial photographs, an avulsion can be seen at the location of the present day Lewis River golf course. The present-day south channel of the Lewis River around Eagle Island appears to be the result of a channel avulsion that occurred in the 1933 flood. The south channel was congested with sediment in 1938 and the wetted channel was clearly subsidiary to the mainstem formed by the north channel. The contemporary Lewis River at this location flows primarily through the south channel, while the north channel appears to be in the process of cutting off. The WTS-3 relicensing report (BioAnalysts et al. 2003) mapped historical channel changes in the lower mainstem using the historical aerial photo record. The results of their assessment for the Eagle Island area are displayed in Figure 6.

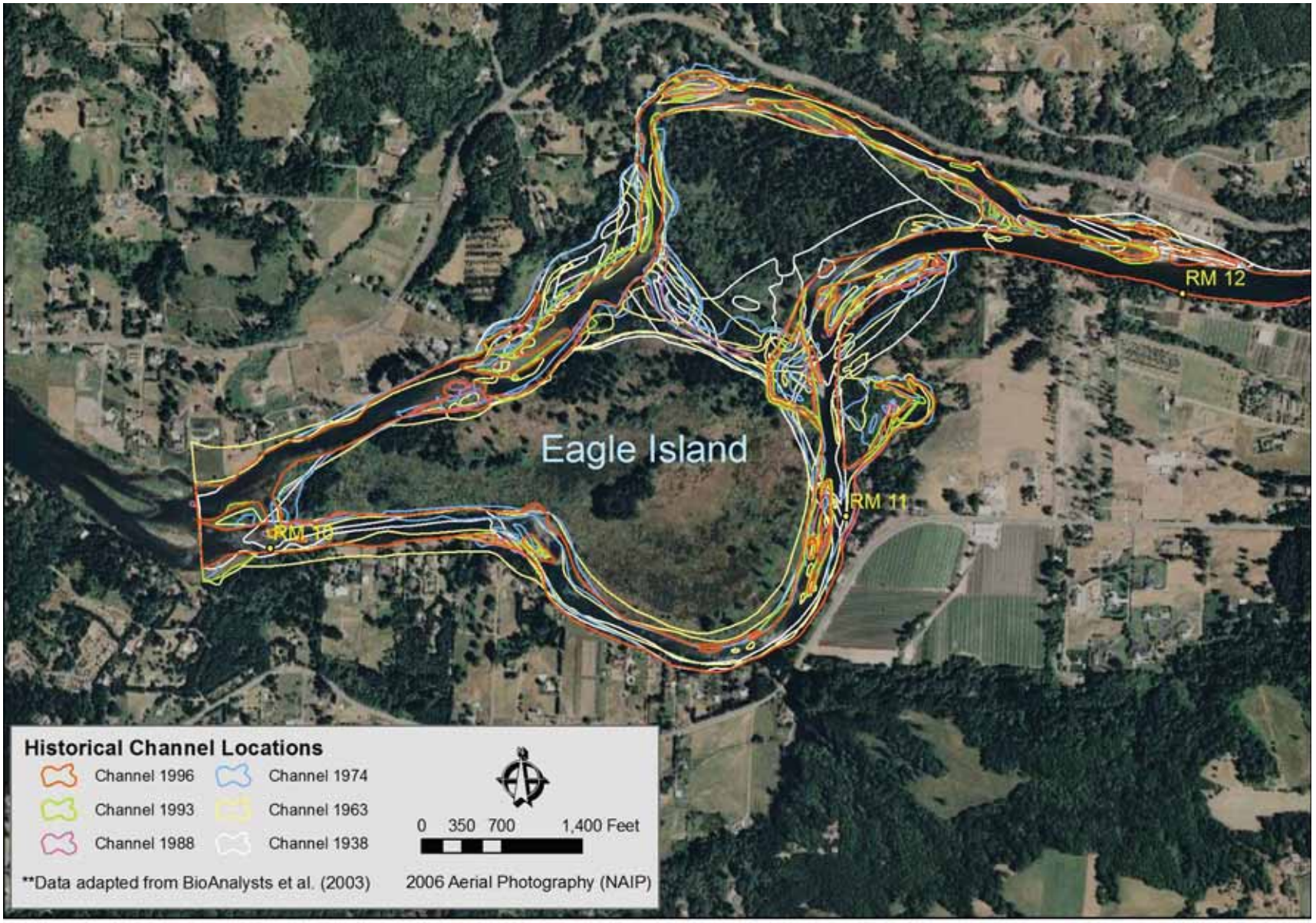


Figure 6. Changes in channel position over time in the Eagle Island area, North Fork Lewis River. Data obtained from BioAnalysts et al. (2003).

The range of fluvial process outcomes, and in turn habitat conditions, in the Lewis River between Merwin Dam and Eagle Island are governed by the reach-scale physical setting of the river. The Lewis River downstream of Merwin Dam can be divided into an upper and lower reach based on differences in the geomorphic character of each reach. The upper reach (approximately RM 19 to RM 14) is a bedrock-confined channel that is relatively straight and has somewhat steeper gradient than the lower reach. The steeper slope and confinement result in higher sediment transport capacity in the upper reach than the lower reach (Stillwater Sciences 2006). High sediment transport capacity, combined with proximity to a sediment barrier (Merwin Dam) creates a condition in which sediment is being exported from the reach without replacement. The bed surface of the upper reach is therefore likely a coarse lag deposit left behind by the 1933 flood, particularly the 0.8-km (0.5 mi) reach immediately below Merwin Dam.

In contrast to the upper reach, the lower reach (approximately RM 14 to RM 9) is less confined and bounded by relatively low-elevation fill terraces. The gradient is lower and the bed surface of the lower reach is finer and more mobile than in the upper reach. There is ample evidence that the bed load is mobile, such as active point bars, deposits of alluvium surrounding the trunks of riparian trees on the left bank at RM 14.5 (probably as result of the 1996 flood), and actively migrating multi-thread channels and mid-channel bars just upstream of Eagle Island. Substrate facies mapping and pebble counts conducted in 2005 show that the lower reach has a bed surface composed mainly of coarse gravel and is more fine-grained overall compared to the upper reach (Figure 7) (Stillwater Sciences 2006). Sediment transport modeling suggests that the return interval of sediment transporting floods in the lower reach is about four years (Stillwater Sciences 2006).

Human intervention has had an impact on channel planform and geomorphic function. As a consequence, aquatic habitat quality and quantity have been affected. The impacts are especially evident in the lower reach in the vicinity of Eagle Island, where the lower gradient unconfined channel is more responsive to perturbation. Gravel mining has been documented in historical aerial photography, with at least one instance at the upstream end of Eagle Island itself (BioAnalysts, et al. 2003). There are multiple bank protection measures for various purposes throughout the lower river. The methods for bank protection range from robust revetments or modest retaining walls to well-manicured lawns to the waters edge. In one instance a large pile of gravel was installed to deflect the river to protect a roadway near RM 12.5; this occurred prior to 1965 based on the aerial photo record (BioAnalysts, et al. 2003). The result of these types of interventions have been modest channel straightening and localized incision leading to an overall reduction and simplification of available aquatic habitat. For example, historically there was a channel that was at least seasonally wetted running across Eagle Island that is no longer active; this feature represents the loss of potentially valuable aquatic habitat.

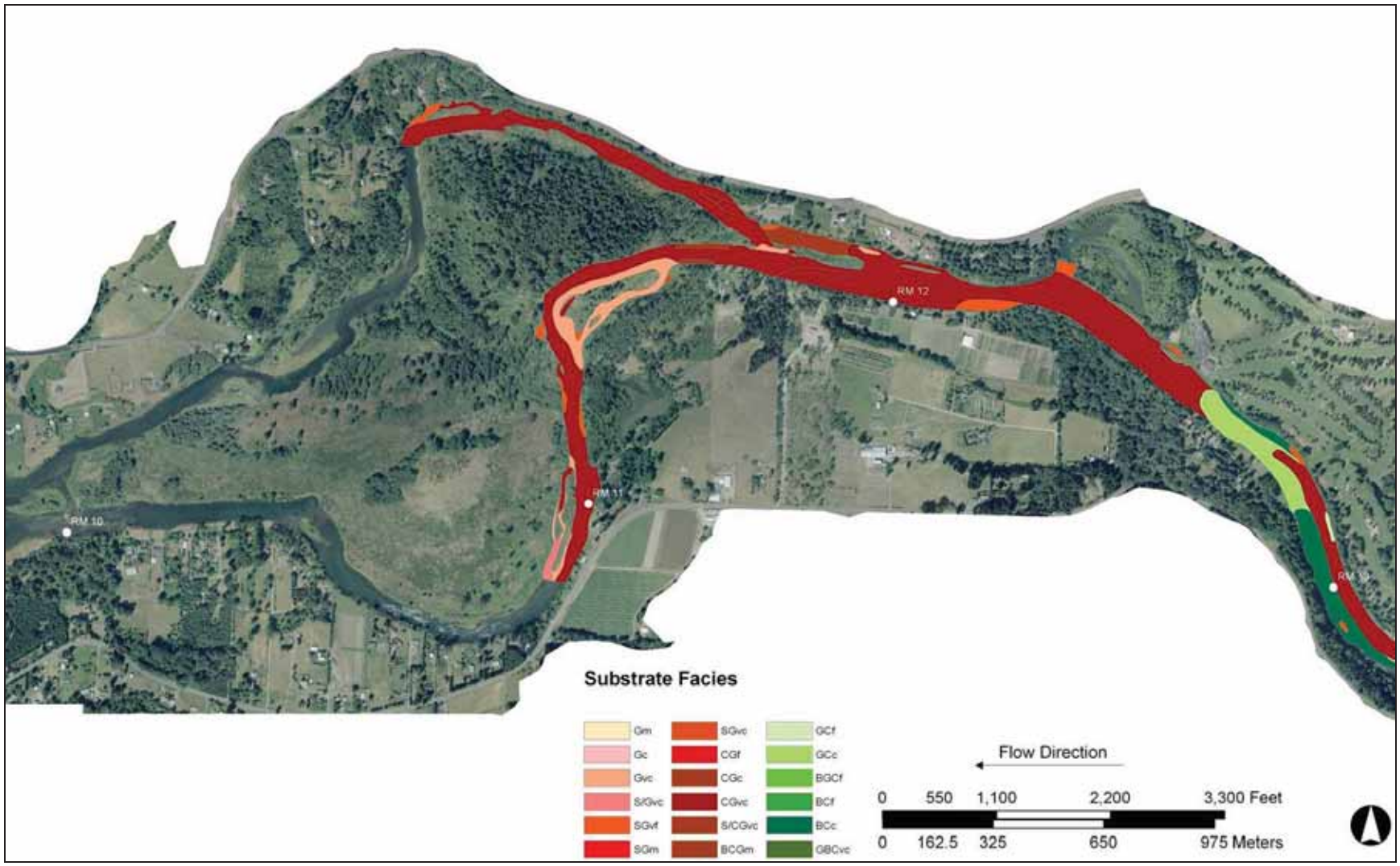


Figure 7. Substrate facies in the vicinity of Eagle Island on the lower Lewis River below Merwin Dam. Red polygons are gravel facies, and green polygons are cobble facies. Mapping was done by Stillwater Sciences (2006).

Habitat Surveys

Contemporary aquatic habitat in the North Fork Lewis River consists of habitat types typical of a large, low-gradient, alluvial river and consists of pools, riffles, and glides. Overall habitat quantity and quality are likely lower than pre-dam conditions because of channel simplification as consequence of flow regulation and incipient urban infrastructure. Reach-scale distinctions in the frequency and distribution of habitat units are driven by differences in the geomorphic setting between the upper and lower reach. The upper reach is continuously bounded by confining bedrock and has large, deep pools formed in the bedrock boundary. The lower reach is unconfined and the boundary consists almost universally of unconsolidated alluvial deposits that reduce the occurrence of deep pools. Low-velocity habitat in the lower river in the vicinity of Eagle Island is dominated by glides. However, meander-bend cut-offs and other relict channel features form backwater habitats in the lower reach that are likely to be important habitat features for juvenile salmonids.

Habitat surveys were conducted in 2001 (BioAnalysts, et al. 2003). The results of the habitat surveys are presented in Table 7. Habitat type maps for the entire river between Merwin Dam and the downstream end of Eagle Island were developed based on the 2001 surveys; a map of habitat types in the vicinity of Eagle Island is shown in Figure 8.

Table 7. Summary of aquatic habitat in the Lewis River from Merwin Dam downstream through the Eagle Island channels, based on Table 2.3-6 presented in WTS 3 in BioAnalysts, et al. (2003).

Confined Reach	Riffle	Glide	Pool	Side Channel
Average length (ft)	871 (22 %)	2,267 (56%)	854 (22%)	none
Average wetted width (ft)	224	252	269	none
Average bankfull width (ft)	350	305	313	none
Total wetted area (sq ft)	1,222,085	3,440,601	1,408, 551	none
Dominant substrate	CO	CO	BO/BR/CO	none
Subdominant substrate	Co/GR	GR	CO	none
Unconfined Reach (including Eagle Island channels)	**Riffle**	**Glide**	**Pool**	**Side Channel**
Average length (ft)	922 (17%)	3.080 (60%)	none	1,175 (23%)
Average wetted width (ft)	210	232	none	87
Average bankfull width (ft)	256	296	none	108
Total wetted area (sq ft)	1,416,530	7,329,776	none	413,750
Dominant substrate	CO/GR	CO	none	GR/SI
Subdominant substrate	GR	GR	none	SA

BO = boulder, CO = cobble, SA = Sand, BR = bedrock, GR = gravel, SI = silt.

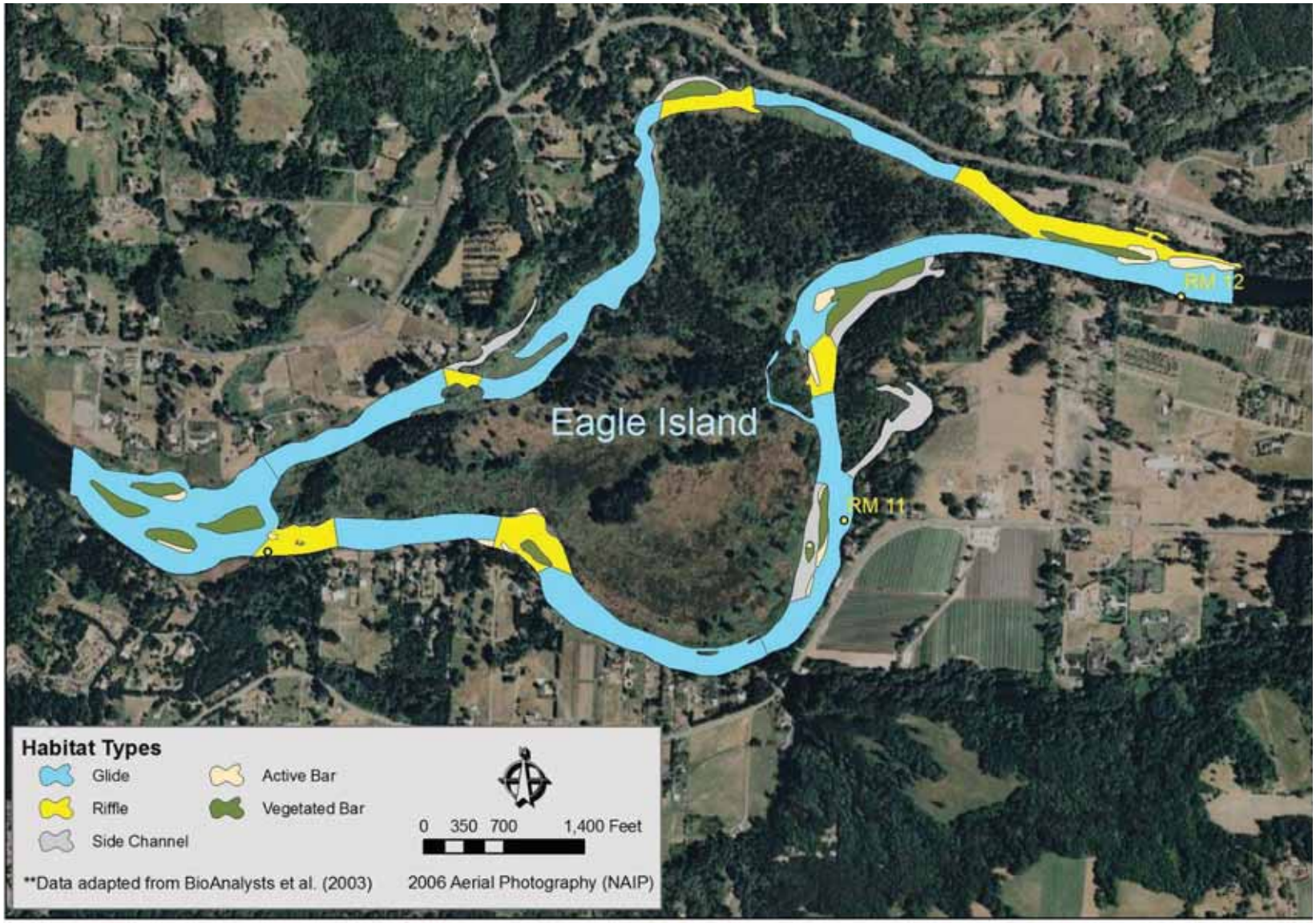


Figure 8. Habitat mapping in the Eagle Island area. Data obtained from BioAnalysts et al. (2003), with slight modifications.

Spawning Gravel Study

Spawning gravel quantity has not changed since Merwin Dam was built (at least since the 1933 flood), and it is not likely to change in the near future (Stillwater Sciences 2009). This finding was supported by the following findings: spawning habitat near the dam has not changed since 1933, sediment transport modeling results show relatively low average annual sediment transport, and tracer experiments show that discharge as great as a 3.5-year recurrence interval transports little sediment (Stillwater Sciences 2006, 2009).

Based upon observations over four non-consecutive years, the average areal extent of mapped spawning habitat in the upper river was found to be about 154,000 m^2 (Table 8), with a standard deviation of ~13%. The general location and spatial extent of mapped polygons of spawning gravel remained similar each year, but there were differences that reflect the imprecision in the methods used. Mapped spawning habitat in the lower reach is shown in Figure 9. This figure also includes spawning habitat mapped by BioAnalysts, et al. (2003) in 2001.

No appreciable change in the area of spawning habitat in the upper river was found between 2005 and 2008, therefore immediate addition of spawning gravel was not warranted (Stillwater Sciences 2009). However, if future spawning habitat monitoring subsequent to large floods reveals a loss of spawning habitat area of about 35%, then the addition of spawning-sized gravel to the upper reach may be warranted. The exact approach for gravel augmentation has not yet been determined, but rather will be developed if the need for gravel augmentation should arise (Stillwater Sciences 2009).

Table 8. Mapped spawning habitat in the Lewis River between Merwin Dam and the Fish Hatchery.

# of Polygons Mapped	2001 spawning habitat area (m^2) [1]	2005 spawning habitat area (m^2)	2007 spawning habitat area (m^2)	2008 spawning habitat area (m^2)
1	17,245	1,448	2,021	6,733
2	4,332	14,517	4,930	6,495
3	7,214	13,153	46,659	1,260
4	9,916	1,936	2,956	921
5	522	49,972	7,426	1,696
6	54,858	15,561	32,521	12,784
7	18,319	23,958	1,045	146
8	--	12,543	12,359	84
9	--	2,441	2,855	29,949
10	--	882	4,851	49,758
11	--	455	5,142	19,494
12	--	10,901	8,946	32,050
13	--	9,933	--	--
14	--	786	--	--
15	--	6,666	--	--
16	--	836	--	--
17	--	1,756	--	--
18	--	1,143	--	--
19	--	650	--	--
Total Area (m^2)	112,407	169,539	131,711	161,371

1. 2001 spawning habitat area is derived from shapefiles generated by BioAnalysts, et al. (2003).

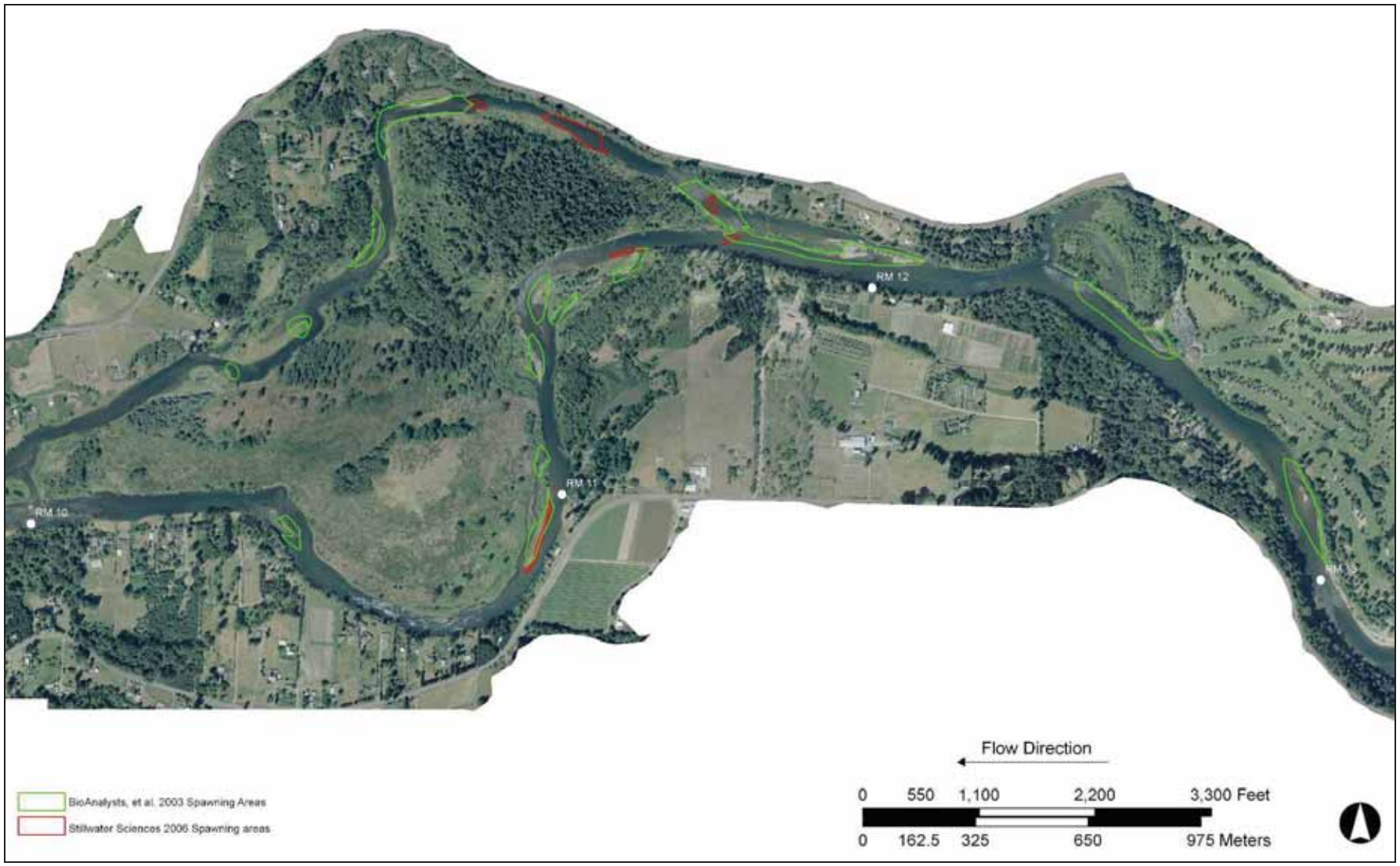


Figure 9. Mapped spawning habitat in the vicinity of Eagle Island on the lower Lewis River below Merwin Dam. Spawning mapping was done by BioAnalysts et al. (2003) and Stillwater Sciences (2006).

Large Woody Debris Conditions

Prior to European settlement, large woody debris (LWD) likely played an important role in providing complex fish habitat in the mainstem Lewis River. LWD conditions have been altered by direct removal, hydropower operations, timber harvest, and channel/streambank manipulations. The frequency and size of LWD in the mainstem is now considerably lower than would have been expected under historical conditions (Interfluve et al. 2008).

LWD in the mainstem Lewis River has been quantified as part of a number of studies, including the Stream Channel Morphology and Aquatic Habitat Study (BioAnalysts, et al. 2003, WTS-3 Report) and a habitat assessment conducted by the Lower Columbia Fish Recovery Board (LCFRB 2004a). The WTS-3 Study counted 72+ pieces (>15 cm diameter and >7.6 meters long) in the Eagle Island channels in 2000 and the LCFRB study (2004a) counted approximately 113 pieces (>10 cm diameter and >7.6 meters long).

Large woody debris (LWD) conditions in the lower river below Merwin Dam were evaluated as part of the Lewis River LWD Study (Interfluve et al. 2008). The study estimated the historical abundance of LWD pieces by reach using a regression model developed from old-growth streams throughout Washington State (Fox and Bolton 2007). These data suggest an historical LWD frequency of approximately 70 pieces per 100 meters, for a total of 2,709 pieces (>10 cm diameter and > 2 meters long) within the Eagle Island reaches (see Table 9). Thus, historical LWD numbers may have been on the order of 20 times larger than current numbers in the Eagle Island reaches.

Table 9. Excerpt of table from the Lewis River LWD Study (Interfluve et al. 2008) showing the results of the regression model predictions for historic numbers of pieces of LWD expected by reach for the Eagle Island reaches. For comparison, also shown are the percentile ranges of wood loading for Western Hemlock forests (applicable to this section of the Lewis River) from Fox (2001). BFW = bank-full width.

Reach Descriptions and characteristics				***Number of LWD[1] Pieces***		
Reach	**Description**	**Reach Length (m)**	**BFW (m)**	**Central distribution (25th percentile, median, 75th percentile) for number of LWD pieces/100m([3])**	**Regression-predicted LWD Pieces/100m (considering all significant variables)[4]**	**Total number of pieces expected for the entire reach**
Lewis 4a	Ross Cr. to Hayes. Cr.	1749	117[5]	57/ 106/ 208	73	1,271
Lewis 4b	Hayes Cr. to Staples Cr.	2100	114[5]	57/ 106/ 208	72	1,509

[1] Minimum size of 10 cm midpoint diameter and 2m in length (Schuett-Hames et al. 1999)
[2] Confined = valley width <2 channel widths; Moderately Confined = valley width is 2-4 channel widths wide.
[3] Based on percentile distributions for bank-full width category (Fox and Bolton 2007)
[4] Based on multiple regressions using bank-full width, forest type, gradient, confinement, & bedform (Fox and Bolton 2007)
[5] Sum of channel widths of north and south channel.

As part of the LWD Study, a survey was conducted on August 10, 2007 to identify the quantity of "key pieces" of LWD in the mainstem. A key piece was defined as a piece that was judged to be self-stabilized within the bankfull channel. In the Eagle Island reaches (Lewis 4A and 4B) a total of 5 key pieces were identified; 4 were cottonwoods and one was of unknown species. One piece in reach 4B was serving as a key piece of a large jam that extended up onto the river right flood terrace (South channel, river mile 11.3). The presence of large key pieces is critical in a system the size of the Lewis, where most wood will only be retained in the channel as part of large jams that are initiated by very large (i.e. old-growth) key pieces.

In general, the LWD study concluded that LWD dynamics have been severely altered in the mainstem. The ability of the Lewis River to support significant quantities of LWD is impacted by: 1) the series of hydroelectric dams that interrupt wood transport, 2) past harvest of large trees that could provide a source for key pieces, 3) alteration of the natural flood regime that could serve to recruit wood from the stream corridor, and 4) channel alterations that reduce channel migration processes that could recruit LWD.

Data Availability and Gaps

Table 10 identifies data sources that are available for the Eagle Island area. In nearly all cases, except for LiDAR data, these data have already been obtained by the project team and will be used to help identify project opportunities.

Table 10. Available data sources for the Eagle Island area.

Data Description	Data Source	Obtained by project team?
Historical channel locations	BioAnalysts et al. 2003	Yes
Substrate mapping	BioAnalysts et al. 2003 Stillwater Sciences	Yes
Habitat typing	BioAnalysts et al. 2003 LCFRB	Yes
Juvenile salmonid catch data	WDFW	Yes
Chinook spawning data	WDFW	Yes
Steelhead spawning data	WDFW	Yes
Adult escapement data	WDFW	Yes
Large woody debris data	BioAnalysts et al. 2003 Interfluve et al. 2008	Yes
Aerial photography	PacifiCorp and various other entities	Yes
LiDAR	Clark County	No

These data provide a good basis for identifying project opportunities; however, there are a number of data gaps that will need to be filled during the project identification and design phases. These include the following:

- Vegetation conditions. Limited data exists regarding the condition of riparian and floodplain vegetation in the Eagle Island area, particularly with respect to the presence of invasive species. Vegetation conditions will help to inform the selection of potential project opportunities in the study area. It is anticipated that restoration of native vegetation communities and control of invasive species will be an important component of restoration efforts in the Eagle Island area.

- Topographic survey data. LiDAR data will be helpful but not detailed enough to evaluate and design enhancement projects in the study area. It will be necessary to collect detailed topographic survey data as part of the project design phase.

- Channel hydraulics. Channel hydraulics, inundation levels, and scour potential throughout the study area will be necessary for development of project designs. These data will be collected as part of the project design phase.

Project Recommendations from Previous Studies

A number of previous studies describe enhancement and protection opportunities within lower North Fork Lewis Basin and within the Eagle Island area in particular. These include the Recovery Plan (LCFRB 2004b), the LCFRB Habitat Strategy (2009), the Water Resources Inventory Area (WRIA) 27 Limiting Factors Analysis (Wade 2000), the Lower North Fork Lewis River Habitat Assessment (LCFRB 2004a), and the Lewis River LWD Study (Interfluve et al. 2008). Enhancement and preservation recommendations from these studies are described below.

Lower Columbia Recovery Plan

The Recovery Plan identifies general measures and actions that are necessary within the lower North Fork Lewis Basin to achieve the regional recovery strategies. These include the following:

1. Protect stream corridor structure and function
2. Protect hillslope processes
3. Manage regulated stream flows to provide for critical components of the natural flow regime
4. Restore floodplain function and channel migration processes in the mainstem and major tributaries
5. Restore access to habitat blocked by artificial barriers
6. Restore channel structure and stability
7. Create/restore off-channel and side-channel habitat
8. Restore degraded hillslope processes on forest, agricultural, and developed lands
9. Restore riparian conditions throughout the basin
10. Restore degraded water quality with emphasis on temperature impairments
11. Provide for adequate instream flows during critical periods
12. Limit intensive recreational use during critical period

LCFRB Habitat Strategy

The LCFRB Habitat Strategy (LCFRB 2009) identifies the types of projects that would yield benefits to salmon and steelhead populations specifically within the Eagle Island reaches. Projects that address the following factors are considered high priority:

- Stream channel habitat structure and bank stability
- Off channel and side channel habitat
- Floodplain function and channel migration processes
- Riparian conditions and functions
- Water quality
- Instream flows
- Watershed conditions and hillslope processes

WRIA 27 Limiting Factors Analysis (2001)

The WRIA 27 Limiting Factors Analysis recommends protection of the off-channel habitat in the Eagle Island area due to it's use as critical rearing habitat for juvenile fall Chinook. No other enhancement or preservation measures were identified in the study area.

Lower North Fork Lewis River Habitat Assessment (2004)

The Lower North Fork Lewis River Habitat Assessment recommended preservation of Eagle Island reaches as the most important measure that could be implemented in the lower North Fork Basin. This study states that this area appears to be the only mainstem area where fluvial geomorphic processes are currently functioning properly. No other enhancement or preservation measures were identified in the study area.

Lewis River LWD Study (2008)

The Lewis River LWD Study recommended LWD supplementation projects within the Lewis River as a means to enhance pool formation, increase cover and complexity, capture and sort gravels, and promote more natural channel adjustment processes. The study identified several specific project opportunities throughout the lower mainstem, including within the Eagle Island area, where a total of 5 project opportunities were identified. These project opportunities are listed below by river mile and are displayed on an aerial photo map in Figure 10.

RM 11.9: Top end of Eagle Island. Construction of bar apex log jams at cross-over channels and at top of island. Jams would be designed to maintain flow into north channel and would provide complex rearing habitat.

RM 10 to 11.7 North Channel: Entire length of north channel. Wood jams installed at numerous potential locations in the north channel to increase complexity and habitat conditions.

RM 11.6 South Channel: Enhancement of existing left-bank side-channel near top end of south channel. Install bar apex LWD jam and numerous other jams within the side-channel to enhance complexity and maintain multi-thread channel. Riparian enhancement is also recommended here.

RM 11.3 South Channel: Enhancement of existing backwater area on river left bank near top end of south channel. Large meander bend jam within backwater area and extending along mainstem channel margin to provide complexity to existing backwater and enhance pool formation and complexity in the main channel. There is also the potential to re-activate an existing flood flow channel as a low-flow side-channel.

RM 11 South Channel: Left bank of south channel 2/3 distance up the south channel. Install jams within existing left bank backwater and extend along channel margins of main channel to enhance cover in backwater and pool formation/cover in main channel.

Figure 10. Aerial map of project opportunities identified in the Lewis River LWD Study.

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EAGLE ISLAND PROJECT IDENTIFICATION AND DESIGN

Tech Memo 2: Preliminary Project Opportunities

To: Lower Columbia Fish Recovery Board and Eagle Island Technical Oversight Group (TOG)

From: Interfluve, Stillwater Sciences, and Berger Abam

Primary Authors: Gardner Johnston, Byron Amerson, Brian Bieger

Date: 8/20/2009

Description: This Technical Memorandum describes preliminary project opportunities that have been identified for the Eagle Island study area.

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BACKGROUND

This document describes a preliminary suite of potential stream and habitat restoration project opportunities in the Eagle Island study area. Based on review, prioritization, and refinement of this list, select projects will be moved forward to the 30% project design stage, with one project eventually taken to the Final Design stage.

Selection of potential projects is based on a consideration of habitat limiting factors, species-specific life history requirements, geomorphic and hydraulic conditions, and riparian vegetation conditions. Projects were derived through a number of methods, including the following:

1. Review and adaptation of existing restoration project enhancement recommendations from the Lewis River LWD Study
2. Office-based analysis of aerial photography and LiDAR data
3. Site visit via foot and boat on August 12, 2009

GEOMORPHIC SETTING

Past and existing land uses, river management, and natural geomorphic processes affect the ability of the Eagle Island area to support aquatic habitat restoration measures. In general, restoration project opportunities appear to be abundant; however, the processes that have resulted in a reduction in habitat quantity and quality will need to be carefully considered when planning future restoration efforts.

Existing and current conditions have been summarized in Tech Memo 1. These conditions, and field observation during the project identification survey, have resulted in the following general conclusions that have helped to guide the project identification process:

1) Channel complexity with respect to the availability of off-channel and side-channel habitats has been reduced since historical conditions. Reach-scale fluvial evolution is progressing toward a simplified channel planform as former multithread channels are abandoned. Past gravel mining, and possibly the effects of the hydropower system on sediment transport, have contributed to incision that has resulted in abandonment of off-channel habitat. Restoration activities that occur at the sub-reach scale in the vicinity of Eagle Island must consider the factors that will contribute to their maintenance and longevity in light of reach-scale trends in channel planform. Incorporating well-designed large wood structures at the inlets of newly excavated and reconfigured side-channels will help to initiate localized flow convergence and seasonally scour the channels to maintain depth and substrate character. In some cases, installation of wood structures alone (i.e. bar apex jams) may be the best approach to restoring natural channel adjustment and habitat formation.

2) The north channel around Eagle Island is progressively being abandoned. This phenomenon has been occurring for more than a decade and can be seen in the historical aerial photo record. All of the projects identified in the north channel need to be evaluated within the

context of the potential for complete north channel abandonment. Any significant effort expended on restoration work in the north channel should be completed in conjunction with efforts to maintain flows into the north channel. Furthermore, it should be recognized that addition of LWD into the north channel may increase roughness that could hinder efforts to keep the north channel active during low flow periods. Hydraulic and geomorphology analysis will be necessary to properly evaluate this risk.

3) There is a significant lack of large woody debris that is necessary to provide routine channel adjustment, habitat formation, storage and sorting of sediments, and aquatic habitat cover and velocity refuge. Restoring LWD should be a key objective but will require engineering approaches due to high stream energies and lack of the size of trees needed to be self-stabilized (i.e. key pieces) within the mainstem Lewis. On the other hand, relative to other areas in the North Fork Lewis, the Eagle Island area likely presents the greatest opportunities for LWD restoration because of the lower energy, split-flow condition.

4) Riparian vegetation conditions have been impacted by past clearing, the introduction of invasive species, and altered channel dynamics. Restoration of streambank, floodplain, and wetland vegetation should be an objective of restoration efforts.

5) Private lands along the landward sides of the north and south channels may affect the feasibility of conducting certain restoration projects.

OVERVIEW OF PROJECT OPPORTUNITIES

A total of 14 potential projects are identified throughout the north and south channels. The north channel projects should be viewed in light of the caveats mentioned above with respect to potential north channel abandonment. The projects primarily consist of creation of new off-channel habitats, enhancement of existing off-channel habitats, installation of LWD, and riparian restoration. A focus is placed on restoring channel dynamics and habitat-forming processes to the extent possible at the reach-scale. The identified treatments take advantage of natural topography such as utilizing historical channel scars and re-activating past channel locations. Most treatments will create velocity refuge from hydro-system flows that are kept higher than historical flows for some portions of the year. The treatments are primarily focused in the upstream portion of the Eagle Island channels, which are closer to spawning areas, are highly used for juvenile rearing, and are less influenced by tidal backwater. A number of sites may provide habitat for chum salmon spawning, but further groundwater/upwelling investigation will be needed to confirm suitability.

Detailed riparian vegetation conditions and vegetation enhancement measures are described for a subset of the project areas. This detailed information can be reasonably interpreted as applying to other nearby project sites where detailed information was not collected.

For most projects, a general construction cost range is provided. However, these should be viewed as very preliminary approximations. Actual costs will require further project development.

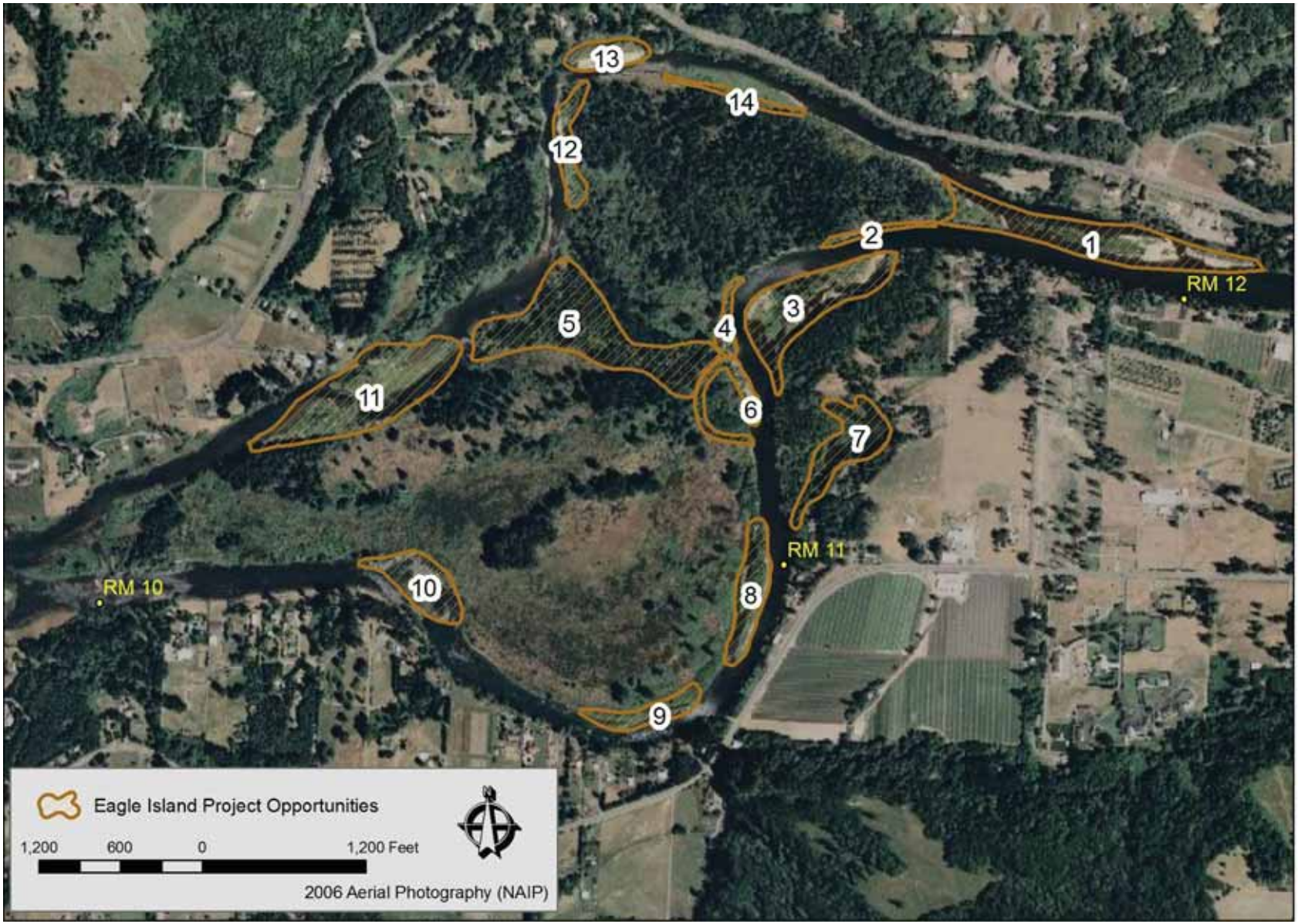

Figure 1. Aerial photo map of Eagle Island showing the location of potential project opportunities.

PROJECT OPPORTUNITIES

Project 1: Channel Split

Site Description

This site is located at the top end of Eagle Island where flow spills over to the north channel; RM 11.8 – 12. This is essentially the same project as the RM 11.9 project from the LWD Study.

The primary flow has been shifting from the north to the south channel since the 1930s. Low flow may no longer reach the north channel if this trend continues. The top end of Eagle Island has yielded relatively high numbers of juvenile salmon in the WDFW seining efforts (see Tech Memo 1).

Figure 2. Aerial view of project site. Cross-over channels just upstream of bifurcation at upstream end of Eagle Island.

Treatment Alternatives

Log jam structures could be designed to maintain summer-season flow into the north channel at locations where low-water spills over from the main channel to the north channel. Structures could be designed to encourage scour (deepening) of cross-over channels to maintain low-water conveyance. Cover and habitat complexity would also be created. There are 2-3 crossover channels in this area, comprising a combined width of 400 – 500 feet. Bar apex log jams could be placed at one or more of these channels to maintain scour depths suitable to convey adequate summer flows into the north channel. Structures would be designed to constrict flow and increase depths at cross-over channels.

Anticipated Benefits

This project will maintain active flow into the north channel, which will increase channel diversity and habitat availability in the reach as a whole. Benefit will also be provided to juvenile salmon and steelhead for velocity refuge and rearing cover. Adult salmon and steelhead will benefit from additional pool habitat and holding cover and sorting of gravels for spawning.

Feasibility and Cost Considerations

Hydraulic and scour analysis would be necessary to ensure that structures function properly in maintaining flow through the channels. This effort would be most successful if paired with log jam placements near the top-end of the south channel that will add roughness and encourage more flow into the north channel during flood events.

Project cost estimate $200,000 to $300,000 depending on number of log jams constructed. Access and de-watering may be challenging given the location between the two channels.

Project 2: Right Bank near Upstream End of South Channel

Site Description

This site is located on the right bank at the upstream end of the south channel. The site is characterized by a 3-5 foot high bank with intermittent bank vegetation. This site is located across the channel from the left bank side-channel entrance (Project #3) and could be reasonably combined with this project and with Project #1.

Figure 3. Right bank at upstream end of south channel. Entrance to left bank side-channel is at left of photo.

Treatment Alternatives

This project would involve the construction of lateral log jam structures along the right bank that are anchored on the right bank and extend out into the active channel. Structures in this location will provide roughness at the top end of the south channel, which will encourage flow into the north channel during flood flows, and will therefore assist in keeping the north channel active.

Anticipated Benefits

This project will enhance nearshore juvenile rearing and adult holding habitat. Structures will also enhance complexity and channel roughness that will encourage flood flows to continue to occupy the north channel.

Feasibility and Cost Considerations

Access will need to be gained to the island for construction of this project. The impact on boating traffic must be considered as part of design. Costs will vary depending on length and scale of treatments.

Project 3: Left Bank Existing Side Channel – South Channel

Site Description

This is the same project as the RM 11.6 project from the LWD Study. This side channel begins on the left side of the south channel river about 250 meters downstream of the upstream end of Eagle Island. This channel is wetted during the low flow season and the channel boundary is composed of gravel. The gravel bar that separates the channel from the mainstem is well-vegetated and has a few mature riparian trees. There are several small islands in this side channel, and overall channel complexity is relatively high. There is currently some wood in the side-channel but scour pools are scarce and riparian cover is poor. The inlet begins in a shallow water reach just upstream of a riffle and the outlet is downstream of the riffle; the gradient is expected to be similar to the mainstem.

This is one of the best sites on the lower Lewis for enhancement of channel complexity and re-introduction of LWD, primarily due to the following: 1) wood jams can be constructed that are protected from mainstem flows, 2) the project enhances existing complexity and channel dynamics, and 3) the project will not affect boat traffic. A secondary benefit of wood placed at this location is the increased roughness that would encourage continued flows in the north channel, especially if combined with projects 1 and 2.

The vegetation on the narrow island in the southern channel is stratified into two separate age classes. The eastern portions of the island are vegetated by young trees and a variety of non-native herbaceous species. Tree species within the eastern portion of the island are limited to Oregon ash, black cottonwood, and red alder. Tree density is very high in the eastern portion of the island with stem counts estimated at 500 per acre. The age class of the trees is in the 10-15 year rage with average tree heights of 8-10 feet. There is very little shrub coverage in the eastern most portion of the island with species limited to Scouler's willow (*Salix scoulerana*), hooker willow (*Salix hookeriana*), Himalayan blackberry, Japanese knotweed (*Polygonum cuspidatum)* and spiraea. This is in contrast to the central and western portions of the island that have a dense shrub layer beneath a canopy of mature black cottonwood and Oregon ash trees. Herbaceous vegetation includes a wide variety of non-native species including colonial bentgrass, Canada thistle *(Cirsium arvense),* smooth hawksbeard, common vetch *(Vicia sativa),*common plantain *(Plantago major),* common tansy *(Tanacetum vulgare),* and curly dock *(Rumex crispus).*

Figure 4. View looking downstream at project area. Head of side-channel is on the right.

Treatment Alternatives

Medium to large jams and individual pieces could be placed throughout the 1,200 foot long side channel. At the head of the side channel, a large bar apex jam could be constructed that wraps the upstream end of the island and extends into the main channel; this would provide habitat benefit to the main channel and could be designed to ensure flow conveyance to the side channel during low flows. Restoration of riparian plant communities (alder, cottonwood, and willow) throughout the entire island would be a major component of work in this area.

Vegetation enhancements near the eastern end of the study area should focus on control of Himalayan blackberry and the establishment of a native shrub/scrub layer. Establishment of a dense shrub layer will improve wildlife habitat values, reduce scour during moderate flood events, and help prevent further establishment of invasive species. Species to be planted in this area will have to be specially selected due to the extremely sandy nature of the soil. Soil sample pits revealed very little organic matter in the soil which will severely limit the ability of some native species to become established. Species will likely be limited to willow, red-osier dogwood, and spirea.

The Himalayan blackberry can be effectively eliminated with herbicide applications in the fall. Japanese knotweed is exceptionally difficult to completely eradicate although this very aggressive species can be effectively suppressed through the implementation of an herbicide treatment schedule. This schedule would include multiple injections of glyphosate throughout the growing season.

Anticipated Benefits

This reach is ideal for restoration since it already contains relatively high-quality aquatic habitat, especially for rearing juvenile salmonids, which were observed in abundance during the survey. Wood placements in the side channel would provide cover and scour pools that would benefit juvenile steelhead, Chinook, and coho rearing throughout the year. LWD jams would also enhance adult holding and spawning.

Feasibility and Cost Considerations

LWD jams could be anchored through burial, piling, or boulder ballast. Flood energy is lower and ability to utilize width and capacity at large flows enables a more stable site for wood habitat creation. Wood extending into main channel at head of side channel (bar apex jam) could be anchored through burial of key members into bar and through boulder ballast.

There appears to be an old access road on the left bank adjacent to the project area. This area is owned by Clark County but access across private lands will be required. The terrain is flat and wood could be transported to the site easily.

This project would have a medium-to-low cost for this type of project due to ease of access and ease of de-watering. The estimated cost range is $200,000 to $300,000, but could vary widely depending on the extent of treatments.

Project 4: Right Bank Alcove – South Channel

Site Description

This site is located on the right bank near the upstream end of the south channel; RM 11.3. This is essentially the same project as the RM 11.3 project from the LWD Study.

There is a large alcove/side-channel on the right bank just upstream of the outlet of the side channel described above for Project #3. This is part of an old meander scar. The alcove provides good opportunity for LWD placements that would encourage continued flow into the alcove/side-channel and would provide good complexity and cover for rearing fish in this protected area. Placed structures would have some protection from large mainstem flows.

Figure 5. View of project site looking upstream

Treatment Alternatives

Lateral, meander-bend wood placements would begin 500 feet upstream of the entrance to the alcove and would extend into the alcove and line the perimeter. A bar apex jam could be constructed on the small island that splits flow into the alcove. These wood placements would maintain scouring flows into the alcove. Jams could also be placed on the mid-channel bar adjacent to this site.

The larger the wood the greater opportunity to extend into the low flow active channel. There currently exists a large jam that is mostly above the bankfull channel on the southern bank of the eddy. This is likely from the February 1996 flood. Some of this wood could be incorporated into the constructed jam within the active channel.

Anticipated Benefits

Log jam construction would provide habitat for adult holding for Chinook, coho, steelhead, and chum – There are known spawning sites adjacent to the project area. Juvenile rearing habitat would be provided throughout the year for Chinook, coho, and steelhead.

Feasibility and Cost Considerations

Access could be provided from the south (left) bank from the same access road described for project #3, but would require a crossing of the south channel. Access from Eagle Island (crossing the north channel) would likely be a more reasonable approach.

The estimated cost range is $200,000 to $300,000, but could vary widely depending on the extent of treatments.

Project 5: Eagle Island Cross-Over Channel

Site Description

This is the overflow channel that crosses Eagle Island during flood flows. The channel was active during low flow periods up until at least 1974; the 1988 aerials show only a connected backwater channel extending partway across the island from the north channel.

The inlet of the cross-island channel begins in the south channel about 700 meters downstream of the upstream end of Eagle Island, and the outlet is in the north channel. The upstream half of the overflow channel consists of multiple shallow overflow channels that eventually converge into one or two primary flow channels before emptying into the north channel. Near the downstream end, the channel boundary is composed of silt and sand up to 60 cm deep overlying gravel substrate, indicating past transport of coarse substrate.

There is thick growth of vegetation composed of bog-loving plants and riparian vegetation including relatively large softwoods and hardwoods. There were multiple pieces of downed wood in the channel; some recruited through in situ mortality, while other accumulations were rafted in place by high flows. Free-flowing scouring flows appear rare in this channel as downed wood and mature riparian trees create roughness that dissipates flow energy. There were several locations where debris was hanging from branches 4 meters from the channel bed from the January 2009 high flows, but there was very little evidence of scour or sediment transport in this channel.

Figure 6. This is the most well-developed portion of the cross-over channel and is close to the downstream end (north channel end) of the overflow channel.

Figure 7. Flood debris from January 2009 flood near outlet of cross-over channel along the left bank of the north channel. Height is 16 feet above terrace.

Treatment Alternatives

Channel excavation would be conducted to activate this channel at low summer flows. Excavation, widening, and realignment of the channel would be required. A new inlet farther upstream coupled with a new outlet further downstream may be necessary to create gradient sufficient to sustain channel maintenance flows to keep this channel active. Connected backwater channels or groundwater-fed chum channels could be incorporated into this project, contingent on groundwater/upwelling monitoring.

Anticipated Benefits

This project would significantly improve channel complexity and habitat availability. This channel has the potential to provide a large area of summer rearing habitat for juvenile salmonids. There is also the potential for chum spawning habitat within the new channel or in groundwater-fed channels that are connected to the new channel.

In the event that the inlet to the north channel becomes abandoned, this project would ensure at least some continued flow through the downstream half of the north channel.

Feasibility and Cost Considerations

This channel has abandoned due to lowering of the base level of the main channel over time, which is related to sediment transport conditions, LWD conditions, and land-use modifications throughout the lower mainstem. The continued influence of these reach- and basin-scale processes need to be adequately considered before proceeding with this project. In addition, placement of LWD would need to proceed with caution, as additional channel roughness may compromise the ability of a new channel to maintain competency and prevent future abandonment.

This project has a high cost due to the length of the channel, the large volume of excavation, and the design requirements. The cost and potential risk of re-abandonment need to be carefully weighed against the potential habitat benefits.

The construction cost will depend largely on the excavation volume and this will need to be determined through a detailed survey. An initial cost approximation is $700,000 to $1,000,000.

Project 6: Right Bank Side Channel RM 11.2 – South Channel

Site Description

This site consists of an abandoned channel on the right bank that begins just downstream of the right bank alcove (Project #4). The channel is filled with silty sand and is overgrown with vegetation. The inlet is just upstream of riffle in the main channel and the outlet enters the main channel downstream of a riffle. There is some ponding of water in this overflow channel. This area appeared to contain an active side-channel in the 1974 aerial photos and a connected backwater channel as recently as 1996. This channel could be re-activated as a low-flow side-channel.

This project could be combined with Project # 4 and #8 as a comprehensive treatment for this area.

This area is characterized by side channels, shallow water habitats, emergent wetlands, and shrub/scrub habitats. Vegetation is a combination of common wetland shrub species such as red-osier dogwood, pacific ninebark, willows, spirea, and areas of dense reed canarygrass. Emergent wetland species include soft rush (*Juncus effuses*), toad rush *(Juncus buffoensis*), dagger tipped rush (*Juncus ensifolius),* bur-reed (*Sparganium erectum*), and slough sedge (*carex obnupta).*

Figure 8. Outlet of abandoned channel.

Treatment Alternatives

Alternatives include re-activation of the right bank side-channel to be active at summer low-flow periods. Installation of large woody structures at the inlet (i.e. bar apex jam)

would constrain flow to maintain channel-flushing flows in the inlet to help maintain flow in the channel during summer low flow periods. This project could also include wood placements along the right-bank channel bar and existing backwater area adjacent to the mainstem.

Installation of woody structures and porous substrate within the constructed side-channel would encourage infiltration of flows and subsequent upwelling downstream that could provide potential chum spawning habitat.

Vegetation enhancements in this area would likely be limited to the installation of native tree species such as Oregon ash and black cottonwood. This would allow for future woody debris recruitment even though these species are hardwoods that will not subsist as long as softwoods. More thorough soil samples in this area will be necessary in order to determine if softwood plantings would be successful in this area.

Eradication of the reed canarygrass within the area would prove difficult and overly expensive. The establishment of a native tree canopy adjacent to the shallow water areas would provide shade and organic matter inputs.

Anticipated Benefits

This project would benefit off-channel and near-shore rearing for salmon and steelhead. A bar apex jam and activation of the side-channel would enhance channel complexity. There is potential here for construction of a chum spawning channel; upwelling conditions would need to be further investigated.

Feasibility and Cost Considerations

Access could be provided from the south (left) bank from the same access road described for project #3, but would require a crossing of the south channel. Access from Eagle Island (crossing the north channel) would likely be a more reasonable approach. Groundwater monitoring should be conducted to evaluate upwelling conditions that may be suitable to support chum spawning habitat.

The estimated cost range is $150,000 to $250,000, but could vary widely depending on the extent of treatments.

Project 7: Left Bank Existing Backwater – South Channel

Site Description

This is essentially the same project as the RM 11 project from the LWD Study. There is an outlet to a backwater channel (old meander scar) on the left bank upstream from where the stream draws close to houses and the roadway. This channel flows through a well-developed riparian forest to a large ponded backwater. The channel bed is gravel mantled by silty sand.

Figure 9. Outlet of existing backwater area on left bank RM 11.

Treatment Alternatives

Small- to medium-sized cover habitat log jams could be constructed within the backwater channel and extending downstream along the left margin of the main channel. There are several pieces of medium-sized logs there currently and accumulations of additional wood are likely if jams are constructed. Jams could be constructed to emulate large wood that has rafted into this location and accumulated over time. A side-channel that is connected to the main channel at the upstream end could also be evaluated for this site, creating flow-through conditions that would enhance channel complexity and rearing habitat.

Anticipated Benefits

Wood cover placements (jams and individual pieces) would provide habitat for adult holding for Chinook, coho, steelhead, and chum – The site is adjacent to a spawning riffle. Juvenile rearing habitat would be provided throughout the year for Chinook, coho, and steelhead.

Feasibility and Cost Considerations

The site is located on private property. There is a high bank adjacent to the site (downstream) with private residences. An adjacent Clark County parcel to the north could potentially be used for staging and to facilitate access.

If access can be reasonably obtained, this would be a relatively inexpensive project for its type. Construction cost range is $100,000 to $200,000.

Project 8: Right Bank Existing Side Channel, RM 11 – South Channel

Site Description

This side channel is about 1,100 meters from the upstream end of Eagle Island on the right side of the river. It is similar to, though smaller than, the side-channel at Project #3. The bar is overtopped above bankfull flows.

Figure 10. Outlet of side-channel right bank RM 11.

Treatment Alternatives

This side channel has restoration opportunities similar to Project #3. Placement of a bar apex jam at the head of the island and large wood placements jams on either side of the inlet to the side channel would encourage moderate scour and deepening of the side channel. The addition of smaller woody structures throughout the channel and downstream of the channel combined with riparian planting would add complexity and cover.

This site could be investigated for upwelling conditions that may support chum spawning habitat.

Anticipated Benefits

This project would enhance channel complexity and dynamics. Juvenile rearing and adult holding habitat would be enhanced through maintenance of side channel habitat and installation of LWD for cover and complexity.

Feasibility and Cost Considerations

This site would require access from Eagle Island. De-watering of the work area during construction would be straightforward as flow into the side-channel can be easily diverted to the main channel. The construction cost range is approximately $150,000 to $200,000.

Project 9: Right Bank Existing Backwater – South Channel

Site Description

This site consists of existing right bank backwater channels near river mile 10.8 in the south channel. These channels are inundated at high flows but may provide quality rearing cover and velocity refuge during the summer.

Figure 11. Existing backwater on right bank in south channel near RM 10.8

Treatment Alternatives

Alternatives include excavation of additional backwater channels, or potentially connected flow-through side channels, plus wood additions for habitat cover and complexity.

This site could be investigated for upwelling conditions that may support chum spawning habitat.

Anticipated Benefits

This project would benefit juvenile salmonid rearing and adult holding, particularly with respect to velocity refuge during periods of the year when hydro-regulated flows are higher than historical flows.

Feasibility and Cost Considerations

Access would be from Eagle Island. The construction cost range estimate is $150,000 to $200,000, but could vary widely depending on the extent of treatments. The potential for chum spawning habitat will require investigation of groundwater/upwelling conditions.

Project 10: Right Bank RM 10.5 – South Channel

Site Description

This site is located at a sharp left bend in the south channel. A riffle and small island are located at the site. Flow is focused on the right bank at the bend. The riparian area is devoid of mature native vegetation.

Figure 12. Right bank near RM 10.5 – South Channel.

Treatment Alternatives

Treatment would include addition of LWD jams for rearing and holding cover and restoration of native riparian vegetation.

Anticipated Benefits

This project would benefit juvenile salmonid rearing and adult holding, particularly with respect to velocity refuge during periods of the year when hydro-regulated flows are higher than historical flows.

Feasibility and Cost Considerations

Access would be from Eagle Island. The construction cost range estimate is $75,000 to $125,000, but could vary widely depending on the extent of treatments.

Project 11: Existing Backwaters – North Channel

Site Description

This site is located approximately 2,000 meters downstream of the upstream end of Eagle Island, in the north channel. This site contains a complex of existing backwater channels on both sides of the north channel. There is an overflow channel on the left bank. This overflow channel is similar in character to overflow channels in Projects 12 and 14. The site is subject to tidal influence from the Columbia River 17 KM downstream.

Treatment Alternatives

Treatment alternatives include installation of large wood apex jams and installation of LWD throughout existing backwater areas to enhance rearing cover and complexity. Connected side-channels could also be created through excavation, or log jams could be placed to encourage natural channel dynamics and adjustment.

This site may be suitable for creation of a chum spawning channel with upwelling conditions, especially if the channel is designed to receive subsurface flow originating from the main channel. Modest excavation of the channel to encourage flows during the late summer may increase available shallow-water habitat for juvenile salmon rearing. Riparian plantings would enhance shade and cover.

Anticipated Benefits

This project would enhance channel complexity and would benefit juvenile rearing and adult holding. There may be the potential for chum spawning habitat.

Feasibility and Cost Considerations

Access could be obtained from Eagle Island. There is private land on the right bank. Cost depends on the scale of the treatments applied and could range from $100,000 to $300,000.

The presence of hyporheic flow and adequate transmissivity of subsurface flow would need to be investigated to evaluate the potential for chum spawning habitat. A clay lens that was observed in the north channel may affect groundwater connectivity in some areas.

As with all of the projects identified in the north channel, there is risk associated with the north channel becoming completely abandoned. Any significant effort expended on restoration work in the north channel should be completed in conjunction with efforts to maintain flows into the north channel. Furthermore, it should be recognized that addition of LWD into the north channel may increase roughness that could hinder efforts to keep the north channel active during low flow periods. Hydraulic and geomorphology analysis will be necessary to properly evaluate this risk.

Project 12: Left Bank Side Channel – North Channel

Site Description

This site is located in the north channel, about 1,000 meters downstream of the Island Boat Ramp. There are actually 2 distinct overflow channels at this location that are not active at summer low flows. These channels are overgrown with vegetation (primarily reed canarygrass) and the bed is composed of silty sand throughout, forming boggy areas and small ponds.

Figure 13. Left bank overflow channel in the north channel.

Treatment Alternatives

One alternative is to create a flow-through side channel that is connected to the mainstem upstream of the riffle at the sharp meander bend. This would increase the gradient and would help to maintain flow competency within the channel. A bar apex jam could help to maintain the scour near the inlet and would add to habitat complexity.

Another alternative is to create a hyporheic-fed channel that is not connected to the main channel at the upstream end but that sources groundwater flow from the main channel. More investigation will be needed to assess feasibility of this approach.

Vegetation enhancements in this area should include installation of native shrubs within the floodplain, which would provide several benefits including: future reduction in

abundance of reed canarygrass, wildlife habitat benefits in the form of food and cover, and roughening of the floodplain. If modification of the northern channel is anticipated, then the effects of dense floodplain plantings will need to be evaluated. Suitable species for this area include willows, red-osier dogwood, spirea, pacific ninebark, and nootka rose.

Anticipated Benefits

This project would enhance channel complexity and dynamics. Juvenile rearing and adult holding habitat would be enhanced through maintenance of side channel habitat and installation of LWD for cover and complexity. This site has the potential to support chum spawning.

Feasibility and Cost Considerations

The presence of hyporheic flow and adequate transmissivity of subsurface flow would need to be investigated to evaluate the potential for chum spawning habitat. Installation of porous substrate and/or groundwater galleries could be utilized to enhance upwelling conditions. A clay lens that was observed in the north channel may affect groundwater connectivity in some areas.

The construction cost range is approximately $150,000 to $250,000, but could vary widely depending on the extent of treatments.

As with all of the projects identified in the north channel, there is risk associated with the north channel becoming completely abandoned. Any significant effort expended on restoration work in the north channel should be completed in conjunction with efforts to maintain flows into the north channel. Furthermore, it should be recognized that addition of LWD into the north channel may increase roughness that could hinder efforts to keep the north channel active during low flow periods. Hydraulic and geomorphology analysis will be necessary to properly evaluate this risk.

Project 13: Right Bank Existing Side-Channel – North Channel

Site Description

This is an active side-channel along the right bank in the north channel approximately 800 meters downstream from the upstream end of Eagle Island. The site offers opportunity for enhancement of rearing cover and complexity through placement of large woody debris.

Figure 14. Existing side-channel on the right bank in the north channel.

Treatment Alternatives

Alternatives include installation of a bar apex jam to encourage continued flow into the side-channel. Additional LWD jams and smaller accumulations could be placed within the side-channel and along the main channel to enhance salmonid rearing complexity and cover.

Anticipated Benefits

This project would enhance channel complexity and dynamics. Juvenile rearing and adult holding habitat would be enhanced through maintenance of side channel habitat and installation of LWD for cover and complexity.

Feasibility and Cost Considerations

This project is located adjacent to private lands. Access could either be obtained from Eagle Island or from private lands. De-watering of the work area during construction would be straightforward as flow into the side-channel can be easily diverted to the main channel. The construction cost range is approximately $100,000 to $200,000, but could vary widely depending on the extent of treatments.

As with all of the projects identified in the north channel, there is risk associated with the north channel becoming completely abandoned. Any significant effort expended on restoration work in the north channel should be completed in conjunction with efforts to maintain flows into the north channel. Furthermore, it should be recognized that addition of LWD into the north channel may increase roughness that could hinder efforts to keep the north channel active during low flow periods. Hydraulic and geomorphology analysis will be necessary to properly evaluate this risk.

Project 14: Left Bank Side Channel – North Channel

Site Description

In the north channel about 430 meters downstream of the Island Boat Ramp is a vegetated gravel bar on the left side of the river with an overflow channel between the gravel bar and Eagle Island. This overflow channel has two outlets and each forms a backwater at low flow. Small schools of salmonid juveniles were observed using each of the backwaters. The overflow channel is gravel-bottomed and both the gravel bar and overflow channel are covered in reed canary grass and small willows. The inlet of the side channel begins in a shallow, low-gradient channel segment and the downstream outlets enter the main channel below a riffle. The side channel has a relatively high gradient.

Figure 15. Left bank overflow channel near the upstream end of the north channel.

Treatment Alternatives

Treatment alternatives include creation of a low flow side-channel or connected backwater channel, or potentially only the placement of a bar apex log jam to induce channel dynamics and adjustment.

This site may be suitable for creation of a chum spawning channel with upwelling conditions, especially if the channel is designed to receive subsurface flow originating from the main channel. Modest excavation of the channel to encourage flows during the late summer may increase available shallow-water habitat for juvenile salmon rearing. Riparian plantings would enhance shade and cover.

Anticipated Benefits

This project would enhance channel complexity and dynamics. Juvenile rearing and adult holding habitat would be enhanced through maintenance of side channel habitat and installation of LWD for cover and complexity. This site has the potential to support chum spawning.

Feasibility and Cost Considerations

The presence of hyporheic flow and adequate transmissivity of subsurface flow would need to be investigated to evaluate the potential for chum spawning habitat. Installation of porous substrate and/or groundwater galleries could be utilized to enhance upwelling conditions. A clay lens that was observed in the north channel may affect groundwater connectivity in some areas.

As with all of the projects identified in the north channel, there is risk associated with the north channel becoming completely abandoned. Any significant effort expended on restoration work in the north channel should be completed in conjunction with efforts to maintain flows into the north channel. Furthermore, it should be recognized that addition of LWD into the north channel may increase roughness that could hinder efforts to keep the north channel active during low flow periods. Hydraulic and geomorphology analysis will be necessary to properly evaluate this risk.

Access could be obtained to Eagle Island from near the Island Boat Ramp. This project has a cost range estimate of $150,000 to $200,000, but could vary widely depending on the extent of treatments.

EAGLE ISLAND PROJECT IDENTIFICATION AND DESIGN

Tech Memo 3: Preliminary Design Report

To: Lower Columbia Fish Recovery Board and Eagle Island Technical Oversight Group (TOG)

From: Interfluve, with technical input from Stillwater Sciences and Berger Abam.

Date: 11/24/2009

Description: This Technical Memorandum is a design report that accompanies the 30% designs for three priority projects in the Eagle Island Reach of the NF Lewis River.

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Introduction

This preliminary design report covers three of the top ranked habitat enhancement opportunities in the Eagle Island reach. This document accompanies the preliminary designs (30% level) for the projects. The three projects are referred to as Sites A, B, and C; their locations are depicted below in Figure 1.

Figure 1. Eagle Island priority habitat enhancement opportunities taken forward to the 30% design phase.

Geomorphic Setting

The project sites are located in the broad alluvial lower Lewis River valley. The stream channel is unconfined at this location. The channel type is pool-riffle dominated by gravel and cobble substrate. Gradient is very flat at approximately 0.1%. The summer low flow wetted width of the south channel at this location is approximately 180 feet. There are few well-defined pools; past habitat surveys have indicated that most of the habitat in this reach is composed of glide habitat (PacifiCorp 2004). Figure 2 depicts a hillshade relief image of the site based on Clark County LiDAR data from 2002.

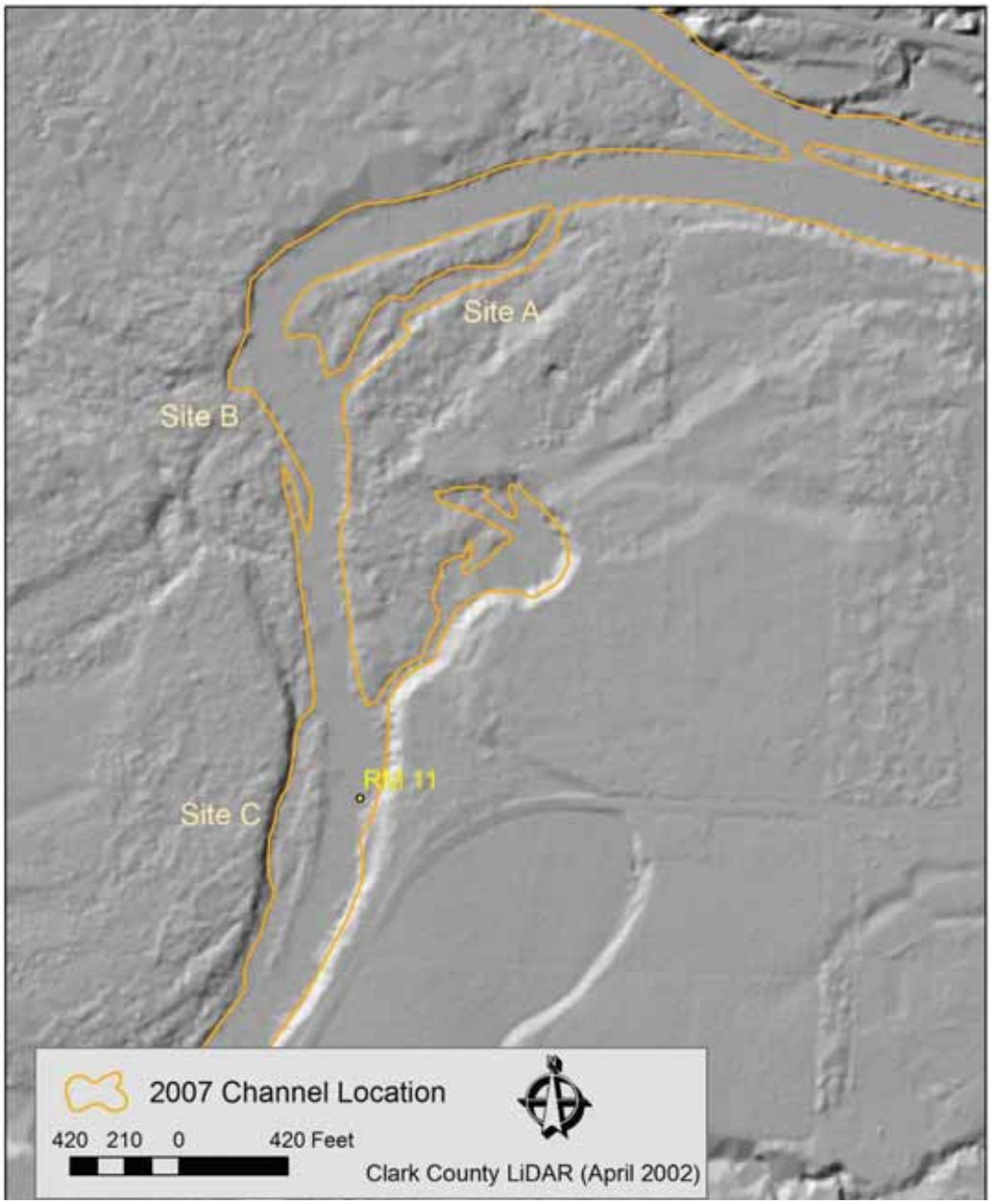

Figure 2. Hillshade relief image of project sites.

The historical record (aerial photos dating back to 1938 and survey maps dating back to 1854) indicates a history of active channel dynamics in the project area. Channel changes are due to natural flood processes as well as human activities including gravel mining. The 1854 Government Land Office survey maps show the river cutting through the middle of the present-day Eagle Island. The 1938 aerial photos show the river channel in a different location than in 1854, with a distinct north channel (active channel in 1938) and a mostly dry south channel that shows signs of significant recent sediment deposition and scour (Figure 3). These features are believed to be the result of the large 1933 flood that resulted in sediment mobilization and reorganization and resurfacing of point bars throughout the lower Lewis River (Stillwater Sciences 2006). The 1938 photos also depict what appears

to be a diversion structure and/or stream crossing at the upstream end of the south channel that may be reducing flow into the south channel. The specific purpose, origin, or effect of this structure is unknown to the investigators. Aerial photos since 1938 show flow in both the north and south Eagle Island channels, with summer flow slowly shifting more to the south channel over time.

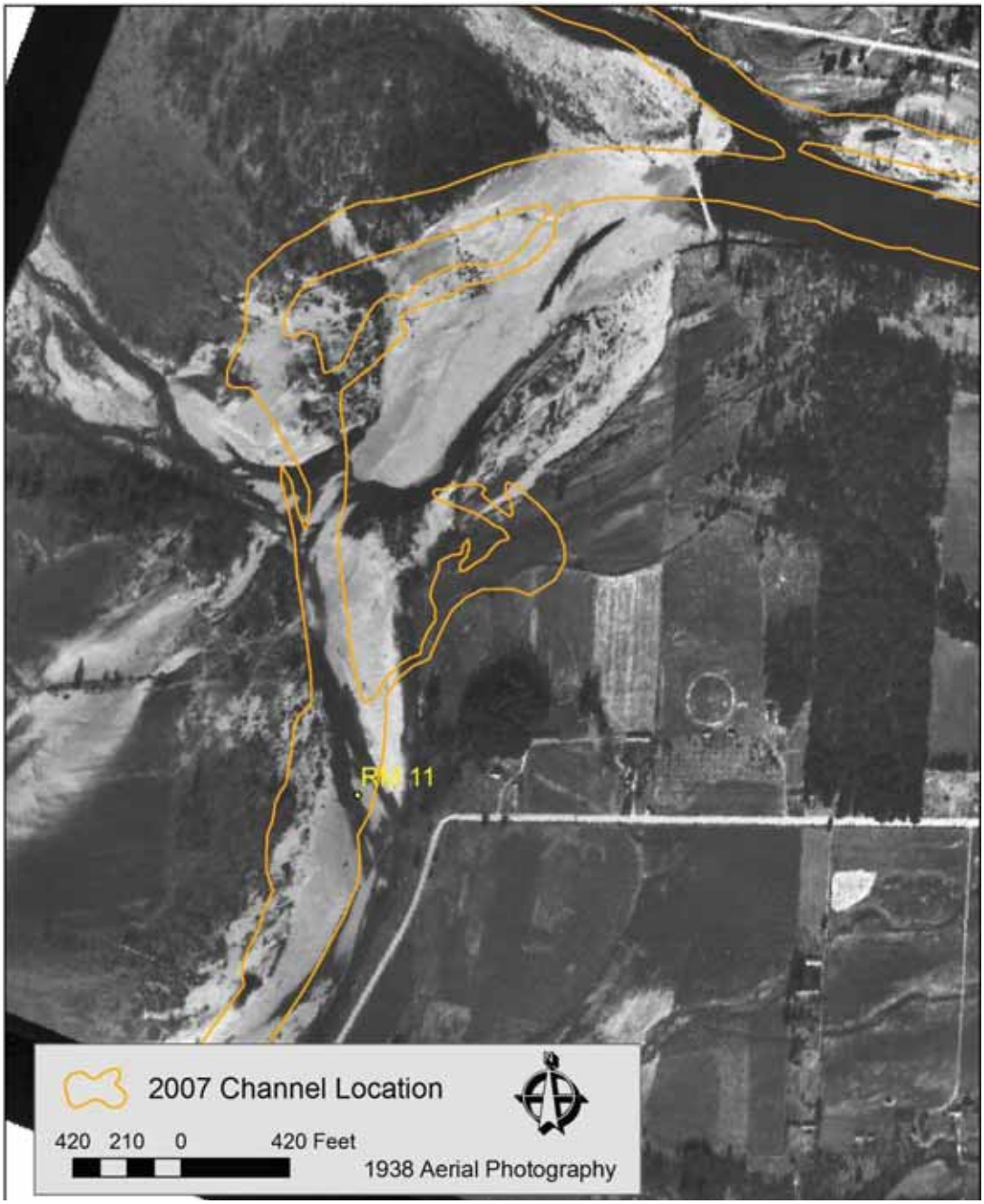

Figure 3. 1938 Aerial Photo overlain with 2007 channel location.

At the reach scale, channel complexity, available habitat cover, and the health of native riparian forest communities have been reduced since historical conditions. Reach-scale fluvial evolution is progressing toward a simplified channel planform as former multithread

channels are abandoned. Past gravel mining, and possibly the effects of the hydropower system on sediment transport, have contributed to incision that has resulted in abandonment of off-channel habitat and has appeared to reduce the frequency of channel adjustment.

Large woody debris quantities have been reduced by past snagging, riparian timber harvest, and interruption of fluvial transport as a result of the hydropower system (Interfluve et al. 2008). There is a significant lack of large woody debris that is necessary to provide routine channel adjustment, habitat formation, storage and sorting of sediments, and aquatic habitat cover and velocity refuge.

The north channel around Eagle Island appears to be moving progressively towards abandonment. This phenomenon can be seen in the aerial photo record. These observations suggest that continued summer season flow into the south channel is expected to continue and that restoration efforts expended here would not be subject to significant channel abandonment risk.

Fish Species and Use

Please refer to the Eagle Island Tech Memo 1 (Existing Conditions) for a summary of fish use and distribution in the entire Eagle Island area.

There is limited information regarding fish use within the specific project areas (Site A-C). Occasional spawning by fall "bright" Chinook has been observed in the upstream 300-400 yards of the Eagle Island channels in December and January (Shane Hawkins, personal communication). Steelhead spawning in the spring is also known to occur in the project area. A map of steelhead redd locations for 2008 and 2009 is presented in Figure 4 (WDFW data).

Since the early 1980s, WDFW has conducted juvenile seining targeting fall Chinook in the spring and early summer (typically late May to early July). The seining effort is conducted in order to capture juvenile fall Chinook for tagging and is not specifically designed to map spatial distribution or habitat preferences for juvenile rearing. Nevertheless, the data does provide some indication of occurrence of juvenile rearing in the project areas. Data from 2004 to 2008 indicate that 200 to 4,000 juvenile fish have been captured annually within the Site A side-channel during spring sampling; 700 to 3,600 have been captured near Site B; and 0 to over 10,000 have been captured near Site C. Based on species composition for the entire lower river, the vast majority of these fish are Chinook, with smaller amounts of coho, trout, and chum (very few chum would be expected in these catches).

Figure 4. WDFW data (unpublished) of steelhead redd locations in the project area.

Restoration Objectives

The following restoration objectives helped to guide the project design approach:

- Promote channel complexity and habitat-forming processes.
- Increase the abundance and complexity of off-channel and side-channel habitat.
- Increase pool habitat quality and quantity.
- Increase the quality and complexity of existing channel margin habitat used for juvenile salmonid rearing and adult holding.
- Increase LWD quantities to greater than 57 pieces/100 meters (25 percentile historical modeled LWD frequency, Interfluve et al. 2008) to increase the availability of rearing and holding cover, complexity, and velocity refuge.
- Restore a native streambank, riparian, wetland, and floodplain vegetation community to provide stability, shade, wildlife habitat, and future LWD recruitment.

Restoration Approaches

The restoration approaches at Sites A, B, and C primarily involve a combination of large woody debris placements that add complexity and cover. Riparian treatments are also included to treat areas disturbed during construction, to control invasive species, and to foster a native riparian vegetation community.

The types and function of large woody debris installations that are detailed in the 30% design plans are described below. LWD installations require ballast to reduce the risk of fluvial transport out of the project area (and likely out of the Lewis River system). Allowing some spatial adjustment of placed woody material is desirable; however, complete loss of wood is undesirable due to the severe lack of wood in the system and the unlikely event of wood being replaced naturally due to young riparian stands and lack of fluvial wood transport from upstream sources.

Habitat cover wood: habitat cover wood consists of individual placements or small accumulations (1-10 pieces) within the active channel that are designed to provide holding and rearing cover. These structures provide velocity refuge during high flow, provide cover from predators, and provide a substrate for macro-invertebrate colonization.

Lateral scour pool jams: lateral scour pool log jams are positioned to induce pool scour. They are typically placed along the outside of meander bends although they may be placed at other locations along the channel boundary as appropriate. These jams provide the functions of cover wood and also maintain pools, sort gravels, and capture additional wood.

Bar apex jams: bar apex jams are positioned with the intent of creating or maintaining a split flow condition around the jam. These jams consist of key members oriented parallel to the flow with racked members positioned perpendicular to the flow along the upstream portion of the jam. Bar apex jams create scour just upstream of the jam and deposition just downstream. They are designed to capture additional fluvial wood from upstream. These jams provide habitat cover and velocity refuge but are mainly designed to enhance channel complexity.

Floodplain wood: floodplain wood consists of individual pieces or small accumulations of wood placed on the floodplain surface to increase floodplain roughness where natural floodplain roughness elements (e.g. vegetation or logs) are insufficient. These placements reduce avulsion risk and erosion associated with unstable channels until a point at which natural vegetation and natural wood recruitment are able to provide natural stability.

Site A – Treatment Strategy

Site Description

This site is located on the river left (south) side of the south channel 250 meters downstream of the upstream end of Eagle Island and consists of a perennially-active side-

channel that is approximately 1,200 feet long (Figure 5). The side-channel is a moderately sinuous gravel-bed channel. The gravel bar that separates the channel from the mainstem is well-vegetated and has a few mature riparian trees. There are several small islands in this side channel, and overall channel complexity is relatively high. There is currently some wood in the side-channel but scour pools are scarce and riparian cover is poor. The inlet begins in a shallow water reach just upstream of a riffle and the outlet is downstream of the riffle; the gradient is similar to the mainstem.

Modest channel complexity has been maintained throughout the 1,200 foot long side-channel. Deposition of gravel bars has created a multithread channel during low water conditions with small backwater eddies and side-channels. However, there are only several existing pieces of LWD to provide habitat cover and promote pool scour.

The vegetation on the narrow island is stratified into two separate age classes. The eastern portions of the island are vegetated by young trees and a variety of non-native herbaceous species. Tree species within the eastern portion of the island are limited to Oregon ash (*Fraxinus latifolia*), black cottonwood (*Populus tricarpa*), and red alder (*Alnus rubra*). Tree density is very high in the eastern portion of the island with stem counts estimated at 500 per acre. The age class of the trees is in the 10-15 year range with average tree heights of 8-10 feet. There is very little shrub coverage in the eastern-most portion of the island with species limited to Scouler's willow (*Salix scoulerana*), hooker willow (*Salix hookeriana*), Himalayan (Armenian) blackberry (*Rubus armeniacus),* Japanese knotweed (*Polygonum cuspidatum)* and spiraea. This is in contrast to the central and western portions of the island that have a dense shrub layer beneath a canopy of mature black cottonwood and Oregon ash trees. Herbaceous vegetation includes a wide variety of non-native species including colonial bentgrass (*Agrostis capillaries*), Canada thistle *(Cirsium arvense),*smooth hawksbeard, common vetch *(Vicia sativa),*common plantain *(Plantago major),* common tansy *(Tanacetum vulgare),* and curly dock *(Rumex crispus).*

This is one of the best sites on the lower Lewis River for enhancement of channel complexity and re-introduction of LWD, primarily due to the following: 1) wood jams can be constructed that are protected from mainstem flows, 2) the project enhances existing complexity and channel dynamics, and 3) the project will not affect boat traffic.

Figure 5. View looking downstream at Site A. Head of side-channel is on the right.

Treatment Approach

Medium to large jams and individual pieces will be placed throughout the 1,200 foot long side-channel. At the head of the side channel, a large bar apex jam will be constructed that wraps the upstream end of the island and extends into the main channel; this will provide habitat benefit to the main channel and will be designed to encourage the maintenance of a split-flow condition during low flows. Two additional bar apex jams will be constructed within the side-channel to encourage split flow conditions to maximize complexity and edge habitat. Lateral scour pool jams will be constructed along channel margins of the side-channel to promote the development of lateral scour pools with wood cover. Habitat cover wood will be placed at numerous locations to provide shelter complexity for salmonid rearing. Placement of floodplain wood will provide roughness elements that are lacking due to the absence of a robust native riparian vegetation community.

Vegetation enhancements near the eastern end of the site will focus on control of Himalayan blackberry and the establishment of a native shrub/scrub layer. The planting of tree species will not be necessary in this area as there are high numbers of red alder, black cottonwood and Oregon ash seedlings already established in this area. Tree numbers are of a density sufficient to provide a canopy closure percentage of 75-100 percent upon maturation. The decision to not augment the existing tree diversity with conifers was based on the fact that conifers would likely experience high rates of mortality in the gravelly and sandy soils in this portion of the island.

Establishment of a dense shrub layer will improve wildlife habitat values, reduce scour during moderate flood events, and help prevent further establishment of invasive species. Species to be planted in this area will be specially selected due to the extremely sandy nature of the soil. Soil sample pits revealed very little organic matter in the soil which will severely limit the ability of some native species to become established. Primary restoration species will consist of willow and red-osier dogwood.

The Himalayan blackberry can be effectively eliminated with herbicide applications in the fall followed up with spot treatments the following spring. Japanese knotweed is exceptionally difficult to completely eradicate although this very aggressive species can be effectively suppressed through the implementation of an herbicide treatment schedule. This schedule would include multiple injections of glyphosate using an herbicide lance throughout the growing season. Effective suppression of actively growing knotweed populations will require successive injections of herbicide over the course of two to three years.

Anticipated Benefits

This reach is ideal for restoration since it already contains relatively high-quality aquatic habitat, especially for rearing juvenile salmonids, which were observed in abundance during the initial survey. Wood placements in the side channel will provide cover and scour pools that will benefit juvenile steelhead, Chinook, and coho rearing throughout the year. LWD jams will also enhance adult holding and spawning.

Feasibility Considerations

Clark County owns the project site although access will be obtained across private lands to the south. Clark County has an access easement from Hayes Road (County Road No. 16) through these properties. De-watering of the work area during construction would be straightforward as flow into the side-channel can be diverted to the main channel.

Preliminary Cost Estimate

This cost estimate is based on the treatment strategy described in the 30% design plans. Alteration to these plans may require adjustment of costs up or down. Costs may also vary depending on the availability of material types (e.g. large woody debris sizes), material transport distances, and the means of material acquisition (e.g. donated material vs. purchased wood). This cost estimate assumes all material is purchased and that transport distance is within 30 miles of the project site.

No.	Bid Item	Unit	Unit Price	Quantity	Subtotal
General					
1	Mobilization	LS	$30,000	1	$30,000
Erosion and Sediment Control					
2	Cofferdams	LF	$35	300	$10,500
3	Stone Construction Entrance	LS	$5,000	1	$5,000
4	Erosion Control	LS	$5,000	1	$5,000
Earthwork					
5	Logs	EACH	$1,000	141	$141,000
6	Logs with Root Wads	EACH	$1,200	55	$66,000
7	Boulders	EACH	$100	352	$35,200
Landscaping					
8	Plant material (bare root)	EACH	$1.75	2,050	$3,588
9	Plant protectors	EACH	$1.10	2,050	$2,255
10	Stakes	EACH	$0.50	2,050	$1,025
11	Plant labor	EACH	$3.75	2,050	$7,688
12	Invasive Species removal	LABOR HOUR	$25	24	$600
			Construction Subtotal		$307,855
			10% Contingency		$30,786
			Project Total		**$338,641**

Cost Estimate Assumptions:

Design flow velocity 6 fps

Logs purchased outright. Considerable savings could be gained if cheaper wood acquisition is obtained

Site B – Treatment Strategy

Site Description

This site is located on river right across from the Site A side-channel outlet. This site contains numerous meander-scar traces from historical mainstem channel locations. The upstream portion of the site consists of a large alcove (Figure 6) and the downstream portion consists of an exposed bar and low-flow backwater channel. The low-flow backwater channel is part of an abandoned channel that begins just downstream of the alcove. The upstream portion of the channel is filled with silty sand and is overgrown with vegetation. The inlet is just upstream of a riffle in the main channel and the outlet enters the main channel downstream of the riffle. There is some ponding of water in this

overflow channel. This area appeared to contain an active side-channel in the 1974 aerial photos and a connected backwater channel as recently as 1996.

This site contains moderate channel complexity but few pieces of LWD with the exception of a large log jam on the terrace at the southern end of the alcove. This jam is likely a relic of the 1996 flood.

This area is characterized by shallow water habitats, emergent wetlands, and shrub/scrub habitats. Vegetation is a combination of common wetland shrub species such as red-osier dogwood (*Cornus sericea)* pacific ninebark (*Physocarpus capitatus),* willows, spirea, and areas of dense reed canarygrass. Emergent wetland species include soft rush (*Juncus effuses*), toad rush *(Juncus buffoensis*), dagger tipped rush (*Juncus ensifolius),* bur-reed (*Sparganium erectum*), and slough sedge (*carex obnupta).*

Evidence of past Chinook spawning (redd features) in this area was observed during the field visit.

Figure 6. View midway through project Site B looking upstream at alcove.

Treatment Approach

This site provides a good opportunity to contribute to the existing complexity by adding a series of apex jams designed to split flow into historical channel scar depressions. The preliminary design includes three bar apex jams to enhance channel dynamics and split flow conditions. Bar apex jams are expected to capture additional wood during floods. The development of large jams is likely to re-establish a dynamic, shifting channel condition in this reach, adding to habitat complexity. Construction of a lateral scour pool jam in the alcove will enhance pool scour and cover. Habitat cover wood in the existing backwater channel will increase habitat cover and complexity. Placement of floodplain wood will provide roughness elements that are lacking due to the absence of a robust native riparian vegetation community.

The vegetation enhancement strategy in this area will be focused on establishing a medium density tree canopy and creating isolated patches of shrub cover. Plantings will occur along the banks and low lying portions of the treatment area. Tree species will include those suited to thrive in moist to seasonally flooded conditions such as Oregon ash and black cottonwood. The goal of the tree plantings is to establish a tree canopy to provide shade of surface waters, increase organic inputs to the stream and provide for future woody

debris recruitment. The plantings in this area will be spaced to prevent complete canopy closure, which could result in the loss of the shade intolerant emergent species currently located in the treatment area. In addition to the proposed tree plantings, a small amount of native shrub species will also be planted in isolated clusters throughout the treatment area. Shrub species will be limited to willows (*Salix spp*) and spirea. The goal of the shrub plantings is to increase wildlife habitat values, provide opportunities for amphibian egg laying, and stabilization of soils.

Anticipated Benefits

This project will benefit off-channel and near-shore rearing for salmon and steelhead. Construction of apex jams and activation of side-channels will enhance channel complexity. Other wood placements will increase the availability of pools and wood cover that will provide refuge habitats for salmonid rearing and holding. The vegetation enhancements will result in increased habitat complexity and native plant species diversity. In addition, water quality benefits such as reduced steam water temperatures and attenuation of sediments should be achieved once the plantings have matured.

Feasibility Considerations

Clark County currently owns this parcel (Eagle Island). Access could be provided from the Island Boat Ramp at the head of the Eagle Island North Channel. This would require a crossing of the north channel and the establishment of an access road across Eagle Island to the project site. It may also be possible to access this site from across the river near project Site A, at least for material delivery to the site.

Preliminary Cost Estimate

This cost estimate is based on the treatment strategy described in the 30% design plans. Alteration to these plans may require adjustment of costs up or down. Costs may also vary depending on the availability of material types (e.g. large woody debris sizes), material transport distances, and the means of material acquisition (e.g. donated material vs. purchased wood). This cost estimate assumes all material is purchased and that transport distance is within 30 miles of the project site.

No.	Bid Item	Unit	Unit Price	Quantity	Subtotal
General					
1	Mobilization	LS	$25,000	1	$25,000
Erosion and Sediment Control					
2	Cofferdams	LF	$35	480	$16,800
3	Stone Construction Entrance	LS	$5,000	1	$5,000
4	Access Road	LS	$5,000	1	$5,000
5	Erosion Control	LS	$5,000	1	$5,000
Earthwork					
6	Logs	EACH	$1,000	99	$99,000
7	Logs with Root Wads	EACH	$1,200	38	$45,600
8	Boulders	EACH	$100	245	$24,500
Landscaping					
9	Seed	ACRE	$370	1	$370
10	Seeding labor	LS	$175	1	$175
11	Plant material (bare root)	EACH	$1.75	1,675	$2,931
12	Plant protectors	EACH	$1.10	1,675	$1,843
13	Stakes	EACH	$0.50	1,675	$838
14	Plant labor	EACH	$3.75	1,675	$6,281
12	Invasive Species removal	LABOR HOUR	$25	32	$800
			Construction Subtotal		$232,056
			10% Contingency		$23,206
			Project Total		**$255,262**

Cost Estimate Assumptions:

Design flow velocity 6 fps

Logs purchased outright. Considerable savings could be gained if cheaper wood acquisition is obtained

Site C – Treatment Strategy

Site Description

This site is located on river right approximately 1,500 feet downstream of Site B. This site consists of a low-water side-channel complex. Most of the bar/island is overtopped above bankfull flows. There is very little LWD in this side-channel. The island is dominated by willows and there are mature riparian trees at the upstream end of the island. The river right streambank is composed of willows, spirea, reed canary grass, and some mature cottonwood. See photo of site in Figure 7.

Figure 7. Downstream end of Site C. Outlet to side channel is on the left of photo.

Treatment Approach

This site contains moderate complexity in the form of a multi-thread channel but LWD quantities are very low or non-existent and complex rearing cover is virtually absent. The preliminary design includes the construction of two apex jams to encourage the continuation of split flow conditions. Two to three lateral scour pool jams are included to promote pool scour and provide cover. Multiple placements of habitat cover wood provide additional rearing cover and complexity.

The island itself currently contains high numbers of willow and red-osier dogwood saplings and therefore the revegetation plan does not include any planting on the island. Revegetation on the bar/island will only be necessary in areas disturbed during construction. Whereas the river-right streambank on Eagle Island does contain some mature black cottonwoods, the current number of trees and shrubs is generally low. Plantings in this area will be completed in order to increase wildlife habitat values, to provide bank stability, and to eventually outcompete the reed canarygrass stands through shading. Suitable species for enhancement in this area include Oregon ash, black cottonwood, red alder, willow, dogwood, and spirea.

Lastly, in order to increase the success of the proposed plantings and limit the spread of invasives, Himalayan blackberry eradication will be necessary within and adjacent to the enhancement areas. As in the previous treatment site, chemical control methods will be the most effective way to eliminate existing patches of Himalayan blackberry.

Anticipated Benefits

This project will benefit off-channel and near-shore rearing for salmon and steelhead. Construction of apex jams and activation of side-channels will enhance channel complexity. Other wood placements will increase the availability of pools and wood cover that will provide refuge habitats for salmonid rearing and holding.

Feasibility Considerations

Clark County currently owns this parcel (Eagle Island). Access could be provided from the Island Boat Ramp at the head of the Eagle Island North Channel. This would require a crossing of the north channel and the establishment of an access road across Eagle Island to the project site. It may also be possible to access this site from across the river near project Site A, at least for material delivery to the site. De-watering of the work area during construction would be straightforward as flow into the side-channel can be diverted to the main channel.

Preliminary Cost Estimate

This cost estimate is based on the treatment strategy described in the 30% design plans. Alteration to these plans may require adjustment of costs up or down. Costs may also vary depending on the availability of material types (e.g. large woody debris sizes), material transport distances, and the means of material acquisition (e.g. donated material vs. purchased wood). This cost estimate assumes all material is purchased and that transport distance is within 30 miles of the project site.

No.	Bid Item	Unit	Unit Price	Quantity	Subtotal
General					
1	Mobilization	LS	$25,000	1	$25,000
Erosion and Sediment Control					
2	Cofferdams	LF	$35	260	$9,100
3	Stone Construction Entrance	LS	$5,000	1	$5,000
4	Access Road	LS	$5,000	1	$5,000
5	Erosion Control	LS	$5,000	1	$5,000
Earthwork					
6	Logs	EACH	$1,000	122	$122,000
7	Logs with Root Wads	EACH	$1,200	44	$52,800
8	Boulders	EACH	$100	294	$29,400
Landscaping					
9	Seed	ACRE	$370	1	$463
10	Seeding labor	LS	$175	1	$219
11	Plant material (bare root)	EACH	$1.75	650	$1,138
12	Plant protectors	EACH	$1.10	650	$715
13	Stakes	EACH	$0.50	650	$325
14	Plant labor	EACH	$3.75	650	$2,438
12	Invasive Species removal	LABOR HOUR	$25	24	$600
			Construction Subtotal		$256,159
			10% Contingency		$25,616
			Project Total		**$281,775**

Cost Estimate Assumptions:

Design flow velocity 6 fps

Logs purchased outright. Considerable savings could be gained if cheaper wood acquisition is obtained

References

Interfluve, Cramer Fish Sciences, and Fox Environmental Services. 2008. Lewis River LWD Study. Prepared for PacifiCorp, Portland, OR.

LCFRB (Lower Columbia Fish Recovery Board). 2004. Lower Columbia Salmon and Steelhead Recovery and Subbasin Plan. Prepared for Northwest Power and Conservation Council.

PacifiCorp. 2004. Stream channel morphology and aquatic habitat study (WTS-3 Study). Final Licensees' 2001 Technical Studies Status Report for the Lewis River Hydroelectric Projects.

Stillwater Sciences. 2006. Lewis River Spawning Gravel Evaluation. Prepared for PacifiCorp, Portland, Oregon and Public Utility District No. 1 of Cowlitz County, Longview, Washington.

EAGLE ISLAND PROJECT IDENTIFICATION AND DESIGN

Tech Memo 4: 90% Design Report

To: Lower Columbia Fish Recovery Board and Eagle Island Technical Oversight Group (TOG)

From: Interfluve, with technical input from Stillwater Sciences and Berger Abam.

Date: 11/24/2009

Description: This Technical Memorandum is a design report that accompanies the 90% designs for Site A in the Eagle Island Reach of the NF Lewis River.

Table of Contents

Introduction

This design report covers Site A that was the top ranked habitat enhancement opportunity in the Eagle Island Reach. Site A was one of three of the top ranked habitat enhancement opportunities for which preliminary (30%) designs were developed. The locations of the top ranked project Sites A, B, and C are depicted below in Figure 1. This document accompanies the 90% design for Site A. Further design development (beyond 30% design) of Sites B & C are beyond the scope of this work.

Figure 1. Eagle Island priority habitat enhancement opportunities taken forward to the 30% design phase. Site A, the top ranked project, has been further developed to 90% design.

Restoration Objectives

The following restoration objectives helped to guide the project design approach:

- Promote channel complexity and habitat-forming processes.
- Increase the abundance and complexity of off-channel and side-channel habitat.
- Increase pool habitat quality and quantity.
- Increase the quality and complexity of existing channel margin habitat used for juvenile salmonid rearing and adult holding.

- Increase LWD quantities to greater than 57 pieces/100 meters (25 percentile historical modeled LWD frequency, Interfluve et al. 2008) to increase the availability of rearing and holding cover, complexity, and velocity refuge.
- Restore a native streambank, riparian, wetland, and floodplain vegetation community to provide stability, shade, wildlife habitat, and future LWD recruitment.

Treatment Strategy

Site Description

This site is located on the river left (south) side of the south channel 250 meters downstream of the upstream end of Eagle Island and consists of a perennially-active side-channel that is approximately 1,200 feet long (Figure 2). The side-channel is a moderately sinuous gravel-bed channel. The gravel bar that separates the channel from the mainstem is well-vegetated and is dominated by shrubs, with some mature riparian trees. There are several small islands in this side channel, and overall channel complexity is relatively high. There is currently some wood in the side-channel but scour pools are scarce and riparian cover is poor. The inlet begins in a shallow water reach just upstream of a riffle and the outlet is downstream of the riffle; the gradient is similar to the mainstem.

Modest channel complexity has been maintained throughout the 1,200 foot long side-channel. Deposition of gravel bars has created a multithread channel during low water conditions with small backwater eddies and side-channels. However, there are only several existing pieces of LWD to provide habitat cover and to promote pool scour.

The vegetation on the narrow island is stratified into two separate age classes. The eastern portions of the island are vegetated by young trees and a variety of non-native herbaceous species. Tree species within the eastern portion of the island are limited to Oregon ash (*Fraxinus latifolia*), black cottonwood (*Populus tricarpa*), and red alder (*Alnus rubra*). Tree density is very high in the eastern portion of the island with stem counts estimated at 500 per acre. The age class of the trees is in the 10-15 year range with average tree heights of 8-10 feet. There is very little shrub coverage in the eastern-most portion of the island with species limited to Scouler's willow (*Salix scoulerana*), hooker willow (*Salix hookeriana*), Himalayan (Armenian) blackberry (*Rubus armeniacus),* Japanese knotweed (*Polygonum cuspidatum)* and spirea (*Spiraea douglasii*). This is in contrast to the central and western portions of the island that have a dense shrub layer beneath a canopy of mature black cottonwood and Oregon ash trees. Herbaceous vegetation includes a wide variety of non-native species including colonial bentgrass (*Agrostis capillaries*), Canada thistle *(Cirsium arvense),* smooth hawksbeard, common vetch *(Vicia sativa),* common plantain *(Plantago major),* common tansy *(Tanacetum vulgare),* and curly dock *(Rumex crispus).*

This is one of the best sites on the lower Lewis River for enhancement of channel complexity and re-introduction of LWD, primarily due to the following: 1) wood jams can be constructed that are protected from mainstem flows, 2) the project enhances existing complexity and channel dynamics, and 3) the project will not affect boat traffic.

Figure 2. View looking downstream at Site A. Head of side-channel is on the right.

Treatment Approach

The restoration approach at Site A involves a combination of large woody debris placements that add complexity and cover. Riparian treatments are also included to treat areas disturbed during construction, to control invasive species, and to foster a native riparian vegetation community.

Medium to large jams and individual pieces will be placed throughout the 1,200 foot long side-channel. At the head of the side channel, a large bar apex jam will be constructed that wraps the upstream end of the island and extends into the main channel; this will provide habitat benefit to the main channel and will be designed to encourage the maintenance of a split-flow condition during low flows. Two additional bar apex jams will be constructed within the side-channel to encourage split flow conditions to maximize complexity and edge habitat. Lateral scour pool jams will be constructed along channel margins of the side-channel to promote the development of lateral scour pools with wood cover. Habitat cover wood will be placed at numerous locations to provide shelter complexity for salmonid rearing. Placement of floodplain wood will provide roughness elements that are lacking due to the absence of a robust native riparian vegetation community. The types and function of large woody debris installations that are detailed in the 90% design plans are described in Table 1.

Table 1. Types of woody debris installations described in the 90% design drawings.

Habitat cover wood
Habitat cover wood consists of individual placements or small accumulations (1-10 pieces) within the active channel that are designed to provide holding and rearing cover. These structures provide velocity refuge during high flow, provide cover from predators, and provide a substrate for macro-invertebrate colonization.
Lateral scour pool jams
Lateral scour pool log jams are positioned to induce pool scour. They are typically placed along the outside of meander bends although they may be placed at other locations along the channel boundary as appropriate. These jams provide the functions of cover wood and also maintain pools, sort gravels, and capture additional wood.
Bar apex jams
Bar apex jams are positioned with the intent of creating or maintaining a split flow condition around the jam. These jams consist of key members oriented parallel to the flow with racked members positioned perpendicular to the flow along the upstream portion of the jam. Bar apex jams create scour just upstream of the jam and deposition just downstream. They are designed to capture additional fluvial wood from upstream. These jams provide habitat cover and velocity refuge but are mainly designed to enhance channel complexity.
Floodplain wood
Floodplain wood consists of individual pieces or small accumulations of wood placed on the floodplain surface to increase floodplain roughness where natural floodplain roughness elements (e.g. vegetation or logs) are insufficient. These placements reduce avulsion risk and erosion associated with unstable channels until a point at which natural vegetation and natural wood recruitment are able to provide natural stability.

Vegetation enhancements near the eastern end of the site will focus on control of Himalayan blackberry and the establishment of a native shrub/scrub layer. The planting of tree species will not be necessary in this area as there are high numbers of red alder, black cottonwood and Oregon ash seedlings already established in this area. Tree numbers are of a density sufficient to provide a canopy closure percentage of 75-100 percent upon maturation. The decision to not augment the existing tree diversity with conifers was based on the likelihood that conifers would experience high rates of mortality in the gravelly and sandy soils on this portion of the island.

Establishment of a dense shrub layer will improve wildlife habitat values, reduce scour during moderate flood events, and help prevent further establishment of invasive species. Species to be planted in this area have been specially selected due to the extremely sandy nature of the soil. Soil sample pits revealed very little organic matter in the soil which will severely limit the ability of some native species to become established. Primary restoration species will consist of willow and red-osier dogwood.

The Himalayan blackberry can be effectively eliminated with herbicide applications in the fall followed up with spot treatments the following spring. Japanese knotweed is exceptionally difficult to completely eradicate although this very aggressive species can be effectively suppressed through the implementation of an herbicide treatment schedule. This schedule would include multiple injections of glyphosate using an herbicide lance throughout the growing season. Effective suppression of actively growing knotweed

populations will require successive injections of herbicide over the course of two to three years.

Anticipated Benefits

This reach is ideal for restoration since it already contains relatively high-quality aquatic habitat, especially for rearing juvenile salmonids, which were observed in abundance during the initial survey. Wood placements in the side channel will provide cover and scour pools that will benefit juvenile steelhead, Chinook, and coho rearing throughout the year. LWD jams will also enhance adult holding and spawning.

Feasibility Considerations

Clark County owns the project site although access will be obtained across private lands to the south. Clark County has an access easement from Hayes Road (County Road No. 16) through these properties. De-watering of the work area during construction will involve diverting side-channel flow into the main channel.

Design Approach

Site Survey

A site survey was performed to support project design. The site survey included cross sections throughout the north and south Eagle Island channels, channel profiles, and high resolution topography data collected in the vicinity of project Site A. The survey was performed using a variety of techniques. The majority of the site topography, profile, and cross-section data were surveyed using a survey grade GPS instrument (i.e. GPS RTK). In addition, a total station survey instrument was used to locate benchmarks for ground station reference and for supplementing the GPS RTK survey data where satellite reception was poor. For channel bathymetry that exceeded wading depth, a boat-mounted sonar depth gauge was used to obtain water depth that was then referenced to water surface elevations surveyed with the GPS RTK. Sonar depths were referenced to the horizontal plane using a Trimble GeoXT resource grade GPS unit. Survey data supported hydraulic analysis throughout the Eagle Island reach, with greater detail for Site A. Points surveyed are shown in black over aerial photography in Figure 3.

Figure 3. Survey points shown overlying aerial photography.

Hydrology

Flood flow magnitudes were developed for various flood recurrence intervals to be input into hydraulic modeling and design calculations (Table 2). For the 10-, 50-, 100-, and 500-year flows, flow magnitudes were obtained from the Lewis River Hydroelectric Projects Flood Management Technical Report (FLD-1) (PacifiCorp 2004). The flows for the flow scenario "Regulated flows with 70,000 acre-feet dependable flood control storage" at Woodland, WA were utilized. The FLD-1 study did not provide 2-year event flows for Woodland, WA but provided 2-year event floods for Ariel (Station #14220500) for the scenario "Regulated flows with actual historic flood control storage". Because a major tributary, Cedar Creek, enters the Lewis River downstream of Ariel, these flows were corrected for the Eagle Island area (RM 8.8 just downstream of Eagle Island). This was accomplished by calculating Cedar Creek flows as 17% of the East Fork near Heisson (Station # 14222500) flows, which is consistent with the methods outlined in the FLD-1 Study. The remainder of the tributary flows between Ariel and RM 8.8 were calculated using the USGS regional regression equations (Sumioka et al. 1998). Cedar Creek and other tributary flows were added to the 2-year flows at Ariel in order to obtain the 2-year event flows for Eagle Island.

Hydraulic Modeling

The hydraulic model was based on the survey shown in Figure 3 and supplemented with LiDAR data supplied by Clark County. The supplemental LiDAR data was used to complete surveyed sections in upland areas. A reach-based model was developed based on the reach-based survey and input as a split flow model in HEC-RAS. Sections for the reach-based model are shown in Figure 4. The reach-based model was used to partition flows between the north and south channels encompassing Eagle Island.

Figure 4. Cross sections used for reach-based HEC-RAS modeling.

The return interval flows were input into the hydraulic model with a normal depth downstream boundary condition. The normal depth boundary condition does not account for tidal influence or potential backwater from downstream bridges. It does however provide a conservative design approach since it analyzes conditions at the highest flow velocities (floods at low tide) that may occur within the reach. With the normal depth boundary condition, flows were found to split around the island with the split flow optimization routine in HEC-RAS. Table 2 shows flow partitioning based on model results for the North and South channels at corresponding return intervals.

An apex bar jam was input into the located within the project site to check the rise in the 100-year flood, assuming that alluvium does not mobilize as a result of log jam placement. The procedure entails modeling existing conditions and then inputting proposed conditions and comparing the results. Large woody debris jams were modeled as blocked obstructions. Model output indicates that the project will increase the 100-year flood elevation, resulting in a 0.01 to 0.03 feet rise, which extends up to the most upstream cross section.

Table 2. Flows used for hydraulic modeling.

Return Interval	Total Flow (cfs)	North Channel Flow (cfs)	South Channel Flow (cfs)
2-year	24,800	12,173	12,627
10-year	65,600	28,337	37,263
50-year	92,600	37,377	55,223
100-year	98,400	39,315	59,085
500-year	150,500	54,781	95,719

The split flow condition allowed for more detailed modeling at Site A using the flow partitioning provided by the reach scale model. The South Channel flows were input into a

hydraulic model that specifically evaluated hydraulic conditions at Site A. Model output was used to calculate hydraulic lift forces imposed on log jams. The Site A hydraulic model utilized four cross sections through Site A and additional sections upstream and downstream of Site A. Hydraulic model cross sections within Site A are shown on Sheet 7 of the 90% drawings and their locations are shown on Sheets 5 and 6 of the drawings. The goal of this modeling and design procedure for Site A was to develop a more detailed understanding of hydraulic forces acting on log jams within the site. The log jams are shown on Sheets 5 through 7 of the 90% drawings.

Log Jam Ballast Design

LWD installations require ballast to reduce the risk of fluvial transport out of the project area (and likely out of the Lewis River system). Allowing some spatial adjustment of placed woody material is desirable; however, complete loss of wood is undesirable due to the severe lack of wood in the system and the unlikely event of wood being replaced naturally due to young riparian stands and lack of fluvial wood transport from upstream sources.

The LWD ballast design for Site A relies on boulder ballast and cable to withstand the vertical forces of buoyancy and lift. Vertical snags were not considered to resist the vertical forces of buoyancy and lift since scour could remove surrounding soils that create friction to resist vertical forces. A table has been provided in the design drawings to assist with determining the correct number of boulders for ballast based on log size. The horizontal drag force has been assumed to be resisted by friction and by the vertical snags that act as pins to resist horizontal movement during flood flows. This assumption recognizes that without vertical movement, the vertical snags would have to snap or be dragged through river cobble to displace horizontally.

Preliminary Cost Estimate

This cost estimate is based on the 90% design drawings and the contract document specifications. The items in the cost estimate correspond to the pay items provided in the measurement and payment section of the specifications. Alteration to these plans may require adjustment of costs up or down. Costs may also vary depending on the availability of material types (e.g. large woody debris sizes), material transport distances, and the means of material acquisition (e.g. donated material vs. purchased wood). This cost estimate assumes all material is purchased and that transport distance is within 30 miles of the project site.

No.	Bid Item	Unit	Unit Price	Quantity	Subtotal
General					
1	Mobilization	LS	$30,000	1	$30,000
Erosion and Sediment Control					
2	Erosion Control	LS	$30,000	1	$30,000
Earthwork					
3	Bulk Excavation	CY	$12	1,000	$12,000
4	Large Woody Debris	EACH	$1,050	200	$210,000
5	Boulders	EACH	$100	352	$35,200
Landscaping					
6	Plantings (Cuttings)	EACH	$3.25	1,800	$5,850
7	Plantings (bare root)	EACH	$5.25	1,220	$6,405
8	Seed Installation	ACRE	$775.00	0.8	$620
9	Invasive Species Control	ACRE	$500	1.5	$750
10	Straw mulch	ACRE	$1,500	2.0	$3,000

Construction Subtotal	$333,825

Permit Acquisition	$20,000
Additional Design	$15,000
Construction Oversight	$25,000

Project Total	**$393,825**

References

Interfluve, Cramer Fish Sciences, and Fox Environmental Services. 2008. Lewis River LWD Study. Prepared for PacifiCorp, Portland, OR.

PacifiCorp. 2004. Flood Management Study (FLD-1 Study). Final Licensees' 2001 Technical Studies Status Report for the Lewis River Hydroelectric Projects.

Sumioka, S.S., D.L. Kresch, and K.D. Kasnick. 1998. Magnitude and frequency of floods in Washington: U.S. Geological Survey Water-Resources Investigations Report 97-4277, 91 p.

Appendix A:

Conceptual Study Design for the

NF Lewis River – Eagle Island North Channel Abandonment Study

Conceptual Study Design for the

NF Lewis River – Eagle Island North Channel Abandonment Study

Prepared by: Inter-Fluve and Stillwater Sciences

Overview

Reach-scale channel evolution on the Lewis River in the vicinity of Eagle Island is progressing through fluvial processes toward a simplified channel planform as formerly active channels are trending towards abandonment in this historically anabranching channel. In particular, the north channel around Eagle Island is being progressively abandoned as evidenced from sequential aerial photography that indicates the primary flow has been shifting from the north to the south channel since the 1930s. Observed changes from air photos and site visits include: 1) modest degradation in the south channel of the Lewis River, 2) sediment deposition in the mouth of the north channel that is effectively forming a natural levee, and 3) progressive riparian vegetation encroachment on the levee. The cause of such change is probably related to various factors, including: past in-channel gravel mining, the effects of the hydropower system in regulating peak flows and reducing sediment supply and transport capacity.

If this trend continues, low flow may no longer reach the north channel, and thwart management efforts designed to maintain the high value fish habitat supported in the north channel. Strategies include restoration treatment alternatives proposed in the Eagle Island Technical Memo 2 (e.g. Project 1 and Project 2, Figure 1) and include the addition of log jams and excavation of the levee at the upstream end of Eagle Island, both designed to encourage flow into the north channel. However, restoration treatments in the north channel must be judged in the context of longer-term reach evolution to understand their longevity and likely maintenance requirements.

In this context, we propose a reach-scale investigation to characterize hydraulic processes and geomorphic evolution. The evaluation will clarify opportunities and constraints associated with both active and passive strategies for maintaining consistent flow through the north channel in support of aquatic habitat.

The objectives of the Eagle Island North Channel Reach Assessment are the following:

1) Model hydraulic processes and geomorphic evolution of the Lewis River in the vicinity of Eagle Island.

2) Evaluate alternatives to maintain flow and habitat function in the north channel.

Data Collection and Analyses

The following activities will provide the necessary supporting data. Where possible, we will build off of existing analyses (e.g. Bio-Analysts 2001, Stillwater Sciences 2006 and 2009, and InterFluve 2008). Activities will include a review of past assumptions and data sources and will incorporate newer data.

Channel Topographic Survey

- A series of detailed channel cross-sections in the reach will be surveyed between RM 10 and RM 13 to define channel dimensions and slope. The channel cross-sections will

extend laterally to include key features of the floodplain and bounding alluvial terraces in the study reach, and to provide a tie-in to the recent LiDAR digital topography. These channel cross section surveys will provide the necessary information to develop hydraulic and sediment transport models for the study reach. The topographic survey will combine a ground-based approach for wadeable areas and a boat-based approach for deeper areas. Existing survey data has been collected as part of ongoing Eagle Island restoration activities. Existing survey data includes cross-sections and profiles of both Eagle Island channels as well as the mainstem Lewis River upstream and downstream of Eagle Island. These survey data will be supplemented with additional survey resolution that is needed to perform 2D hydraulic modeling.

Hydrology and Hydraulic Modeling

- Develop updated flow duration curves based on the USGS gage 14220500 at Ariel. Similar information has been compiled as part of past investigations but will be updated with recent data.

- Develop a 2D hydraulic model to evaluate flow hydraulics between the south and north channels of Eagle Island under current conditions, and under proposed conditions with the potential restoration treatments. Combined with a detailed understanding of the sediment composition of the site (see below), the hydraulic model will allow evaluation of the ability of the north channel to route sediment under the proposed restoration treatments.

Sediment Transport and Geomorphic Analysis

- Surface and bulk sediment samples will be sampled throughout the site to characterize the particle-size distribution of the riverbed, riverbank, and floodplain materials. Combined with the hydraulic model, these data will support estimates of sediment transport used to characterize bed and bank mobility under existing conditions and the various restoration treatment alternatives.

- Equilibrium sediment conditions will be characterized to determine trends in sediment aggradation and incision. This will require an estimate of sediment supply which we assume can be estimated without completing a detailed sediment budget for the basin.

- Estimate sediment routing potential through both the south and north channels under existing conditions and under each of the proposed restoration treatments based on the results of the hydraulic model and bulk sediment characteristics.

- Historic flooding, channel migration, and riparian vegetation conditions will be characterized and compared to existing conditions and land-use as part of the site evaluation.

Evaluation of Restoration Treatment Alternatives

Proposed restoration treatment alternatives will be evaluated, considering new data and guided by stakeholder objectives. Brief descriptions of the potential restoration treatment alternatives that may be considered are included below (more detail for Project Alternatives 2 and 3 are presented in the Eagle Island Technical Memo 2 [InterFluve 2009]). These and possibly other alternatives will be evaluated for their impact on maintenance of low-flow discharge and long-term channel geometry in the north channel. Additional alternatives or combinations of proposed alternatives will likely be developed as part of the analysis.

Project Alternative 1: No action alternative. This alternative will be evaluated to provide a baseline for comparison of the proposed alternatives.

Project Alternative 2: Bar apex jam(s) at the top end of Eagle Island (Site 1 in Figure 1). This alternative involves the construction of bar apex log jam structures to maintain summer-season flow into the north channel at locations where water spills over from the main channel to the north channel. Structures would be designed to encourage scour (deepening) of cross-over channels to maintain low-water conveyance. Cover and habitat complexity would also be created.

Project Alternative 3: Add roughness to the top of the south channel (Sites 2 and 3 in Figure 1). Install log jam structures on the right bank and left bank side-channel area. Structures at these locations would be designed to provide roughness at the top end of the south channel, encouraging flow into the north channel during floods; and therefore assisting in keeping the north channel active. Cover and habitat complexity would also be created.

Project Alternative 3: Dredging at top of north channel. This alternative would entail dredging of streambed material to ensure continued flow of water into the north channel. Dredging may present the lowest-risk method of ensuring continued flow into the north channel, but would likely require repeat dredging over time and may be difficult to permit.

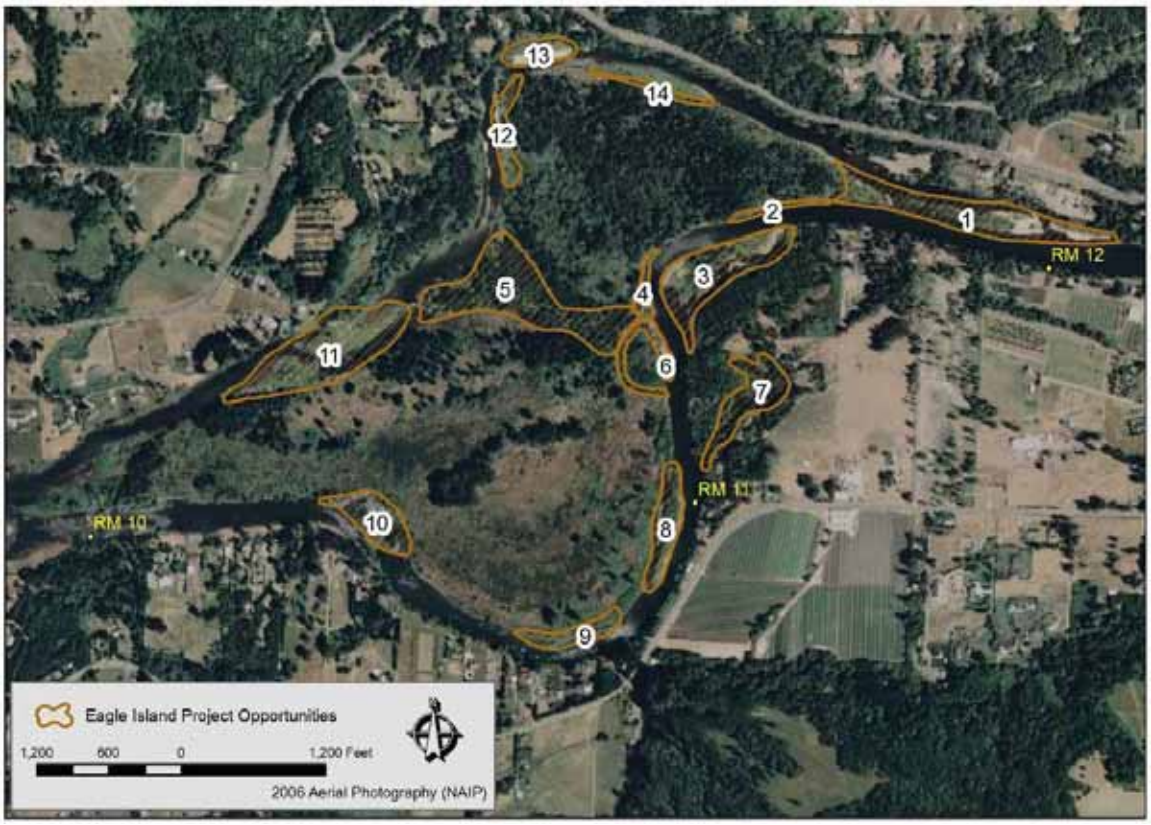

Figure 1. Aerial photo map of Eagle Island showing the location of potential project opportunities.

Planning-level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. This estimate is based on assumptions for time requirements and material quantities, using 2009 rates. Additional information obtained during site investigations will be needed to finalize actual quantities and costs.

Project Element	Cost	Notes and Assumptions
Site Topographic Survey	$35,000	Includes a crew of 2 land based survey crews, and one boat based crew of 2 for 1 week of surveying. Assumes existing survey and LiDAR data can be used.
Data Reduction and Analysis	$10,000	Includes analysis and data QA/QC
Hydrology and 2D Hydraulic Modeling	$22,000	Assumes 2 weeks for a hydrologist / engineer. Includes development of a hydraulic model for existing conditions, and proposed restoration treatments.
Geomorphic Analysis	$6,000	Assumes 2 weeks for a fluvial geomorphologist
Evaluation of Restoration treatment Alternatives	$6,000	Includes selection of a preferred alternative. Assumes 2 weeks for 2 engineers / fluvial geomorphologists
Implementation Total	$80,000	
Project Delivery		Items below are calculated as a percentage of the implementation sub-total
Development of final report (15%)	$15,000	
Contract Administration (5%)	$5,000	
Project Delivery Sub-Total	$20,000	
Total Estimate	$100,000	Rounded to the nearest $1,000

References

Bio-Analysts, EDAW, Historical Research Associates, Hardin-Davis, Mason Bruce & Girard, Meridian Environmental, Mobrand Biometrics, Montgomery Watson Harza, Northwest Hydraulic Consultants, Washington Department of Fish and Wildlife, and Watershed GeoDynamics. 2003. Final Licensee's 2001 technical study status reports for the Lewis River Hydroelectric Projects. FERC No. 935, 2071, 2111, 2213. Prepared for PacifiCorp, Portland, Oregon and Public Utility District No. 1 of Cowlitz County, Longview, Washington.

Interfluve, Cramer Fish Sciences, and Fox Environmental Services. 2008. Lewis River LWD Study. Prepared for PacifiCorp, Portland, OR.

Stillwater Sciences. 2006. Lewis River Spawning Gravel Evaluation. Prepared for PacifiCorp, Portland, Oregon and Public Utility District No. 1 of Cowlitz County, Longview, Washington.

Stillwater Sciences. 2009 Lewis River Spawning Gravel Evaluation, Final Report. Prepared for PacifiCorp, Portland, Oregon and Public Utility District No. 1 of Cowlitz County, Longview, Washington.

LOCATION MAP
STATE OF WASHINGTON

VICINITY MAP

SITE MAP

Preliminary Not For Construction

ABBREVIATIONS

LWD	LARGE WOODY DEBRIS
ESC	EROSION SEDIMENT AND CONTROL
FES	FABRIC ENCAPSULATED SOIL
FT	FEET
STA	STATION
ELEV	ELEVATION
IN	INCH
APPROX	APPROXIMATE
YR	YEAR
'	FEET
"	INCH
°	DEGREES
%	PERCENT
INV	INVERT
DIA	DIAMETER
HDPE	HIGH DENSITY POLYETHYLENE
OHW	ORDINARY HIGH WATER

SHEET INDEX

90% DESIGN

NO.	BY	DATE	REVISION DESCRIPTION

RP	BN	BN, GJ
DRAWN	DESIGNED	CHECKED
BN	11/20/09	
APPROVED	DATE	PROJECT

Lewis River – Eagle Island
Habitat Restoration – Site A
Woodland, Washington

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Cover, Sheet Index and Vicinity Map

SHEET
1 OF 12

EXISTING DATA

GENERAL TOPOGRAPHIC INFORMATION IS PROVIDED FROM LIDAR FROM CLARK COUNTY AND SPECIFIC PROJECT AREA SURVEY PERFORMED BY INTER-FLUVE, INC.

SOILS

LEWIS RIVER GRAVEL BAR.

UTILITIES

THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR HAVING UTILITIES LOCATED PRIOR TO CONSTRUCTION ACTIVITIES.

THE CONTRACTOR SHALL IMMEDIATELY CONTACT THE AFFECTED UTILITY SERVICE TO REPORT ANY DAMAGED OR DESTROYED UTILITIES. THE CONTRACTOR SHALL PROVIDE EQUIPMENT OR LABOR TO AID THE AFFECTED UTILITY SERVICE IN REPAIRING DAMAGED OR DESTROYED UTILITIES AT NO COST TO THE OWNER.

CONSTRUCTION ACCESS

THE CONTRACTOR SHALL ENTER THE SITE FROM NW 15TH AVE. NEAR ITS INTERSECTION WITH NW HAYES ROAD.

THE CONTRACTOR IS SOLELY RESPONSIBLE FOR OBTAINING ANY REQUIRED TRAFFIC CONTROL OR ACCESS PERMITS.

THE CONTRACTOR IS SOLELY RESPONSIBLE FOR PROVIDING ANY REQUIRED TRAFFIC CONTROL INCLUDING, BUT NOT LIMITED TO, SIGNAGE AND FLAGGERS.

ALL SAPLING AND TREES TO BE TRANSPLANTED OR REMOVED SHALL BE APPROVED BY THE OWNER'S REPRESENTATIVE AND CLEARLY MARKED.

ALL EQUIPMENT, MATERIALS AND PERSONNEL SHALL REMAIN WITHIN THE LIMITS OF DISTURBANCE.

THE CONTRACTOR SHALL KEEP THE WORK AREAS IN A NEAT AND SIGHTLY CONDITION FREE OF DEBRIS AND LITTER FOR THE DURATION OF THE PROJECT.

COFFERDAM

WORK AREA(S) SHALL BE ISOLATED BY COFFERDAMS INSTALLED UPSTREAM AND DOWNSTREAM OF ENHANCEMENT AREA. COFFERDAM MAY BE CONSTRUCTED WITH SAND FILLED BULK BAGS AND LINED WITH VISQUEEN ADJACENT TO ACTIVE FLOW IN THE CHANNEL.

DEWATERING OF WORK AREA(S) SHALL OCCUR CONCURRENT WITH FISH RESCUE. THE OWNER WILL BE RESPONSIBLE FOR CONDUCTING AND COORDINATING THE FISH RESCUE. THE CONTRACTOR SHALL COORDINATE DEWATERING WITH FISH RESCUE ACTIVITIES.

PUMPING SHALL BE PERFORMED TO KEEP WORK AREA DEWATERED. PUMPED DISCHARGE SHALL RELEASE SEDIMENT-LADEN WATER IN A MANNER THAT DOES NOT CAUSE CONTAMINATION OR INCREASE TURBIDITY OF SURFACE WATERS. (SEE CONTROL DEWATERING).

FISH RESCUE

COFFER DAM SHALL BE INSTALLED TO ISOLATE WORK.

INITIAL DEWATERING SHALL OCCUR SLOWLY BY INCREMENTALLY REDUCING COFFER DAMMED AREAS OVER A PERIOD OF 30 MINUTES TO ALLOW TIME FOR FISH TO FIND RESIDUAL POOLS WITHOUT RISK OF SUDDEN STRANDING.

RESIDUAL POOLS WITHIN THE DEWATERED CONSTRUCTION SITE SHALL BE PUMPED DRY USING SCREENED PUMP INTAKES. TRAPPED FISH SHALL BE RESCUED.

FISH BARRIERS AND PUMP INTAKES SHALL ADHERE TO NMFS SCREENING CRITERIA, NATIONAL MARINE FISHERIES SERVICE JUVENILE FISH SCREEN CRITERIA (REVISED FEBRUARY 16, 1995) AND ADDENDUM: JUVENILE FISH SCREEN CRITERIA FOR PUMP INTAKES (MAY 9, 1996)

ALL FISH RESCUE EFFORTS SHALL BE SUPERVISED BY A QUALIFIED FISHERIES/AQUATIC BIOLOGIST EXPERIENCED WITH THE COLLECTION AND HANDLING OF SALMONID FISHES FROM CONSTRUCTION SITES.

ALL FISH TRAPPED IN RESIDUAL POOLS WITHIN THE PROJECT AREA WILL BE CAREFULLY COLLECTED BY SEINE AND/OR DIP NETS AND PLACED IN CLEAN TRANSFER CONTAINERS WITH ADEQUATE VOLUME OF WATER AND HELD WITHIN NO LONGER THAN 10 MINUTES.

CAPTURED FISHES SHALL BE IMMEDIATELY RELEASED TO DOWNSTREAM OR UPSTREAM OF THE CONSTRUCTION SITE, DEPENDING ON SPECIES AND LIFESTAGE.

TREE SALVAGE

ANY REMOVED VEGETATION GREATER THAN 6 INCHES DIAMETER AND 15 FEET LONG SHOULD BE INCORPORATED INTO LOG JAM STRUCTURES. CONTRACTOR IS RESPONSIBLE FOR REMOVING SMALLER CLEARING AND GRUBBING DEBRIS FROM THE SITE AT THE END OF THE PROJECT UNLESS DIRECTED BY THE OWNER'S REPRESENTATIVE.

LIVE TREES

ALL TREES NOT MARKED FOR REMOVAL SHALL BE LEFT STANDING UNDISTURBED. LOGGING ACTIVITY SHALL NOT DEBARK OR DAMAGE LIVE TREES.

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General Notes

SHEET 2 OF 12

SITE PLAN

LEGEND

- ACCESS ROUTE
- PROPERTY LINES
- LIMITS OF DISTURBANCE

0 400 800

SCALE IN FEET

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Site Plan and Access

SHEET 3 OF 12

LEGEND

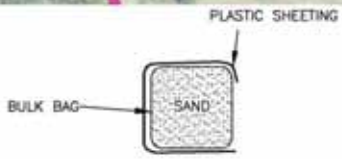
- TEMPORARY COFFER DAM
- ACCESS ROUTE
- STAGING/STOCKPILE
- LIMITS OF DISTURBANCE
- SEDIMENT FENCE

0 150 300

SCALE IN FEET

PLAN VIEW

Preliminary Not For Construction



SECTION A–A'

NO SCALE

NOTES:
1. PLACE COFFER DAMS PRIOR TO PERFORMING IN-WATER WORK.

3. REMOVE COFFER DAMS AFTER IN-WATER WORK IS COMPLETE.

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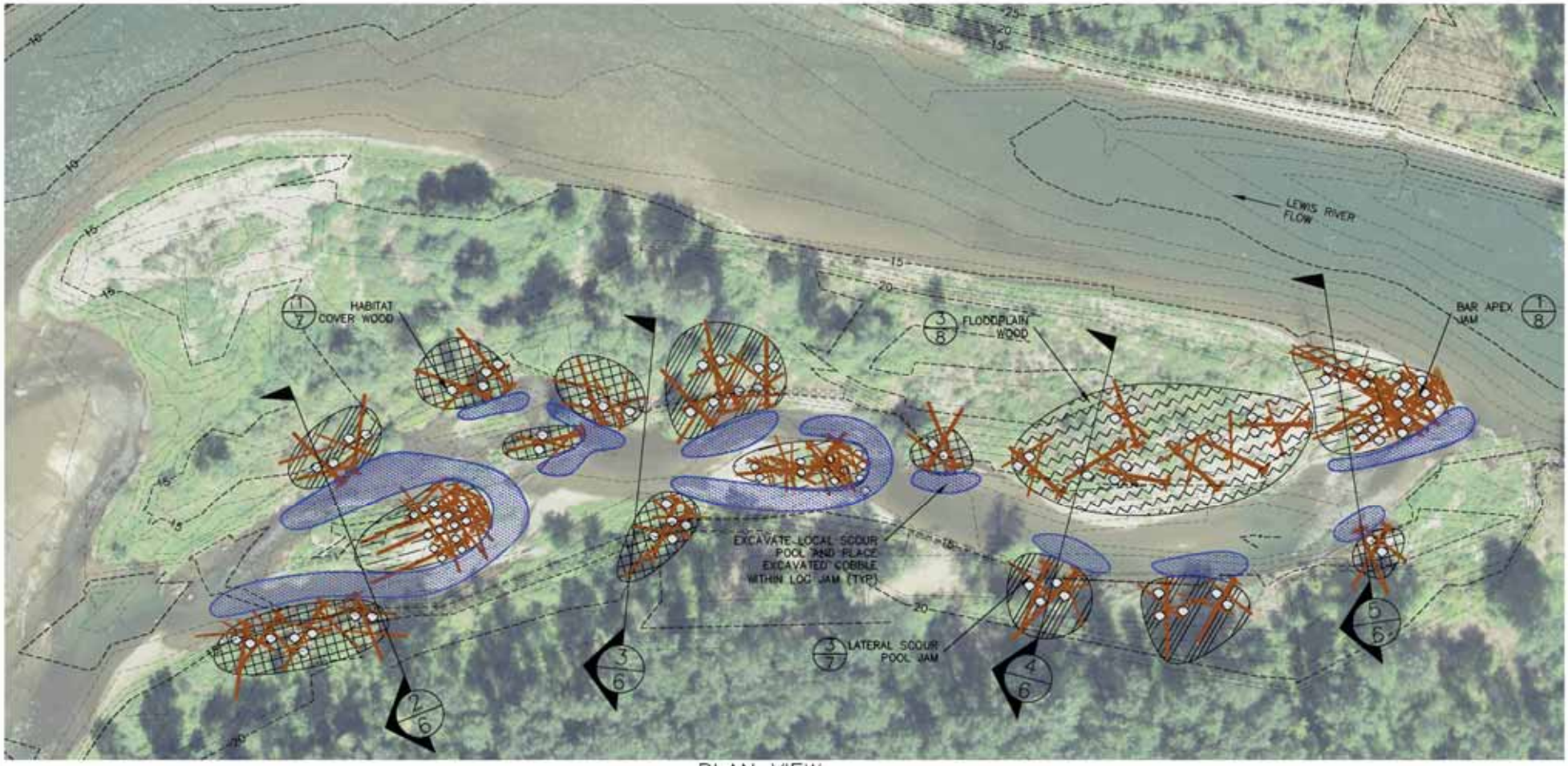
Erosion and Sediment Control Plan

SHEET 4 OF 12



PLAN VIEW

LEGEND

- EXISTING CONTOURS (1 FOOT INTERVALS)
- WOOD
- BOULDER BALLAST
- LOCALIZED SCOUR POOLS
- HABITAT WOOD COVER 1/7
- LATERAL SCOUR POOL JAM 3/7
- FLOODPLAIN WOOD 3/8
- BAR APEX JAM 1/8

0 50 100

SCALE IN FEET

NOTE:
SPECIFIC ORIENTATION OF LOGS AND BALLAST MATERIALS MAY VARY FROM PLAN VIEW DRAWING DEPENDING ON SIZE AND SHAPE OF MATERIAL ACQUIRED AND SITE CONDITIONS AT TIME OF CONSTRUCTION.

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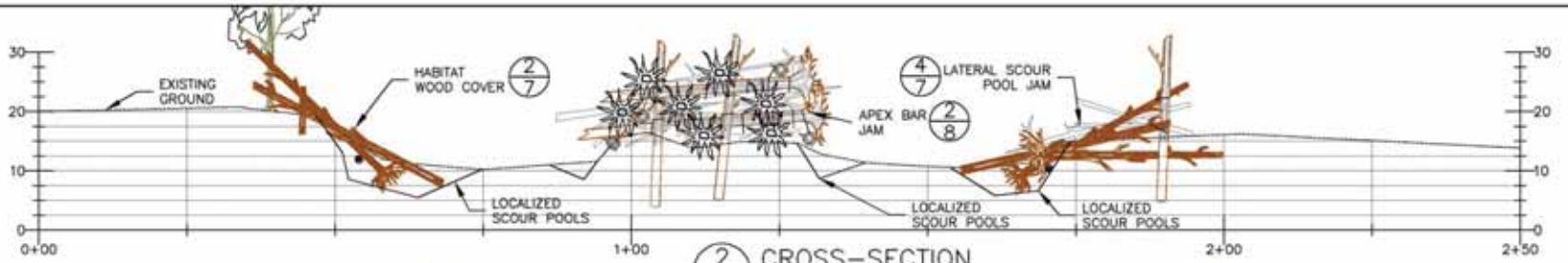
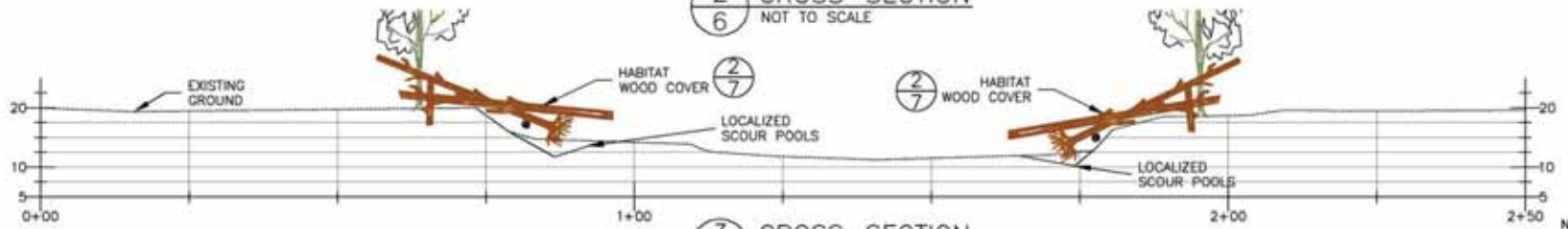
Plan View
Habitat Restoration

SHEET 5 OF 12

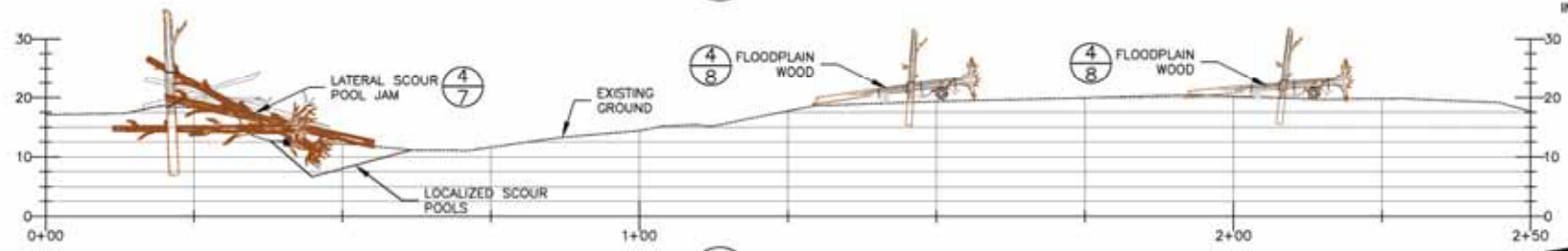


2/6 CROSS-SECTION
NOT TO SCALE



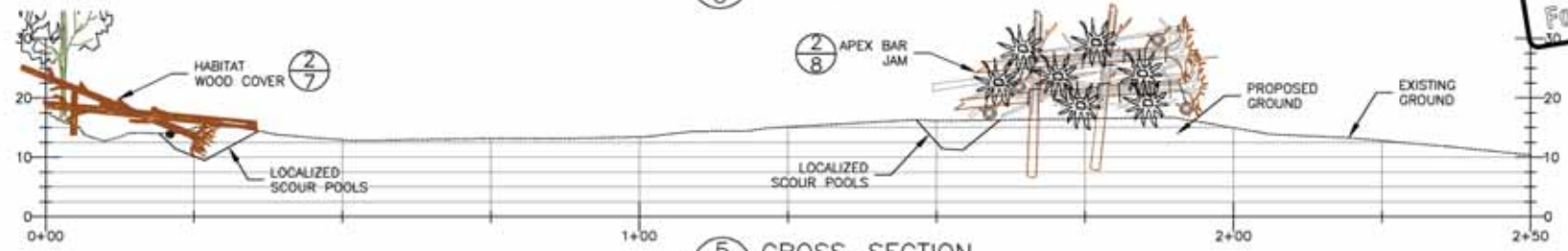
3/6 CROSS-SECTION
NOT TO SCALE

NOTE:
CROSS-SECTION INFORMATION WAS COMPILED USING SURVEY DATA CONDUCTED OCT, 2009 BY INTER-FLUVE, INC.



4/6 CROSS-SECTION
NOT TO SCALE

Preliminary Not For Construction



5/6 CROSS-SECTION
NOT TO SCALE

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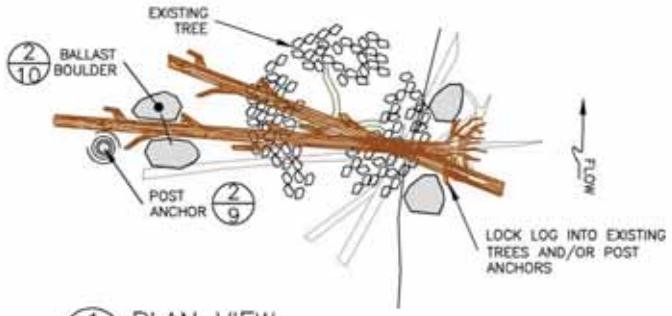
Cross-Sections

SHEET
6 OF 12



1/7 PLAN VIEW
TYPICAL HABITAT WOOD COVER
NOT TO SCALE

NOTES

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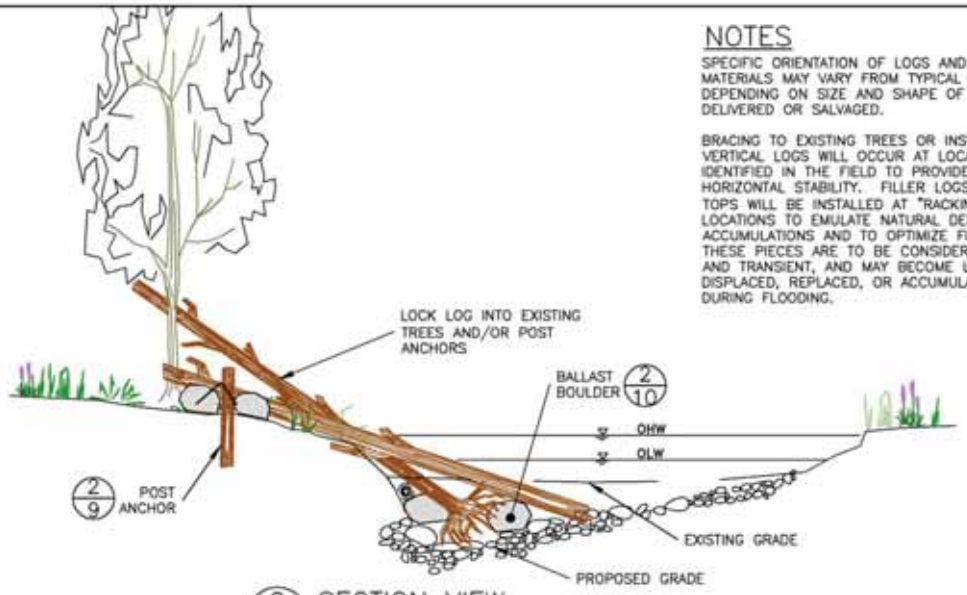
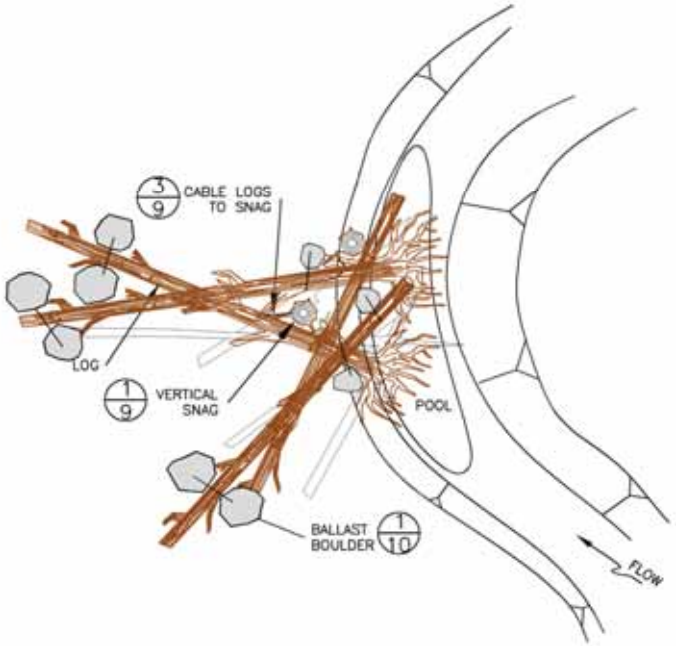
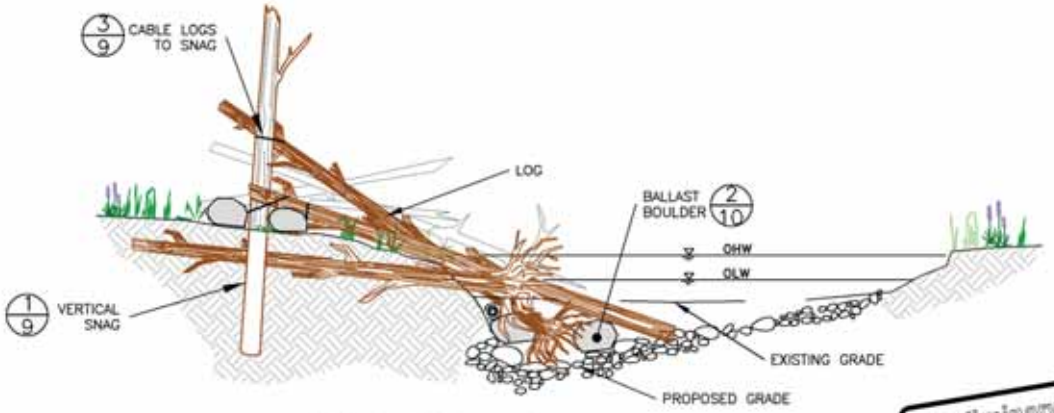
BRACING TO EXISTING TREES OR INSTALLED VERTICAL LOGS WILL OCCUR AT LOCATIONS IDENTIFIED IN THE FIELD TO PROVIDE HORIZONTAL STABILITY. FILLER LOGS AND TREE TOPS WILL BE INSTALLED AT "RACKING" LOCATIONS TO EMULATE NATURAL DEBRIS ACCUMULATIONS AND TO OPTIMIZE FISH HABITAT. THESE PIECES ARE TO BE CONSIDERED MOBILE AND TRANSIENT, AND MAY BECOME LOOSE, DISPLACED, REPLACED, OR ACCUMULATED ONTO DURING FLOODING.



2/7 SECTION VIEW
TYPICAL HABITAT COVER WOOD
NOT TO SCALE



3/7 PLAN VIEW
TYPICAL LATERAL SCOUR POOL JAM
NOT TO SCALE



4/7 SECTION VIEW
TYPICAL LATERAL SCOUR POOL JAM
NOT TO SCALE

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Typical Details

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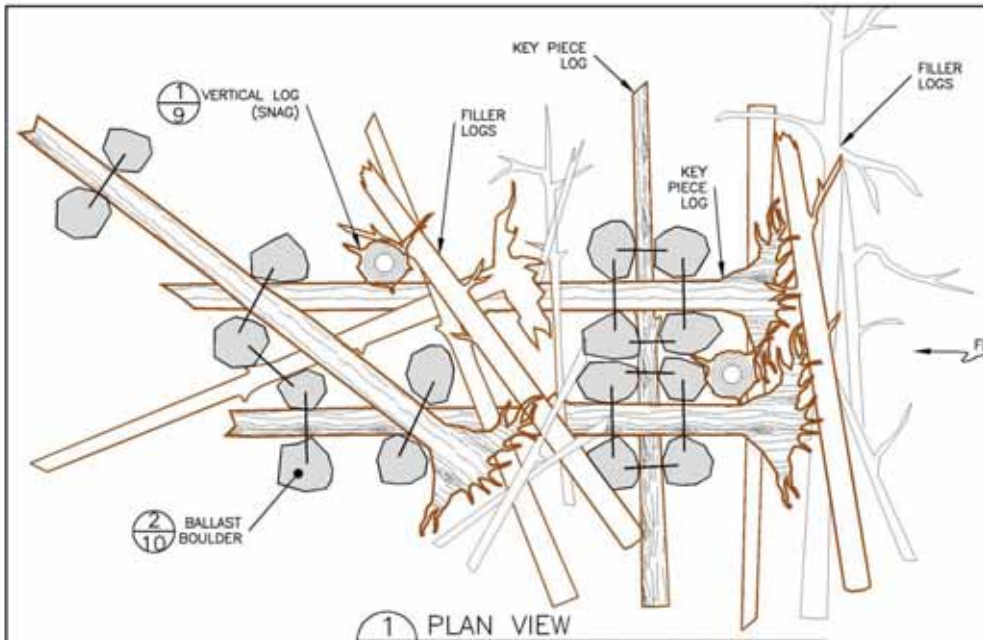
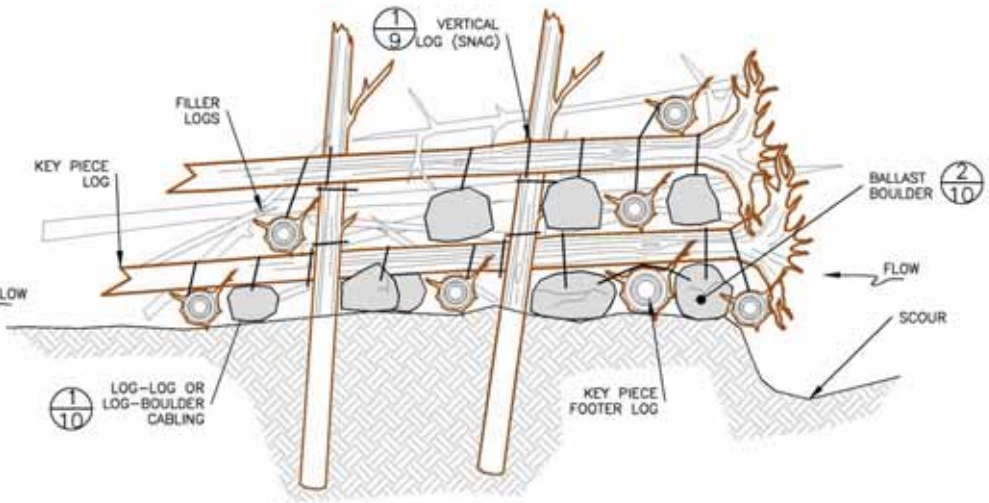
7 OF 12



1/8 PLAN VIEW
TYPICAL BAR APEX LOG JAM
NOT TO SCALE



2/8 SECTION VIEW
TYPICAL BAR APEX LOG JAM
NOT TO SCALE

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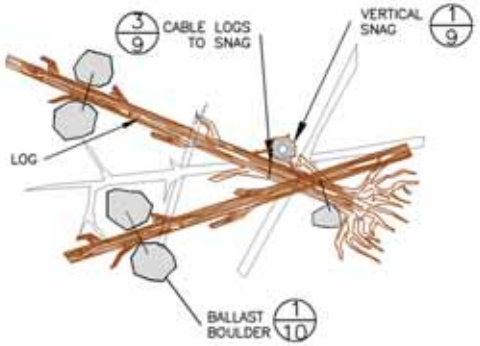
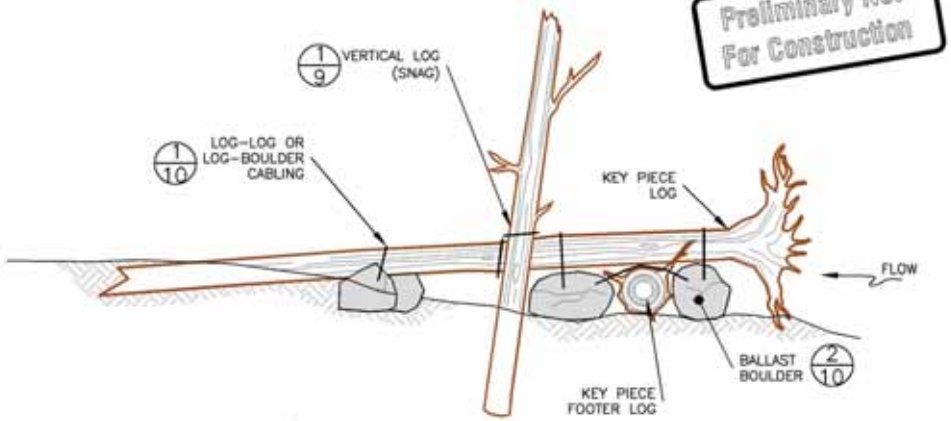


3/8 PLAN VIEW
TYPICAL FLOODPLAIN WOOD
NOT TO SCALE



4/8 SECTION VIEW
TYPICAL FLOODPLAIN WOOD
NOT TO SCALE

NO.	BY	DATE	REVISION DESCRIPTION

RP (DRAWN)	BN (DESIGNED)	BN, GJ (CHECKED)
BN (APPROVED)	11/20/09 (DATE)	(PROJECT)

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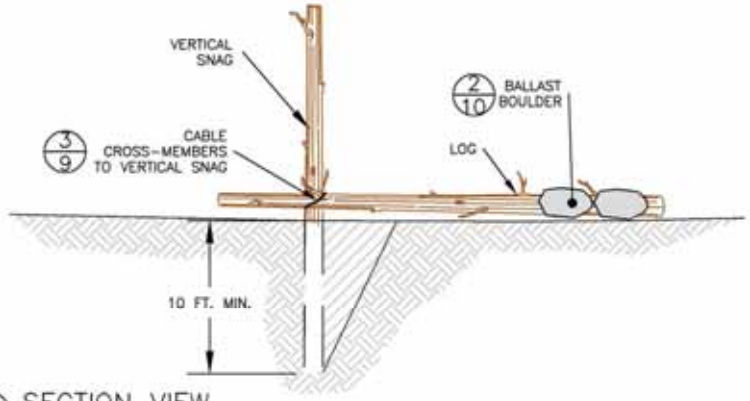
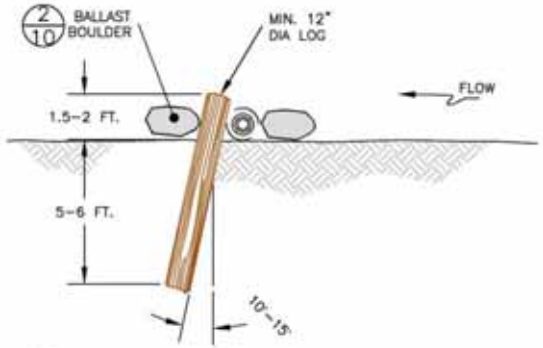
Typical Details

SHEET 8 OF 12

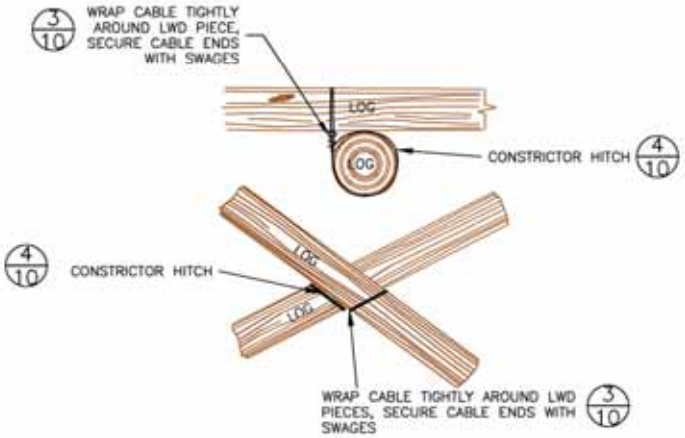


1/9 SECTION VIEW
TYPICAL LOGS SECURED AT VERTICAL SNAG
NOT TO SCALE

CABLING
USE 1/2 INCH GALVANIZED CABLE. CABLE SHALL BE CONSTRICTOR HITCHED AROUND VERTICAL SNAG WRAPPED ONCE AROUND OTHER LOG BEFORE ENDS ARE FASTENED TOGETHER. THERE SHALL BE NO SLACK IN THE CABLE AFTER IT IS FASTENED.



2/9 SECTION VIEW
TYPICAL LWD POST ANCHOR
NOT TO SCALE



3/9 DETAIL VIEWS
TYPICAL LOG CABLING
NOT TO SCALE

Preliminary Not For Construction

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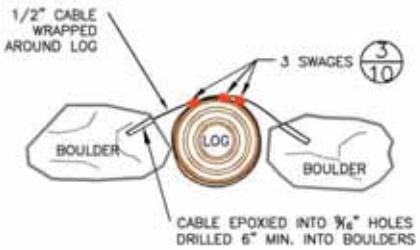
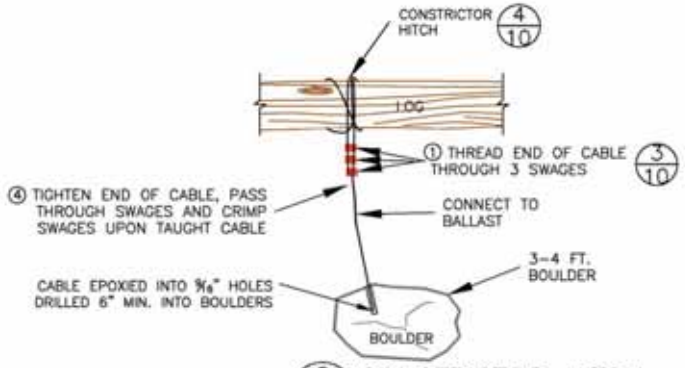
Typical Details

SHEET 9 OF 12

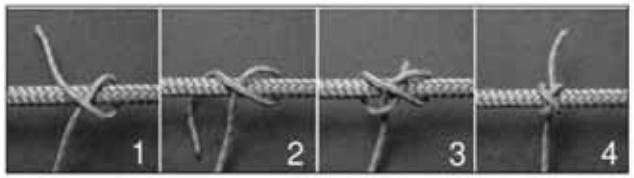


1/10 LWD INSTALLATION DETAILS



2/10 CONSTRICTOR HITCH CABLE WRAP

3/10 SWAGES CABLE SPLICE DETAIL



4/10 CONSTRICTOR HITCH CABLE KNOT DETAIL

Log Wood Buoyancy Force in Pounds Assumes Wood Specific Gravity =0.5	
DBH X Log Length (feet)	Safety Factor 1.5
1 x 30	1104
2 x 30	4416
3 x 30	9935
1 x 40	1472
2 x 40	5887
Additional Root Wad Buoyancy Force in Pounds.	
Estimate Based on 35% Void Space	
Adjust as needed based on void space in each root wad.	
2 X 2 Foot Diameter RW	64
3 X 3 Foot Diameter RW	215
4 X 4 Foot Diameter RW	510
5 X 5 Foot Diameter RW	997
6 X 6 Foot Diameter RW	1722

NOTE:
THE NUMBER OF ANCHOR ROCKS PER ANCHORED LOG STRUCTURE SHALL BE AS SHOWN ON THE TABLES PROVIDED ON THIS SHEET USING APPROPRIATE NUMBER OF BOULDERS AND THE SIZE OF LOGS.

Submerged Boulder Ballast in Pounds. Assumes Rock Specific Gravity of 2.65 and lift @ 6fps	
Boulder Diameter	Ballast
3 Foot	1289
2 - Boulder Configuration	2579
4 - Boulder Configuration	3868
3.5 Foot	2085
2 - Boulder Configuration	4171
4 - Boulder Configuration	6256
4 Foot	3156
2 - Boulder Configuration	6311
4 - Boulder Configuration	9467

Preliminary Not For Construction

BOULDER BALLAST AND WOOD CABLING:

BOULDER BALLAST NOTES

DESCRIPTION
THIS WORK CONSISTS OF INSTALLING LOGS WITH ROOT WADS INTO ANCHORED LOG STRUCTURES AS SHOWN ON THE PLANS AND AS DIRECTED BY THE OWNERS REPRESENTATIVE.

MATERIALS
ANCHORS FOR THIS WORK WILL CONSIST OF CABLED BOULDERS. BOULDERS SHALL BE NON-FRACTURED BASALT WITH A MINIMUM SPECIFIC GRAVITY OF 2.65.

CABLE SHALL BE GALVANIZED, STEEL CORE, AND SHALL HAVE A MINIMUM DIAMETER OF 1/2 INCH.

SWAGES SHALL BE ZINC PLATED COPPER AND SHALL MEET THE PERFORMANCE REQUIREMENTS OF MILITARY STANDARD MS-51844, REV. C, SLEEVES, SWAGING-WIRE ROPE. MINIMUM OF 3 SWAGES PER CONNECTION.

EPOXY FOR ANCHORING SHALL BE HILTI HIT RE 500 ADHESIVE OR APPROVED EQUAL.

CONSTRUCTION

FINAL POSITIONING OF THE ANCHORED LOG STRUCTURES SHALL BE IN THE APPROXIMATE LOCATION AS SHOWN ON THE PLANS AND AS APPROVED IN THE FIELD BY THE OWNERS REPRESENATIVE.

GENERAL NOTES , CONT'D

FINAL POSITIONING OF THE ANCHORED LOG STRUCTURES SHALL BE IN THE APPROXIMATE LOCATION AS SHOWN ON THE PLANS AND AS APPROVED IN THE FIELD BY THE OWNERS REPRESENATIVE.

BALLAST BOULDERS SHALL BE SECURED AS SHOWN ON THE PLANS.

DRILL HOLES IN SOLID ROCK AND AVOID ANY CRACKS OR FRACTURES. HOLES SHALL BE 9/16 INCH IN DIAMETER. HOLES MUST BE DRILLED 6 INCHES, MINIMUM, INTO ROCK. HOLES MUST BE CLEANED OF LOOSE ROCK FRAGMENTS AND POWDER WITH A BRUSH AND WATER. HOLES MUST BE CLEAN OF ALL DUST, DEBRIS, OIL, AND SOAP RESIDUES. THE HOLES MUST FLUSH CLEAR TO INSURE NO MATERIAL EXISTS BETWEEN THE CABLE, EPOXY, AND ROCK SURFACE. INSTALL EPOXY PER MANUFACTURER'S RECOMMENDATIONS.

CABLE SHALL BE WRAPPED ONCE AROUND LOG BEFORE ENDS ARE INSERTED INTO THE DRILLED HOLES FILLED WITH EPOXY. WIPE CABLE WITH CLEAN ACETONE SOAKED RAG TO REMOVE OILS AND GREASES PRIOR TO INSERTION INTO EPOXY FILLED HOLE. FILL DRILL HOLES ENOUGH TO ENSURE COMPLETE COVERAGE WITH EPOXY. INSERT CABLE INTO HOLE SO THAT END OF CABLE HITS THE BOTTOM OF THE HOLE. EXCESS EPOXY SHOULD COME OUT OF THE TOP OF THE HOLE AS CABLE IS SEATED IN DRILL HOLE.

MINIMUM 3 SWAGES PER CONNECTION. SWAGES SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATION, SPACING AND SWAGE TOOL DIAMETER FOR THE SIZE AND LOAD RATING OF THE CABLE BEING USED. SWAGING TOOL SHALL BE CHECKED FOR PROPER COMPRESSION, ACCORDING TO MANUFACTURER'S RECOMMENDATIONS, USING A GAUGE PROVIDED BY THE MANUFACTURER OF THE SWAGE FITTINGS BEING INSTALLED.

NO.	BY	DATE	REVISION DESCRIPTION

RP	BN	BN, GJ
DRAWN	DESIGNED	CHECKED
BN	11/20/09	
APPROVED	DATE	PROJECT

Lewis River – Eagle Island
Habitat Restoration – Site A
Woodland, Washington

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Typical Details

SHEET
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THE CONTRACTOR IS ADVISED THAT THE PROJECT AREA DRAINS TO A SALMON BEARING STREAM AND/OR STATE WATERS AND THAT THE CONTRACTOR IS RESPONSIBLE TO PROTECT THE RECEIVING WATERS FROM DELETERIOUS EFFECTS OF CONSTRUCTION.

THE CONTRACTOR IS RESPONSIBLE FOR PROVIDING THE EROSION CONTROL MEASURES SHOWN OR DESCRIBED IN THE CONTRACT DOCUMENTS AND ANY ADDITIONAL MEASURES THAT MAY BE REQUIRED BY THE CONTRACTORS MEANS AND METHODS OF CONSTRUCTION AS NEEDED TO CONTROL EROSION AND SEDIMENT AT THE CONSTRUCTION SITE AND TO PREVENT VIOLATION OF SURFACE WATER QUALITY, GROUND WATER QUALITY, OR SEDIMENT MANAGEMENT STANDARDS. EROSION CONTROL MEASURES SHALL BE MAINTAINED THROUGHOUT THE COURSE OF CONSTRUCTION AND UNTIL ALL DISTURBED EARTH IS STABILIZED IN FINISH GRADES.

EROSION CONTROL

CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING AND MAINTAINING ALL NECESSARY EROSION CONTROL FACILITIES TO COMPLY WITH APPLICABLE EROSION CONTROL REGULATIONS.

AN APPROVED EROSION AND SEDIMENT CONTROL (ESC) PLAN IS PROVIDED IN THESE DRAWINGS. THE BID AND CONSTRUCTION CONTRACT ARE BASED UPON IT. THE CONTRACTOR SHALL BE SOLEY RESPONSIBLE FOR PROVIDING EROSION CONTROL MEASURES TO COMPLY WITH APPLICABLE REGULATIONS AND PERMITS.

THE FOLLOWING RECOMMENDATIONS FOR AN ESC PLAN WILL PROVIDE A GUIDELINE FOR THE CONTRACTOR TO DEVELOP AND IMPLEMENT AN ESC PLAN.

A. THE IMPLEMENTATION OF THESE RECOMMENDATIONS FOR AN ESC PLAN AND THE CONSTRUCTION, MAINTENANCE, REPLACEMENT, AND UPGRADING OF THESE ESC FACILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR UNTIL ALL CONSTRUCTION IS COMPLETED AND APPROVED, AND VEGETATION IS ESTABLISHED.

B. THE BOUNDARIES OF THE CLEARING LIMITS SHOWN ON THIS PLAN SHALL BE CLEARLY FLAGGED IN THE FIELD PRIOR TO CONSTRUCTION. DURING THE CONSTRUCTION PERIOD, NO DISTURBANCE BEYOND THE FLAGGED CLEARING LIMITS SHALL BE PERMITTED. THE FLAGGING SHALL BE MAINTAINED BY THE CONTRACTOR FOR THE DURATION OF CONSTRUCTION.

C. ESC FACILITIES AS APPROXIMATELY SHOWN ON THIS PLAN ARE TO BE CONSTRUCTED IN CONJUNCTION WITH ALL CLEARING AND GRADING ACTIVITIES, AND IN SUCH A MANNER AS TO ENSURE THAT SEDIMENT AND SEDIMENT LADEN WATER DO NOT ENTER THE DRAINAGE SYSTEM, OR VIOLATE APPLICABLE WATER STANDARDS.

D. THE ESC FACILITIES SHOWN ON THE ESC PLAN ARE THE MINIMUM REQUIREMENTS FOR ANTICIPATED SITE CONDITIONS. DURING THE CONSTRUCTION PERIOD, THESE ESC FACILITIES SHALL BE UPGRADED AS NEEDED FOR STORM EVENTS AND TO ENSURE THAT SEDIMENT AND SEDIMENT-LADEN WATER DO NOT LEAVE THE SITE.

E. THE ESC FACILITIES SHALL BE INSPECTED DAILY BY THE CONTRACTOR AND MAINTAINED AS NECESSARY TO ENSURE THEIR CONTINUED FUNCTIONING.

F. FROM OCTOBER 1 – APRIL 30, NO SUBSTANTIALLY UNWORKED SOILS SHALL REMAIN EXPOSED FOR MORE THAN TWO DAYS AT A TIME. FROM MAY 1 – SEPT 30 NO SUBSTANTIALLY UNWORKED SOILS SHALL REMAIN EXPOSED FOR MORE THAN SEVEN DAYS AT A TIME.

SEDIMENT FENCES

1. THE SILT FENCE SHALL BE PURCHASED IN A CONTINUOUS ROLL CUT TO THE LENGTH OF THE BARRIER TO AVOID USE OF JOINTS. WHEN JOINTS ARE NECESSARY, SILT FENCE SHALL BE SPLICED TOGETHER ONLY AT A SUPPORT POST, WITH A MINIMUM 12 INCH OVERLAP, AND BOTH ENDS SECURELY FASTENED TO THE POST, OR OVERLAP 2"X2" POSTS AND ATTACH AS APPROVED BY THE OWNER'S REPRESENTATIVE.

2. THE SILT FENCE IS TO BE INSTALLED AT LOCATIONS SHOWN ON THE PLAN ALONG THE DOWNHILL PERIMETER OF DISTURBED AREAS. THE FENCE POSTS SHALL BE SPACED A MAXIMUM OF 4 FEET APART AND DRIVEN SECURELY INTO THE GROUND A MINIMUM OF 12 INCHES.

3. THE SILT FENCE SHALL HAVE A MINIMUM VERTICAL BURIAL OF 6 INCHES. ALL EXCAVATED MATERIAL FROM FILTER FABRIC FENCE INSTALLATION SHALL BE BACKFILLED AND COMPACTED, ALONG THE ENTIRE DISTURBED AREA.

4. STANDARD OR HEAVY DUTY SILT FENCE SHALL HAVE MANUFACTURED STITCHED LOOPS FOR 2" x 2" POST INSTALLATION.

5. SILT FENCES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFUL PURPOSE, BUT NOT BEFORE THE UPSLOPE AREA HAS BEEN PERMANENTLY PROTECTED AND STABILIZED.

6. SILT FENCES SHALL BE INSPECTED BY THE CONTRACTOR IMMEDIATELY AFTER EACH RAINFALL AND AT LEAST DAILY DURING PROLONGED RAINFALL. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.

7. ON PROJECT COMPLETION THE CONTRACTOR SHALL REMOVE ALL SILT FENCES AND TEMPORARY EROSION CONTROL MEASURES FROM THE PROJECT SITE.

INSPECTION AND MAINTENANCE

ALL BEST MANAGEMENT PRACTICES (BMPs) SHALL BE INSPECTED, MAINTAINED, AND REPAIRED AS NEEDED TO ASSURE CONTINUED PERFORMANCE OF THEIR INTENDED FUNCTION. ALL ON-SITE EROSION AND SEDIMENT CONTROL MEASURES SHALL BE INSPECTED AT LEAST ONCE EVERY SEVEN DAYS AND WITHIN 24 HOURS AFTER ANY STORM EVENT GREATER THAN 0.5 INCHES OF RAIN PER 24 HOUR PERIOD.

SEDIMENT MUST BE REMOVED FROM SILT FENCES BEFORE IT REACHES APPROXIMATELY ONE THIRD THE HEIGHT OF THE FENCE, ESPECIALLY IF HEAVY RAINS ARE EXPECTED.

STABILIZE SOILS AND PROTECT SLOPES

FROM MAY 1 THROUGH SEPTEMBER 30, ALL EXPOSED SOILS SHALL BE PROTECTED FROM EROSION BY MULCHING, PLASTIC SHEETING, HYDROSEED COVERING, OR OTHER APPROVED MEASURES WITHIN ONE WEEK OF GRADING. FROM OCTOBER 1 THROUGH APRIL 30, ALL EXPOSED SOILS MUST BE PROTECTED WITHIN 2 DAYS OF GRADING. SOILS SHALL BE STABILIZED BEFORE A WORK SHUTDOWN, HOLIDAY OR WEEKEND IF NEEDED BASED ON THE WEATHER FORECAST. SOIL STOCKPILES MUST BE STABILIZED AND PROTECTED WITH SEDIMENT TRAPPING MEASURES. HYDROSEED AS SOON AS PRACTICAL ALL DISTURBED AREAS NOT INDICATED IN THE CONTRACT DOCUMENTS FOR OTHER PERMANENT STABILIZATION MEASURES.
DESIGN, CONSTRUCT, AND PHASE CUT AND FILL SLOPES IN A MANNER THAT WILL MINIMIZE EROSION. REDUCE SLOPE VELOCITIES ON DISTURBED SLOPES BY PROVIDING TEMPORARY BARRIERS. STORMWATER FROM OFF SITE SHOULD BE HANDLED SEPARATELY FROM STORMWATER GENERATED ON SITE.

AFTER FINAL SITE STABILIZATION

ALL TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE REMOVED WITHIN 30 DAYS AFTER FINAL SITE STABILIZATION IS ACHIEVED OR AFTER THE TEMPORARY BMPs ARE NO LONGER NEEDED. TRAPPED SEDIMENT SHALL BE REMOVED FROM THE SITE OR INCORPORATED INTO FINISHED GRADING. DISTURBED SOIL AREAS RESULTING FROM REMOVAL SHALL BE PERMANENTLY STABILIZED.

CONSTRUCTION ACCESS

PUBLIC RIGHTS-OF-WAY SHALL BE KEPT IN A CLEAN AND SERVICEABLE CONDITION AT ALL TIMES. IN THE EVENT MATERIALS ARE INADVERTENTLY DEPOSITED ON ROADWAYS THE MATERIAL SHALL BE PROMPTLY REMOVED. MATERIALS ARE TO BE SWEPT AND REMOVED PRIOR TO ANY STREET FLUSHING.

SILT FENCE SHALL BE PLACED ALONG ACCESS ROUTES, STOCKPILE AREA, AND DOWNSTREAM OF OUTLET COFFER DAM.

CONTROL POLLUTANTS

CONTRACTOR MUST PREPARE A SPILL PREVENTION CONTROL AND COUNTER MEASURE (SPCC) PLAN AND IMPLEMENT REQUIRED MEASURES TO CONTROL POLLUTANTS. SEE THE SPECIAL PROVISIONS.

ALL POLLUTANT DISCHARGES OTHER THAN SEDIMENT THAT OCCUR ON SITE DURING CONSTRUCTION SHALL BE HANDLED AND DISPOSED OF IN A MANNER THAT DOES NOT CAUSE CONTAMINATION OF STORMWATER, GROUNDWATER, OR SOILS TO REMAIN ON SITE.

THE USE OF LIME, FLY ASH, OR OTHER SOIL AMENDMENTS THAT COULD ALTER THE PH OF DISCHARGE WATERS IS PROHIBITED.

SEDIMENT CONTROLS

THE DUFF LAYER, NATIVE TOP SOIL, AND NATURAL VEGETATION SHALL BE RETAINED IN AN UNDISTURBED STATE TO THE MAXIMUM EXTENT PRACTICABLE. THE CONTRACTOR SHALL MARK ALL AREAS WHICH ARE NOT TO BE DISTURBED, INCLUDING SETBACKS, SENSITIVE/CRITICAL AREAS AND THEIR BUFFERS. TREES AND DRAINAGE COURSES NOT TO BE DISTURBED SHALL BE MARKED AND FLAGGED BEFORE CONSTRUCTION ACTIVITIES ARE INITIATED. THESE AREAS SHALL BE PROTECTED BY THE CONTRACTOR WITH BARRIER FENCING AS SHOWN ON THE DRAWING AND AS DIRECTED BY THE ENGINEER WHEN CONSTRUCTION ACTIVITIES ARE INITIATED.

THE CONTRACTOR MAY ELECT TO CONSTRUCT TEMPORARY SEDIMENTATION PONDS, TANKS, OR OTHER FACILITIES AS NECESSARY TO CONTROL RUNOFF AND/OR TO FILTER DEWATERING DISCHARGE.

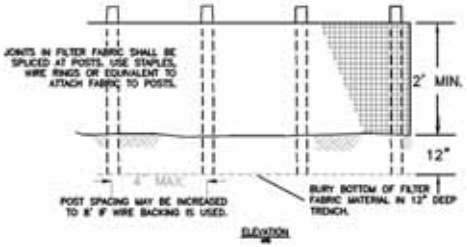
CONTROL DEWATERING

HIGHLY TURBID OR CONTAMINATED DEWATERING WATER FROM CONSTRUCTION EQUIPMENT OPERATION SHALL BE PREVENTED FROM DELIVERING SEDIMENT TO THE RIVER. DISPOSAL OPTIONS FOR DEWATERING DISCHARGE INCLUDE:

1. SEDIMENT-LADEN WATER MAY BE PUMPED TO AN UPLAND AREA AND ALLOWED TO SHEET FLOW OVER UNDISTURBED GROUND THROUGH EXISTING VEGETATION TO INFILTRATE INTO THE GROUND.

2. USE OF AN APPROPRIATELY SIZED AND MAINTAINED SEDIMENTATION BAG (DIRTBAG) OR OTHER SEDIMENTATION FACILITY WITH OUTFALL TO A DITCH OR SWALE FOR SMALL VOLUMES OF LOCALIZED DEWATERING.

NOTES:
1. FENCE SHALL NOT BE INSTALLED ON SLOPES STEEPER THAN 2:1.
2. JOINTS IN FILTER FABRIC SHALL BE OVERLAPPED 12 INCHES AT POST.
3. USE STAPLES, WIRE RINGS, OR EQUIVALENT TO ATTACH FABRIC.
4. REMOVE SEDIMENT WHEN IT REACHES 1/3 FENCE HEIGHT.



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1/11 SILT FENCE DETAIL

NO.	BY	DATE	REVISION DESCRIPTION

RP DRAWN	BN DESIGNED	BN, GJ CHECKED
BN APPROVED	11/20/09 DATE	PROJECT

Lewis River – Eagle Island Habitat Restoration – Site A
Woodland, Washington

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Erosion Control Notes and Details

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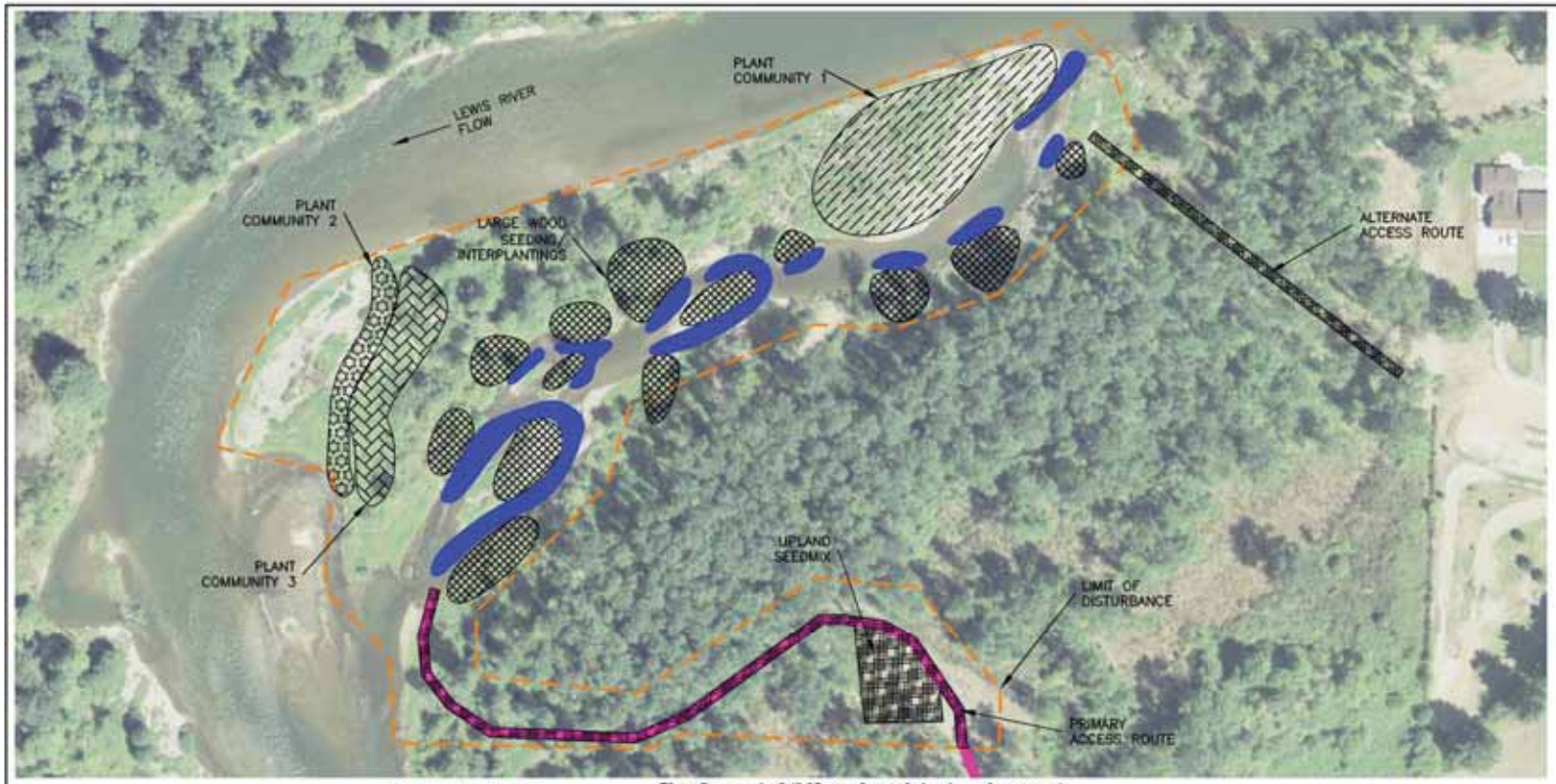

PLAN VIEW

N

0 150 300

SCALE IN FEET

LEGEND

- ACCESS ROUTE
- LIMITS OF DISTURBANCE
- PLANT COMMUNITY 1 – RIPARIAN UNDERSTORY ENHANCEMENTS
- PLANT COMMUNITY 2 – RIPARIAN SHRUB/SCRUB ENHANCEMENTS
- PLANT COMMUNITY 3 – FORESTED RIPARIAN ENHANCEMENTS
- LARGE WOOD SEEDING/ INTERPLANTINGS
- UPLAND SEED MIX

NOTE:
SITE ACCESS ROADS AND OTHER DISTURBED AREAS TO BE SEEDED WITH NATIVE EROSION CONTROL SEED MIX.

Preliminary Not For Construction

Plant Community 1 (0.86-acre riparian understory enhancement)

Common Name	Scientific Name	Plant Form	Minimum Size	Required Number
Shrubs – 6 foot spacing on center				
Red-osier dogwood	*Cornus sericea*	Cuttings	36"	350
Columbia Willow	*Salix fluviatilis*	Cuttings	36"	300
Nootka rose	*Rosa nutkana*	Bare root	24"	180
Black hawthorn	*Crataegus douglasii*	Bare root	24"	100
Pacific ninebark	*Physocarpus capitatus*	Bare root	24"	100
			Total Shrubs	1030

Plant Community 2 (0.23-acre riparian shrub/scrub community)

Common Name	Scientific Name	Plant Form	Minimum Size	Required Number
Shrubs – 5 foot spacing on center				
Pacific willow	*Salix lasiandra*	Cuttings	36"	150
Douglas spirea	*Spirea douglasii*	Bare root	24"	125
Columbia Willow	*Salix fluviatilis*	Cuttings	36"	100
			Total Shrubs	400

Plant Community 3 (0.35-acre forested riparian enhancement)

Common Name	Scientific Name	Plant Form	Minimum Size	Required Number
Trees – 12 foot spacing on center				
Black cottonwood	*Populus balsamifera*	Bare root	24"	30
Oregon Ash	*Fraxinus latifolia*	Bare root	24"	35
Red alder	*Alnus rubra*	Bare root	24"	20
			Total Trees	105
Shrubs – 5 foot spacing on center				
Ocean spray	*Holodiscus discolor*	Bare root	24"	210
Pacific ninebark	*Physocarpus capitatus*	Bare root	24"	150
Serviceberry	*Amelanchier alnifolia*	Bare root	24"	125
Red elderberry	*Sambucus racemosa*	Bare root	24"	125
			Total Shrubs	610

Large Wood Inter-plantings (1.03 - acres)

Common Name	Scientific Name	Plant Form	Minimum Size	Required Number
Shrubs – approximately 7 foot spacing on center				
Pacific willow	*Salix lasiandra*	Cuttings	36"	300
Red-osier dogwood	*Cornus sericea*	Cuttings	36"	300
Columbia Willow	*Salix fluviatilis*	Cuttings	36"	300
			Total Shrubs	900

Upland Access/Staging Area Restoration seed mix (0.89-acre upland staging area restoration)

Seed Mix Contents– Seed at approximately 10 lbs/ acre		
Common Name	Latin Name	% of seed mix (by weight)
Blue Wildrye	*Elymus glaucus*	40
California brome	*Bromus carinatus*	40
Red fescue	*Festuca rubra*	13
Tufted hairgrass	*Deschampsia caespitosa*	7

Riparian Restoration seed mix (1.03-acre riparian disturbance restoration)

Seed Mix Contents– Seed at approximately 18 lbs/ acre		
Common Name	Latin Name	% of seed mix (by weight)
Blue Wildrye	*Elymus glaucus*	46
Red Fescue	*Festuca rubra rubra*	31
Tufted hairgrass	*Deschampsia caespitosa*	12
Western managrass	*Glyceria occidentalis*	2
American slough grass	*schmannia cyzigachne*	2

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Lewis River – Eagle Island
Habitat Restoration – Site A
Woodland, Washington

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Revegetation Plan

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LOCATION MAP
STATE OF WASHINGTON

VICINITY MAP

SITE MAP

Preliminary Not For Construction

ABBREVIATIONS

LWD	LARGE WOODY DEBRIS
ESC	EROSION SEDIMENT AND CONTROL
FES	FABRIC ENCAPSULATED SOIL
FT	FEET
STA	STATION
ELEV	ELEVATION
IN	INCH
APPROX	APPROXIMATE
YR	YEAR
'	FEET
"	INCH
°	DEGREES
%	PERCENT
INV	INVERT
DIA	DIAMETER
HDPE	HIGH DENSITY POLYETHYLENE
OHW	ORDINARY HIGH WATER

SHEET INDEX

30% DESIGN

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Lewis River – Eagle Island
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Cover, Sheet Index and Vicinity Map

SHEET 1 OF 12

EXISTING DATA

GENERAL TOPOGRAPHIC INFORMATION IS PROVIDED FROM LIDAR FROM CLARK COUNTY AND SPECIFIC PROJECT AREA SURVEY PERFORMED BY INTER-FLUVE, INC.

SOILS

LEWIS RIVER GRAVEL BAR.

UTILITIES

THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR HAVING UTILITIES LOCATED PRIOR TO CONSTRUCTION ACTIVITIES.

THE CONTRACTOR SHALL IMMEDIATELY CONTACT THE AFFECTED UTILITY SERVICE TO REPORT ANY DAMAGED OR DESTROYED UTILITIES. THE CONTRACTOR SHALL PROVIDE EQUIPMENT OR LABOR TO AID THE AFFECTED UTILITY SERVICE IN REPAIRING DAMAGED OR DESTROYED UTILITIES AT NO COST TO THE OWNER.

CONSTRUCTION ACCESS

THE CONTRACTOR IS SOLELY RESPONSIBLE FOR OBTAINING ANY REQUIRED TRAFFIC CONTROL OR ACCESS PERMITS.

THE CONTRACTOR IS SOLELY RESPONSIBLE FOR PROVIDING ANY REQUIRED TRAFFIC CONTROL INCLUDING, BUT NOT LIMITED TO, SIGNAGE AND FLAGGERS.

ALL SAPLING AND TREES TO BE TRANSPLANTED OR REMOVED SHALL BE APPROVED BY THE OWNER'S REPRESENTATIVE AND CLEARLY MARKED.

ALL EQUIPMENT, MATERIALS AND PERSONNEL SHALL REMAIN WITHIN THE LIMITS OF DISTURBANCE.

THE CONTRACTOR SHALL KEEP THE WORK AREAS IN A NEAT AND SIGHTLY CONDITION FREE OF DEBRIS AND LITTER FOR THE DURATION OF THE PROJECT.

COFFERDAM

WORK AREA(S) SHALL BE ISOLATED BY COFFERDAMS INSTALLED UPSTREAM AND DOWNSTREAM OF ENHANCEMENT AREA. COFFERDAM MAY BE CONSTRUCTED WITH SAND FILLED BULK BAGS AND LINED WITH VISQUEEN ADJACENT TO ACTIVE FLOW IN THE CHANNEL.

DEWATERING OF WORK AREA(S) SHALL OCCUR CONCURRENT WITH FISH RESCUE. THE OWNER WILL BE RESPONSIBLE FOR CONDUCTING AND COORDINATING THE FISH RESCUE. THE CONTRACTOR SHALL COORDINATE DEWATERING WITH FISH RESCUE ACTIVITIES.

PUMPING SHALL BE PERFORMED TO KEEP WORK AREA DEWATERED. PUMPED DISCHARGE SHALL RELEASE SEDIMENT-LADEN WATER IN A MANNER THAT DOES NOT CAUSE CONTAMINATION OR INCREASE TURBIDITY OF SURFACE WATERS. (SEE CONTROL DEWATERING).

FISH RESCUE

COFFER DAM SHALL BE INSTALLED TO ISOLATE WORK.

INITIAL DEWATERING SHALL OCCUR SLOWLY BY INCREMENTALLY REDUCING COFFER DAMMED AREAS OVER A PERIOD OF 30 MINUTES TO ALLOW TIME FOR FISH TO FIND RESIDUAL POOLS WITHOUT RISK OF SUDDEN STRANDING.

RESIDUAL POOLS WITHIN THE DEWATERED CONSTRUCTION SITE SHALL BE PUMPED DRY USING SCREENED PUMP INTAKES. TRAPPED FISH SHALL BE RESCUED.

FISH BARRIERS AND PUMP INTAKES SHALL ADHERE TO NMFS SCREENING CRITERIA, NATIONAL MARINE FISHERIES SERVICE JUVENILE FISH SCREEN CRITERIA (REVISED FEBRUARY 16, 1995) AND ADDENDUM: JUVENILE FISH SCREEN CRITERIA FOR PUMP INTAKES (MAY 9, 1996)

ALL FISH RESCUE EFFORTS SHALL BE SUPERVISED BY A QUALIFIED FISHERIES/AQUATIC BIOLOGIST EXPERIENCED WITH THE COLLECTION AND HANDLING OF SALMONID FISHES FROM CONSTRUCTION SITES.

ALL FISH TRAPPED IN RESIDUAL POOLS WITHIN THE PROJECT AREA WILL BE CAREFULLY COLLECTED BY SEINE AND/OR DIP NETS AND PLACED IN CLEAN TRANSFER CONTAINERS WITH PORTABLE AERATION.

CAPTURED FISHES SHALL BE IMMEDIATELY RELEASED TO DOWNSTREAM OR UPSTREAM OF THE CONSTRUCTION SITE, DEPENDING ON SPECIES AND LIFESTAGE.

TREE SALVAGE

ANY REMOVED VEGETATION GREATER THAN 6 INCHES DIAMETER AND 15 FEET LONG SHOULD BE INCORPORATED INTO LOG JAM STRUCTURES. CONTRACTOR IS RESPONSIBLE FOR REMOVING SMALLER CLEARING AND GRUBBING DEBRIS FROM THE SITE AT THE END OF THE PROJECT UNLESS DIRECTED BY THE OWNER'S REPRESENTATIVE.REES THAT ARE REMOVED DURING CONSTRUCTION WILL BE USED AS PART OF THE PROJECT. TREES SHALL BE REMOVED WITH ROOT WADS ATTACHED UNLESS THEIR SIZE PROHIBITS THEIR SAFE REMOVAL WITH ROOT WAD ATTACHED. IN THESE CASES THE TREES SHALL BE FELLED AND THE ROOT WADS SALVAGED. TREE TOPS WILL BE UTILIZED AND BE CUT TO FIELD DIRECTED LENGTHS DEPENDENT ON TREE SIZE AND SPECIES.

LIVE TREES

ALL TREES NOT MARKED FOR REMOVAL SHALL BE LEFT STANDING UNDISTURBED. LOGGING ACTIVITY SHALL NOT DEBARK OR DAMAGE LIVE TREES.

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General Notes

SHEET
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SITE PLAN

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Site Plan and Access

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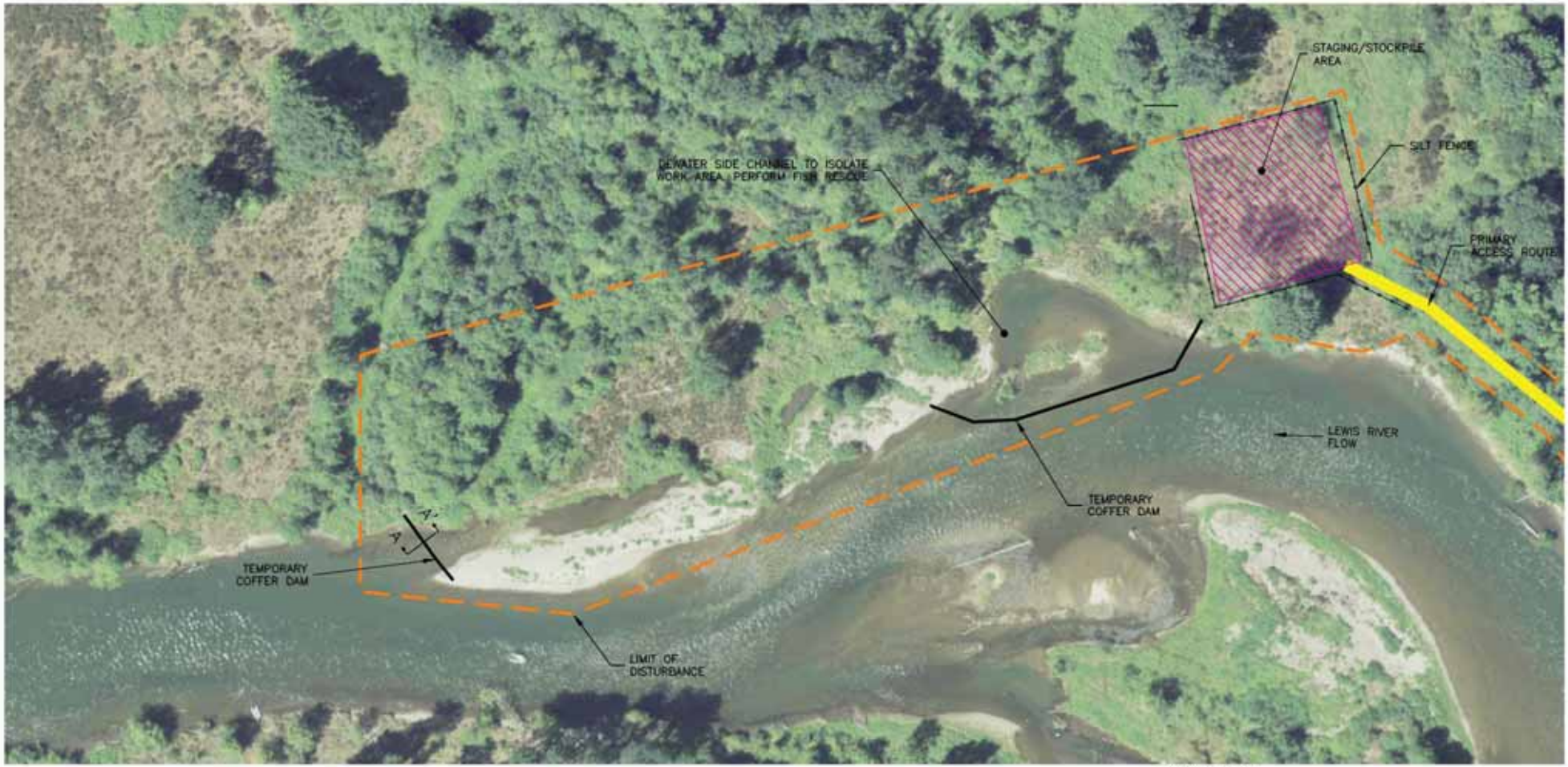

LEGEND

- TEMPORARY COFFER DAM
- ACCESS ROUTE
- STAGING/STOCKPILE
- LIMITS OF DISTURBANCE
- SEDIMENT FENCE

0 100 200

SCALE IN FEET

PLAN VIEW

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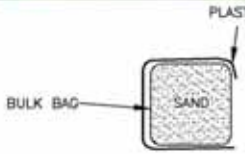

SECTION A–A'

NO SCALE

NOTES:
1. PLACE COFFER DAMS PRIOR TO PERFORMING IN-WATER WORK.

3. REMOVE COFFER DAMS AFTER IN-WATER WORK IS COMPLETE.

NO.	BY	DATE	REVISION DESCRIPTION

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BN	11/09/09	
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Erosion and Sediment Control Plan

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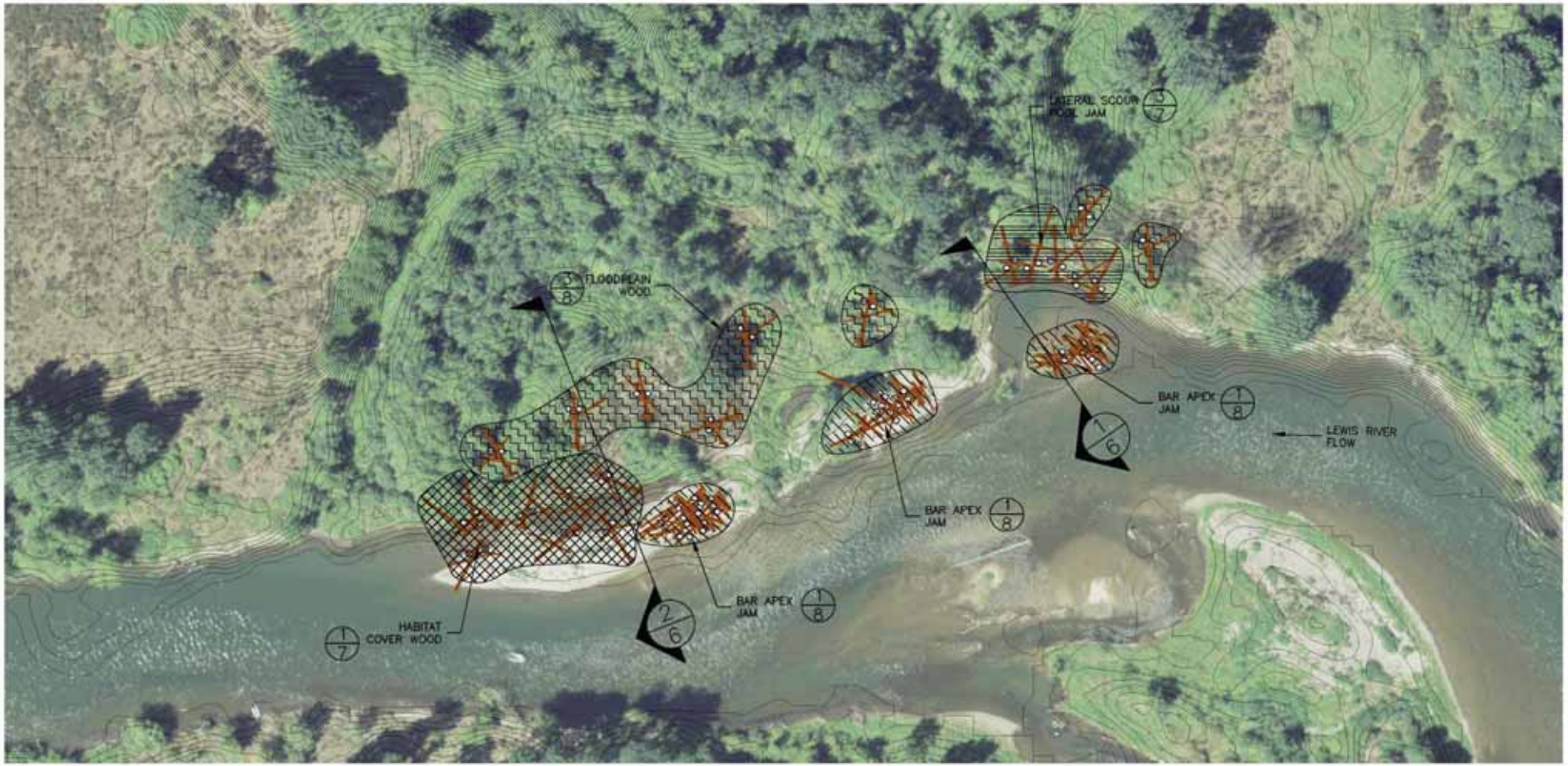

PLAN VIEW

LEGEND

- WOOD
- BOULDER BALLAST
- LIDAR CONTOURS (1 FOOT INTERVALS)
- HABITAT WOOD COVER 1/7 2/7
- LATERAL SCOUR POOL JAM 3/7 4/7
- FLOODPLAIN WOOD 3/8 4/8
- BAR APEX JAM 1/8 2/8

0 100 200
SCALE IN FEET

NOTE:
SPECIFIC ORIENTATION OF LOGS AND BALLAST MATERIALS MAY VARY FROM PLAN VIEW DRAWING DEPENDING ON SIZE AND SHAPE OF MATERIAL ACQUIRED AND SITE CONDITIONS AT TIME OF CONSTRUCTION.

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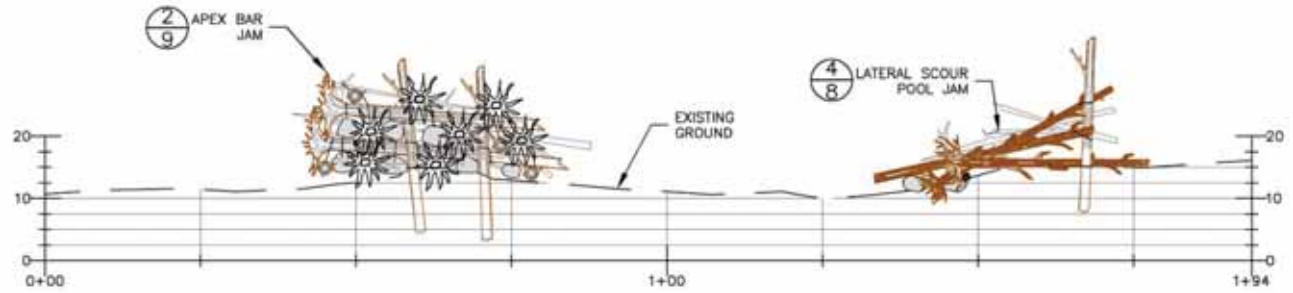
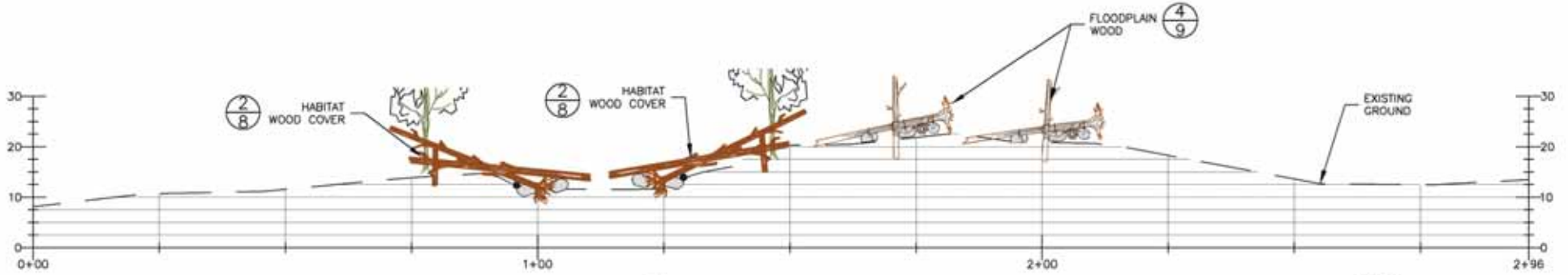
Plan View
Habitat Restoration



1/6 CROSS-SECTION
NOT TO SCALE



2/6 CROSS-SECTION
NOT TO SCALE

NOTE:
CROSS-SECTION INFORMATION WAS COMPILED USING SURVEY DATA CONDUCTED OCT, 2009 BY INTER-FLUVE, INC.

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Cross-Sections

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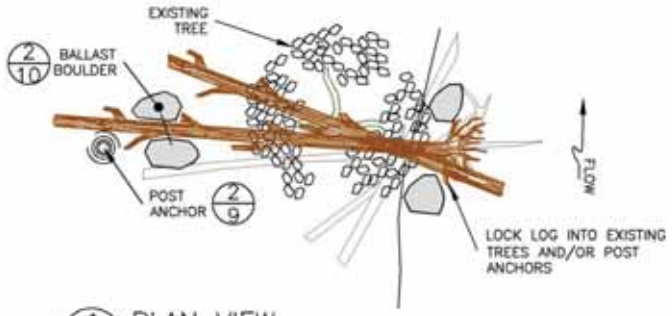
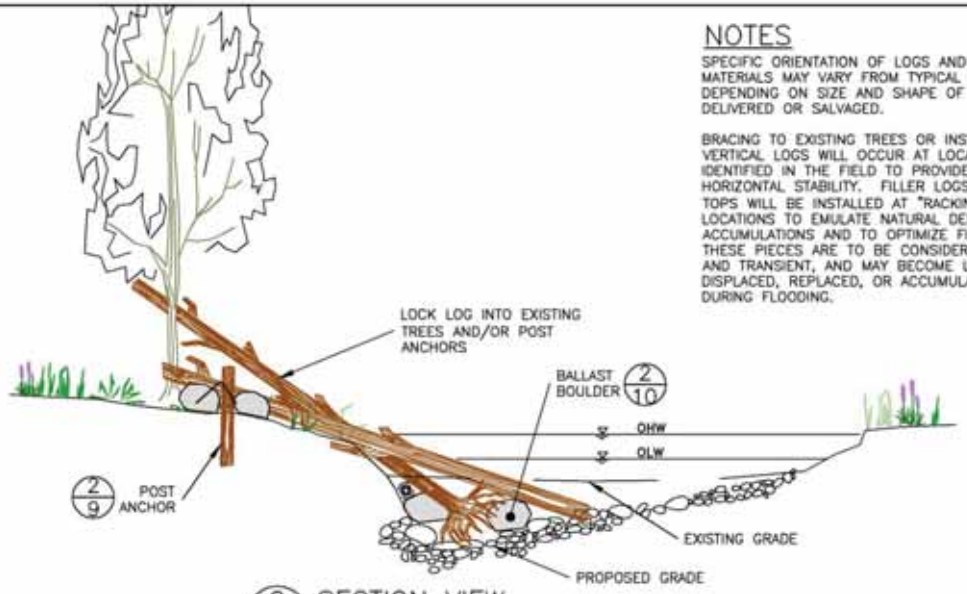


1/7 PLAN VIEW
TYPICAL HABITAT WOOD COVER
NOT TO SCALE

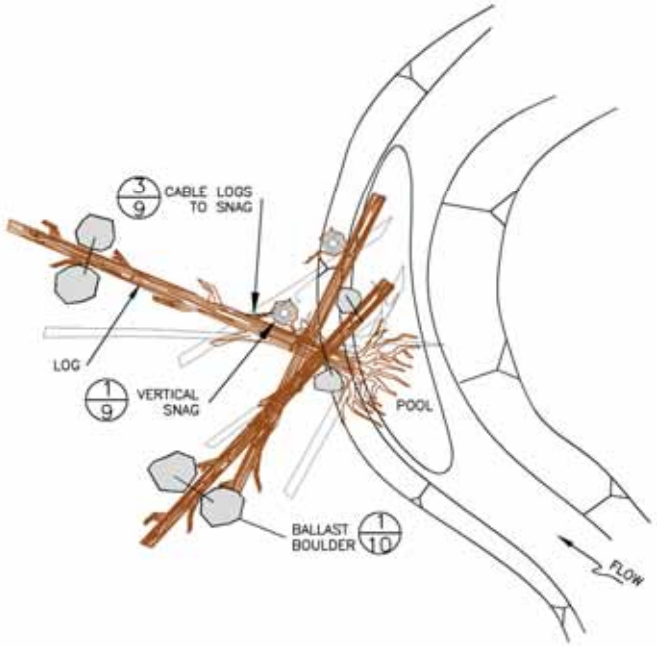
NOTES

SPECIFIC ORIENTATION OF LOGS AND BALLAST MATERIALS MAY VARY FROM TYPICAL DRAWINGS DEPENDING ON SIZE AND SHAPE OF MATERIAL DELIVERED OR SALVAGED.

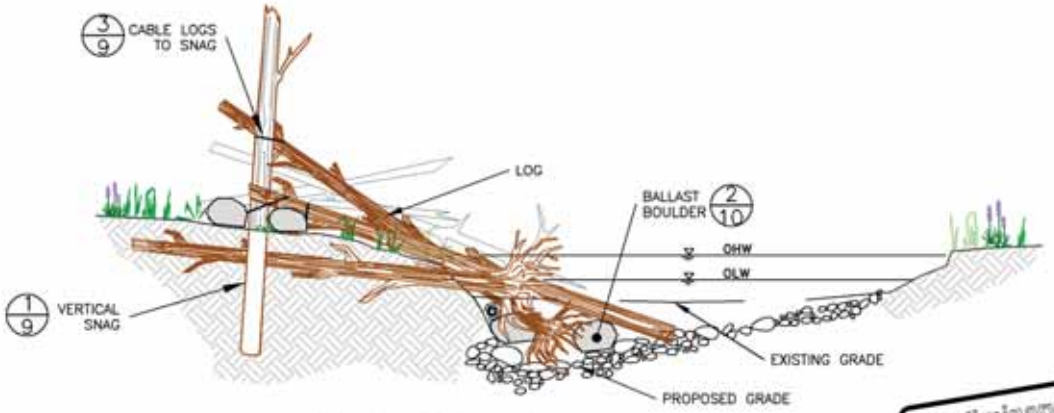
BRACING TO EXISTING TREES OR INSTALLED VERTICAL LOGS WILL OCCUR AT LOCATIONS IDENTIFIED IN THE FIELD TO PROVIDE HORIZONTAL STABILITY. FILLER LOGS AND TREE TOPS WILL BE INSTALLED AT "RACKING" LOCATIONS TO EMULATE NATURAL DEBRIS ACCUMULATIONS AND TO OPTIMIZE FISH HABITAT. THESE PIECES ARE TO BE CONSIDERED MOBILE AND TRANSIENT, AND MAY BECOME LOOSE, DISPLACED, REPLACED, OR ACCUMULATED ONTO DURING FLOODING.



2/7 SECTION VIEW
TYPICAL HABITAT COVER WOOD
NOT TO SCALE



3/7 PLAN VIEW
TYPICAL LATERAL SCOUR POOL JAM
NOT TO SCALE



4/7 SECTION VIEW
TYPICAL LATERAL SCOUR POOL JAM
NOT TO SCALE

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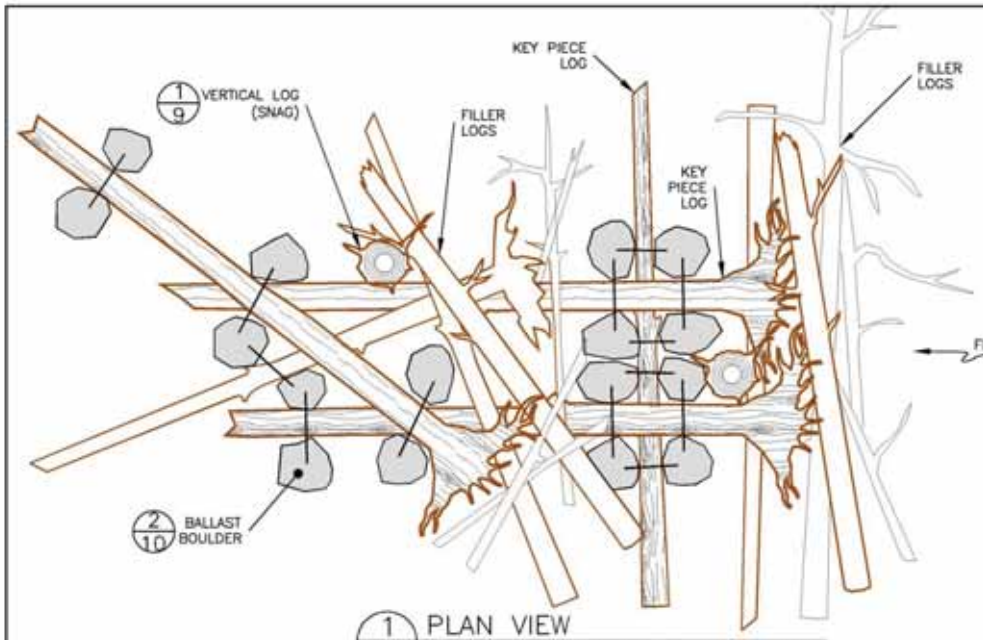
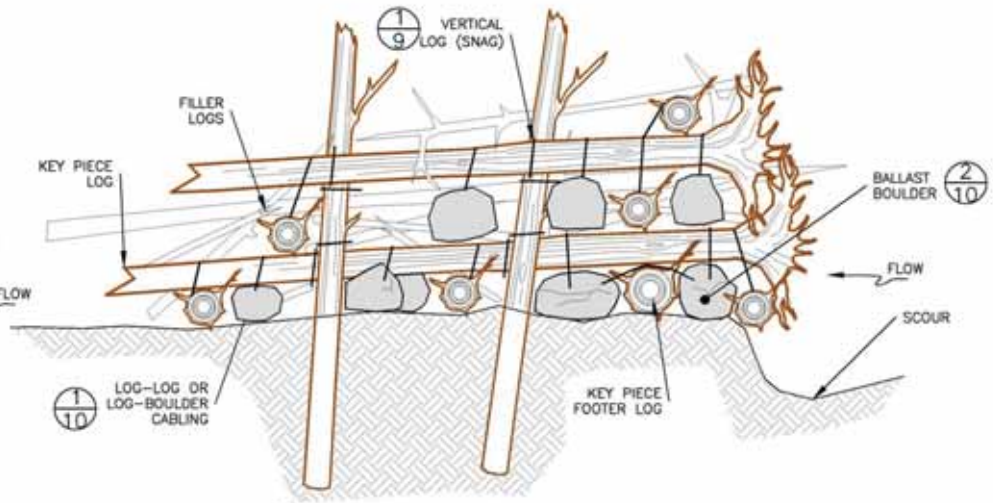
7 OF 12



1/8 PLAN VIEW
TYPICAL BAR APEX LOG JAM
NOT TO SCALE

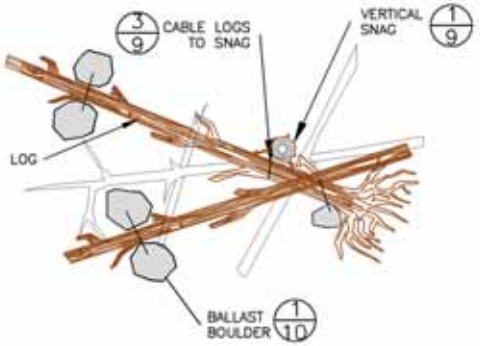


2/8 SECTION VIEW
TYPICAL BAR APEX LOG JAM
NOT TO SCALE

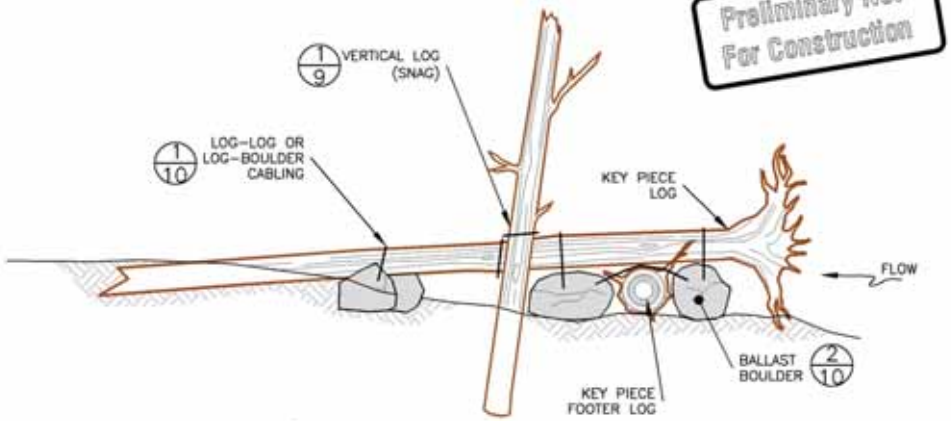
NOTES

SPECIFIC ORIENTATION OF LOGS AND BALLAST MATERIALS MAY VARY FROM TYPICAL DRAWINGS DEPENDING ON SIZE AND SHAPE OF MATERIAL DELIVERED OR SALVAGED.

BRACING TO EXISTING TREES OR INSTALLED VERTICAL LOGS WILL OCCUR AT LOCATIONS IDENTIFIED IN THE FIELD TO PROVIDE HORIZONTAL STABILITY. FILLER LOGS AND TREE TOPS WILL BE INSTALLED AT "RACKING" LOCATIONS TO EMULATE NATURAL DEBRIS ACCUMULATIONS AND TO OPTIMIZE FISH HABITAT. THESE PIECES ARE TO BE CONSIDERED MOBILE AND TRANSIENT, AND MAY BECOME LOOSE, DISPLACED, REPLACED, OR ACCUMULATED ONTO DURING FLOODING.



3/8 PLAN VIEW
TYPICAL FLOODPLAIN WOOD
NOT TO SCALE



4/8 SECTION VIEW
TYPICAL FLOODPLAIN WOOD
NOT TO SCALE

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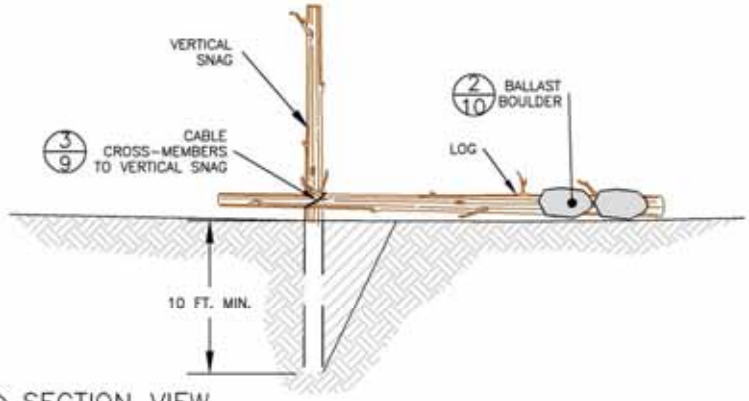
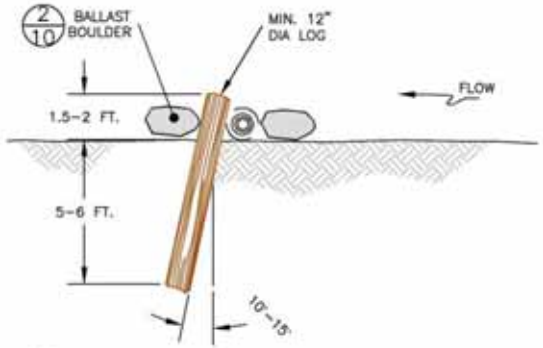
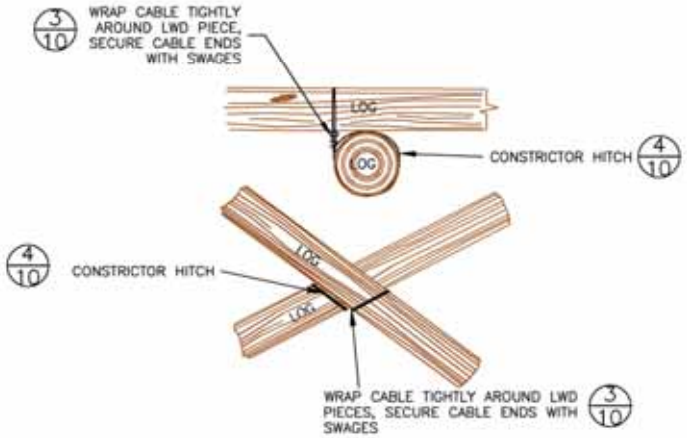


1/9 SECTION VIEW
TYPICAL LOGS SECURED AT VERTICAL SNAG
NOT TO SCALE

CABLING
USE 1/2 INCH GALVANIZED CABLE. CABLE SHALL BE CONSTRICTOR HITCHED AROUND VERTICAL SNAG WRAPPED ONCE AROUND OTHER LOG BEFORE ENDS ARE FASTENED TOGETHER. THERE SHALL BE NO SLACK IN THE CABLE AFTER IT IS FASTENED.



2/9 SECTION VIEW
TYPICAL LWD POST ANCHOR
NOT TO SCALE



3/9 DETAIL VIEWS
TYPICAL LOG CABLING
NOT TO SCALE

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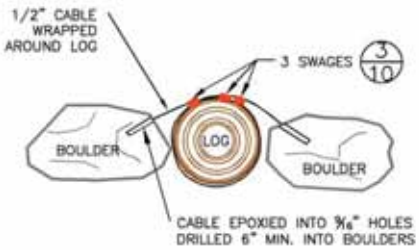
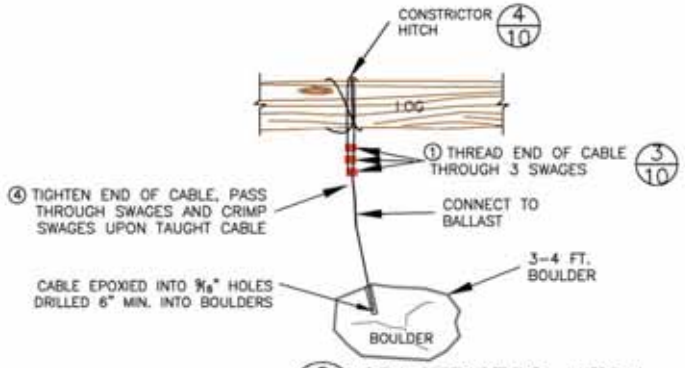
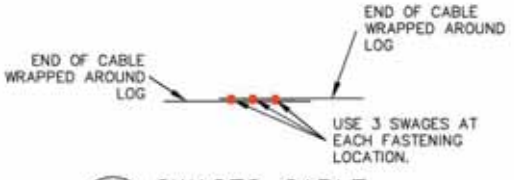


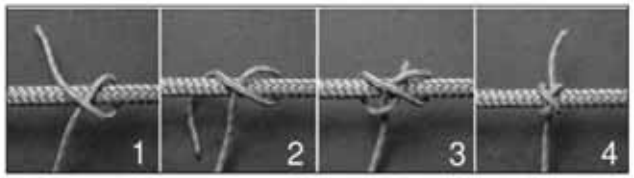
1/10 LWD INSTALLATION DETAILS



2/10 CONSTRICTOR HITCH CABLE WRAP



3/10 SWAGES CABLE SPLICE DETAIL



4/10 CONSTRICTOR HITCH CABLE KNOT DETAIL

Log Wood Buoyancy Force in Pounds Assumes Wood Specific Gravity =0.5	
DBH X Log Length (feet)	Safety Factor 1.5
1 x 30	1104
2 x 30	4416
3 x 30	9935
1 x 40	1472
2 x 40	5887
Additional Root Wad Buoyancy Force in Pounds.	
Estimate Based on 35% Void Space	
Adjust as needed based on void space in each root wad.	
2 X 2 Foot Diameter RW	64
3 X 3 Foot Diameter RW	215
4 X 4 Foot Diameter RW	510
5 X 5 Foot Diameter RW	997
6 X 6 Foot Diameter RW	1722

NOTE:
THE NUMBER OF ANCHOR ROCKS PER ANCHORED LOG STRUCTURE SHALL BE AS SHOWN ON THE TABLES PROVIDED ON THIS SHEET USING APPROPRIATE NUMBER OF BOULDERS AND THE SIZE OF LOGS.

Submerged Boulder Ballast in Pounds. Assumes Rock Density of 2.65 and lift @ 6fps	
Boulder Diameter	Ballast
3 Foot	1289
2 - Boulder Configuration	2579
4 - Boulder Configuration	3868
3.5 Foot	2085
2 - Boulder Configuration	4171
4 - Boulder Configuration	6256
4 Foot	3156
2 - Boulder Configuration	6311
4 - Boulder Configuration	9467

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BOULDER BALLAST AND WOOD CABLING:

BOULDER BALLAST NOTES

DESCRIPTION
THIS WORK CONSISTS OF INSTALLING LOGS WITH ROOT WADS INTO ANCHORED LOG STRUCTURES AS SHOWN ON THE PLANS AND AS DIRECTED BY THE OWNERS REPRESENTATIVE.

MATERIALS
ANCHORS FOR THIS WORK WILL CONSIST OF CABLED BOULDERS. BOULDERS SHALL BE NON-FRACTURED BASALT WITH A MINIMUM SPECIFIC GRAVITY OF 2.65.

CABLE SHALL BE GALVANIZED, STEEL CORE, AND SHALL HAVE A MINIMUM DIAMETER OF 1/2 INCH.

SWAGES SHALL BE ZINC PLATED COPPER AND SHALL MEET THE PERFORMANCE REQUIREMENTS OF MILITARY STANDARD MS-51844, REV. C, SLEEVES, SWAGING-WIRE ROPE. MINIMUM OF 3 SWAGES PER CONNECTION.

EPOXY FOR ANCHORING SHALL BE HILTI HIT RE 500 ADHESIVE OR APPROVED EQUAL.

CONSTRUCTION

FINAL POSITIONING OF THE ANCHORED LOG STRUCTURES SHALL BE IN THE APPROXIMATE LOCATION AS SHOWN ON THE PLANS AND AS APPROVED IN THE FIELD BY THE OWNERS REPRESENATIVE.

GENERAL NOTES , CONT'D

FINAL POSITIONING OF THE ANCHORED LOG STRUCTURES SHALL BE IN THE APPROXIMATE LOCATION AS SHOWN ON THE PLANS AND AS APPROVED IN THE FIELD BY THE OWNERS REPRESENATIVE.

BALLAST BOULDERS SHALL BE SECURED AS SHOWN ON THE PLANS.

DRILL HOLES IN SOLID ROCK AND AVOID ANY CRACKS OR FRACTURES. HOLES SHALL BE 9/16 INCH IN DIAMETER, HOLES MUST BE DRILLED 6 INCHES, MINIMUM, INTO ROCK. HOLES MUST BE CLEANED OF LOOSE ROCK FRAGMENTS AND POWDER WITH A BRUSH AND WATER. HOLES MUST BE CLEAN OF ALL DUST, DEBRIS, OIL, AND SOAP RESIDUES. THE HOLES MUST FLUSH CLEAR TO INSURE NO MATERIAL EXISTS BETWEEN THE CABLE, EPOXY, AND ROCK SURFACE. INSTALL EPOXY PER MANUFACTURER'S RECOMMENDATIONS.

CABLE SHALL BE WRAPPED ONCE AROUND LOG BEFORE ENDS ARE INSERTED INTO THE DRILLED HOLES FILLED WITH EPOXY. WIPE CABLE WITH CLEAN ACETONE SOAKED RAG TO REMOVE OILS AND GREASES PRIOR TO INSERTION INTO EPOXY FILLED HOLE. FILL DRILL HOLES ENOUGH TO ENSURE COMPLETE COVERAGE WITH EPOXY. INSERT CABLE INTO HOLE SO THAT END OF CABLE HITS THE BOTTOM OF THE HOLE. EXCESS EPOXY SHOULD COME OUT OF THE TOP OF THE HOLE AS CABLE IS SEATED IN DRILL HOLE.

MINIMUM 3 SWAGES PER CONNECTION. SWAGES SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATION, SPACING AND SWAGE TOOL DIAMETER FOR THE SIZE AND LOAD RATING OF THE CABLE BEING USED. SWAGING TOOL SHALL BE CHECKED FOR PROPER COMPRESSION, ACCORDING TO MANUFACTURER'S RECOMMENDATIONS, USING A GAUGE PROVIDED BY THE MANUFACTURER OF THE SWAGE FITTINGS BEING INSTALLED.

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THE CONTRACTOR IS ADVISED THAT THE PROJECT AREA DRAINS TO A SALMON BEARING STREAM AND/OR STATE WATERS AND THAT THE CONTRACTOR IS RESPONSIBLE TO PROTECT THE RECEIVING WATERS FROM DELETERIOUS EFFECTS OF CONSTRUCTION.

THE CONTRACTOR IS RESPONSIBLE FOR PROVIDING THE EROSION CONTROL MEASURES SHOWN OR DESCRIBED IN THE CONTRACT DOCUMENTS AND ANY ADDITIONAL MEASURES THAT MAY BE REQUIRED BY THE CONTRACTORS MEANS AND METHODS OF CONSTRUCTION AS NEEDED TO CONTROL EROSION AND SEDIMENT AT THE CONSTRUCTION SITE AND TO PREVENT VIOLATION OF SURFACE WATER QUALITY, GROUND WATER QUALITY, OR SEDIMENT MANAGEMENT STANDARDS. EROSION CONTROL MEASURES SHALL BE MAINTAINED THROUGHOUT THE COURSE OF CONSTRUCTION AND UNTIL ALL DISTURBED EARTH IS STABILIZED IN FINISH GRADES.

EROSION CONTROL

CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING AND MAINTAINING ALL NECESSARY EROSION CONTROL FACILITIES TO COMPLY WITH APPLICABLE EROSION CONTROL REGULATIONS.

AN APPROVED EROSION AND SEDIMENT CONTROL (ESC) PLAN IS PROVIDED IN THESE DRAWINGS. THE BID AND CONSTRUCTION CONTRACT ARE BASED UPON IT. THE CONTRACTOR SHALL BE SOLEY RESPONSIBLE FOR PROVIDING EROSION CONTROL MEASURES TO COMPLY WITH APPLICABLE REGULATIONS AND PERMITS.

THE FOLLOWING RECOMMENDATIONS FOR AN ESC PLAN WILL PROVIDE A GUIDELINE FOR THE CONTRACTOR TO DEVELOP AND IMPLEMENT AN ESC PLAN.

A. THE IMPLEMENTATION OF THESE RECOMMENDATIONS FOR AN ESC PLAN AND THE CONSTRUCTION, MAINTENANCE, REPLACEMENT, AND UPGRADING OF THESE ESC FACILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR UNTIL ALL CONSTRUCTION IS COMPLETED AND APPROVED, AND VEGETATION IS ESTABLISHED.

B. THE BOUNDARIES OF THE CLEARING LIMITS SHOWN ON THIS PLAN SHALL BE CLEARLY FLAGGED IN THE FIELD PRIOR TO CONSTRUCTION. DURING THE CONSTRUCTION PERIOD, NO DISTURBANCE BEYOND THE FLAGGED CLEARING LIMITS SHALL BE PERMITTED. THE FLAGGING SHALL BE MAINTAINED BY THE CONTRACTOR FOR THE DURATION OF CONSTRUCTION.

C. ESC FACILITIES AS APPROXIMATELY SHOWN ON THIS PLAN ARE TO BE CONSTRUCTED IN CONJUNCTION WITH ALL CLEARING AND GRADING ACTIVITIES, AND IN SUCH A MANNER AS TO ENSURE THAT SEDIMENT AND SEDIMENT LADEN WATER DO NOT ENTER THE DRAINAGE SYSTEM, OR VIOLATE APPLICABLE WATER STANDARDS.

D. THE ESC FACILITIES SHOWN ON THE ESC PLAN ARE THE MINIMUM REQUIREMENTS FOR ANTICIPATED SITE CONDITIONS. DURING THE CONSTRUCTION PERIOD, THESE ESC FACILITIES SHALL BE UPGRADED AS NEEDED FOR STORM EVENTS AND TO ENSURE THAT SEDIMENT AND SEDIMENT-LADEN WATER DO NOT LEAVE THE SITE.

E. THE ESC FACILITIES SHALL BE INSPECTED DAILY BY THE CONTRACTOR AND MAINTAINED AS NECESSARY TO ENSURE THEIR CONTINUED FUNCTIONING.

F. FROM OCTOBER 1 – APRIL 30, NO SUBSTANTIALLY UNWORKED SOILS SHALL REMAIN EXPOSED FOR MORE THAN TWO DAYS AT A TIME. FROM MAY 1 – SEPT 30 NO SUBSTANTIALLY UNWORKED SOILS SHALL REMAIN EXPOSED FOR MORE THAN SEVEN DAYS AT A TIME.

SEDIMENT FENCES

1. THE SILT FENCE SHALL BE PURCHASED IN A CONTINUOUS ROLL CUT TO THE LENGTH OF THE BARRIER TO AVOID USE OF JOINTS. WHEN JOINTS ARE NECESSARY, SILT FENCE SHALL BE SPLICED TOGETHER ONLY AT A SUPPORT POST, WITH A MINIMUM 12 INCH OVERLAP, AND BOTH ENDS SECURELY FASTENED TO THE POST, OR OVERLAP 2"X2" POSTS AND ATTACH AS APPROVED BY THE OWNER'S REPRESENTATIVE.

2. THE SILT FENCE IS TO BE INSTALLED AT LOCATIONS SHOWN ON THE PLAN ALONG THE DOWNHILL PERIMETER OF DISTURBED AREAS. THE FENCE POSTS SHALL BE SPACED A MAXIMUM OF 4 FEET APART AND DRIVEN SECURELY INTO THE GROUND A MINIMUM OF 12 INCHES.

3. THE SILT FENCE SHALL HAVE A MINIMUM VERTICAL BURIAL OF 6 INCHES. ALL EXCAVATED MATERIAL FROM FILTER FABRIC FENCE INSTALLATION SHALL BE BACKFILLED AND COMPACTED, ALONG THE ENTIRE DISTURBED AREA.

4. STANDARD OR HEAVY DUTY SILT FENCE SHALL HAVE MANUFACTURED STITCHED LOOPS FOR 2" x 2" POST INSTALLATION.

5. SILT FENCES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFUL PURPOSE, BUT NOT BEFORE THE UPSLOPE AREA HAS BEEN PERMANENTLY PROTECTED AND STABILIZED.

6. SILT FENCES SHALL BE INSPECTED BY THE CONTRACTOR IMMEDIATELY AFTER EACH RAINFALL AND AT LEAST DAILY DURING PROLONGED RAINFALL. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.

7. ON PROJECT COMPLETION THE CONTRACTOR SHALL REMOVE ALL SILT FENCES AND TEMPORARY EROSION CONTROL MEASURES FROM THE PROJECT SITE.

INSPECTION AND MAINTENANCE

ALL BEST MANAGEMENT PRACTICES (BMPs) SHALL BE INSPECTED, MAINTAINED, AND REPAIRED AS NEEDED TO ASSURE CONTINUED PERFORMANCE OF THEIR INTENDED FUNCTION. ALL ON-SITE EROSION AND SEDIMENT CONTROL MEASURES SHALL BE INSPECTED AT LEAST ONCE EVERY SEVEN DAYS AND WITHIN 24 HOURS AFTER ANY STORM EVENT GREATER THAN 0.5 INCHES OF RAIN PER 24 HOUR PERIOD.

SEDIMENT MUST BE REMOVED FROM SILT FENCES BEFORE IT REACHES APPROXIMATELY ONE THIRD THE HEIGHT OF THE FENCE, ESPECIALLY IF HEAVY RAINS ARE EXPECTED.

STABILIZE SOILS AND PROTECT SLOPES

FROM MAY 1 THROUGH SEPTEMBER 30, ALL EXPOSED SOILS SHALL BE PROTECTED FROM EROSION BY MULCHING, PLASTIC SHEETING, HYDROSEED COVERING, OR OTHER APPROVED MEASURES WITHIN ONE WEEK OF GRADING. FROM OCTOBER 1 THROUGH APRIL 30, ALL EXPOSED SOILS MUST BE PROTECTED WITHIN 2 DAYS OF GRADING. SOILS SHALL BE STABILIZED BEFORE A WORK SHUTDOWN, HOLIDAY OR WEEKEND IF NEEDED BASED ON THE WEATHER FORECAST. SOIL STOCKPILES MUST BE STABILIZED AND PROTECTED WITH SEDIMENT TRAPPING MEASURES. HYDROSEED AS SOON AS PRACTICAL ALL DISTURBED AREAS NOT INDICATED IN THE CONTRACT DOCUMENTS FOR OTHER PERMANENT STABILIZATION MEASURES.
DESIGN, CONSTRUCT, AND PHASE CUT AND FILL SLOPES IN A MANNER THAT WILL MINIMIZE EROSION. REDUCE SLOPE VELOCITIES ON DISTURBED SLOPES BY PROVIDING TEMPORARY BARRIERS. STORMWATER FROM OFF SITE SHOULD BE HANDLED SEPARATELY FROM STORMWATER GENERATED ON SITE.

AFTER FINAL SITE STABILIZATION

ALL TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE REMOVED WITHIN 30 DAYS AFTER FINAL SITE STABILIZATION IS ACHIEVED OR AFTER THE TEMPORARY BMPs ARE NO LONGER NEEDED. TRAPPED SEDIMENT SHALL BE REMOVED FROM THE SITE OR INCORPORATED INTO FINISHED GRADING. DISTURBED SOIL AREAS RESULTING FROM REMOVAL SHALL BE PERMANENTLY STABILIZED.

CONSTRUCTION ACCESS

PUBLIC RIGHTS-OF-WAY SHALL BE KEPT IN A CLEAN AND SERVICEABLE CONDITION AT ALL TIMES. IN THE EVENT MATERIALS ARE INADVERTENTLY DEPOSITED ON ROADWAYS THE MATERIAL SHALL BE PROMPTLY REMOVED. MATERIALS ARE TO BE SWEPT AND REMOVED PRIOR TO ANY STREET FLUSHING.

SILT FENCE SHALL BE PLACED ALONG ACCESS ROUTES, STOCKPILE AREA, AND DOWNSTREAM OF OUTLET COFFER DAM.

CONTROL POLLUTANTS

CONTRACTOR MUST PREPARE A SPILL PREVENTION CONTROL AND COUNTER MEASURE (SPCC) PLAN AND IMPLEMENT REQUIRED MEASURES TO CONTROL POLLUTANTS. SEE THE SPECIAL PROVISIONS.

ALL POLLUTANT DISCHARGES OTHER THAN SEDIMENT THAT OCCUR ON SITE DURING CONSTRUCTION SHALL BE HANDLED AND DISPOSED OF IN A MANNER THAT DOES NOT CAUSE CONTAMINATION OF STORMWATER, GROUNDWATER, OR SOILS TO REMAIN ON SITE.

THE USE OF LIME, FLY ASH, OR OTHER SOIL AMENDMENTS THAT COULD ALTER THE PH OF DISCHARGE WATERS IS PROHIBITED.

SEDIMENT CONTROLS

THE DUFF LAYER, NATIVE TOP SOIL, AND NATURAL VEGETATION SHALL BE RETAINED IN AN UNDISTURBED STATE TO THE MAXIMUM EXTENT PRACTICABLE. THE CONTRACTOR SHALL MARK ALL AREAS WHICH ARE NOT TO BE DISTURBED, INCLUDING SETBACKS, SENSITIVE/CRITICAL AREAS AND THEIR BUFFERS. TREES AND DRAINAGE COURSES NOT TO BE DISTURBED SHALL BE MARKED AND FLAGGED BEFORE CONSTRUCTION ACTIVITIES ARE INITIATED. THESE AREAS SHALL BE PROTECTED BY THE CONTRACTOR WITH BARRIER FENCING AS SHOWN ON THE DRAWING AND AS DIRECTED BY THE ENGINEER WHEN CONSTRUCTION ACTIVITIES ARE INITIATED.

THE CONTRACTOR MAY ELECT TO CONSTRUCT TEMPORARY SEDIMENTATION PONDS, TANKS, OR OTHER FACILITIES AS NECESSARY TO CONTROL RUNOFF AND/OR TO FILTER DEWATERING DISCHARGE.

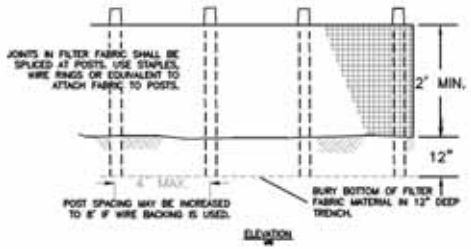
CONTROL DEWATERING

HIGHLY TURBID OR CONTAMINATED DEWATERING WATER FROM CONSTRUCTION EQUIPMENT OPERATION SHALL BE PREVENTED FROM DELIVERING SEDIMENT TO THE RIVER. DISPOSAL OPTIONS FOR DEWATERING DISCHARGE INCLUDE:

1. SEDIMENT-LADEN WATER MAY BE PUMPED TO AN UPLAND AREA AND ALLOWED TO SHEET FLOW OVER UNDISTURBED GROUND THROUGH EXISTING VEGETATION TO INFILTRATE INTO THE GROUND.

2. USE OF AN APPROPRIATELY SIZED AND MAINTAINED SEDIMENTATION BAG (DIRTBAG) OR OTHER SEDIMENTATION FACILITY WITH OUTFALL TO A DITCH OR SWALE FOR SMALL VOLUMES OF LOCALIZED DEWATERING.

NOTES:
1. FENCE SHALL NOT BE INSTALLED ON SLOPES STEEPER THAN 2:1.
2. JOINTS IN FILTER FABRIC SHALL BE OVERLAPPED 12 INCHES AT POST.
3. USE STAPLES, WIRE RINGS, OR EQUIVALENT TO ATTACH FABRIC.
4. REMOVE SEDIMENT WHEN IT REACHES 1/3 FENCE HEIGHT.



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1/11 SILT FENCE DETAIL

NO.	BY	DATE	REVISION DESCRIPTION

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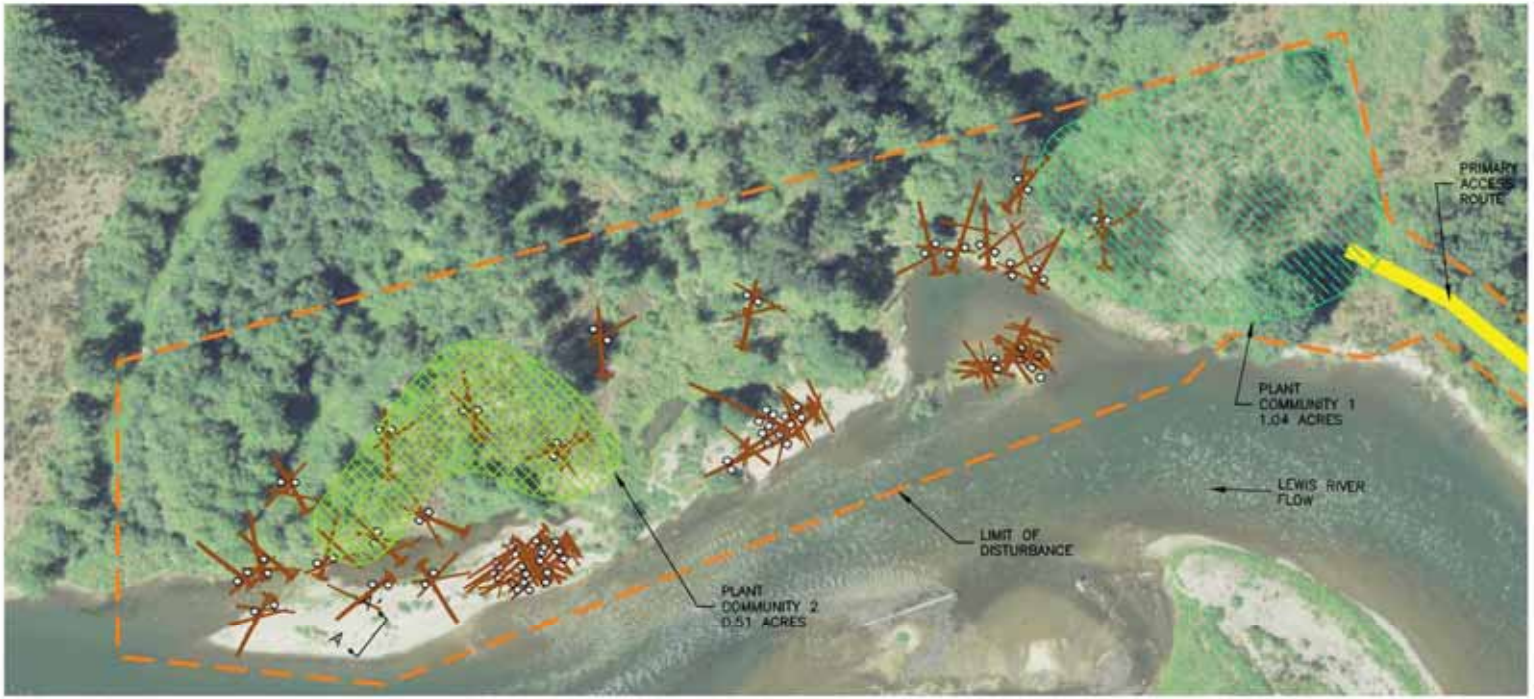
Erosion Control Notes and Details

SHEET 11 OF 12



PLAN VIEW

0 100 200

SCALE IN FEET

LEGEND

- WOOD
- BOULDER BALLAST
- ACCESS ROUTE
- LIMITS OF DISTURBANCE
- PLANT COMMUNITY 1 (1.04 ACRES)
- PLANT COMMUNITY 2 (0.51 ACRES)

Plant Community 1
Upland Restoration Community (1.04 acres)

Common Name	Scientific Name	Plant Form	Minimum Size	Required Number
Trees – approximately 15 foot spacing on center				
Red alder	Alnus rubra	Bare root	24"	135
Big leaf maple	Acer macrophyllum	Bare root	2 gal/24"	90
Douglas-fir	Pseudotsuga menziesii	Bare root	5 gal/24"	90
			Total Trees	225
Shrubs – approximately 5 foot spacing on center				
Evergreen huckleberry	Vaccinium ovatum	Bare root	2 gal/24"	375
Beaked hazelnut	Corylus cornuta	Bare root	2 gal/24"	275
Snowberry	Symphoricarpos spp.	Bare root	2 gal/24"	225
			Total Shrubs	875
Seed – Upland mix for staging area restoration – Seed at approximately 20 lbs/ acre				
Blue wildrye	Elymus glaucus	40% at composition by weight		
California brome	Bromus carinatus	40% at composition by weight		
Red fescue	Festuca rubra	20% at composition by weight		

Plant Community 2
Riparian Tree/Shrub Community (0.51 acres)

Common Name	Scientific Name	Plant Form	Minimum Size	Required Number
Trees – approximately 15 foot spacing on center				
Black cottonwood	Populus balsamifera	Bare root	24"	30
Oregon ash	Fraxinus latifolia	Bare root	24"	45
			Total Trees	75
Shrubs – approximately 5 foot spacing on center				
Pacific willow	Salix lasiandra	Bare root	36"	175
Sitka willow	Salix sitchensis	Bare root	36"	175
Cougar spirea	Spiraea douglasii	Bare root	24"	150
			Total Shrubs	500

NOTE:
SITE ACCESS ROADS AND OTHER DISTURBED AREAS TO BE SEEDED WITH NATIVE EROSION CONTROL SEED MIX.

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Revegetation Plan

SHEET 12 OF 12

LOCATION MAP
STATE OF WASHINGTON

VICINITY MAP

SITE MAP

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ABBREVIATIONS

LWD	LARGE WOODY DEBRIS
ESC	EROSION SEDIMENT AND CONTROL
FES	FABRIC ENCAPSULATED SOIL
FT	FEET
STA	STATION
ELEV	ELEVATION
IN	INCH
APPROX	APPROXIMATE
YR	YEAR
'	FEET
"	INCH
°	DEGREES
%	PERCENT
INV	INVERT
DIA	DIAMETER
HDPE	HIGH DENSITY POLYETHYLENE
OHW	ORDINARY HIGH WATER

SHEET INDEX

30% DESIGN

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Cover, Sheet Index and Vicinity Map

SHEET
1 OF 12

EXISTING DATA

GENERAL TOPOGRAPHIC INFORMATION IS PROVIDED FROM LIDAR FROM CLARK COUNTY AND SPECIFIC PROJECT AREA SURVEY PERFORMED BY INTER-FLUVE, INC.

SOILS

LEWIS RIVER GRAVEL BAR.

UTILITIES

THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR HAVING UTILITIES LOCATED PRIOR TO CONSTRUCTION ACTIVITIES.

THE CONTRACTOR SHALL IMMEDIATELY CONTACT THE AFFECTED UTILITY SERVICE TO REPORT ANY DAMAGED OR DESTROYED UTILITIES. THE CONTRACTOR SHALL PROVIDE EQUIPMENT OR LABOR TO AID THE AFFECTED UTILITY SERVICE IN REPAIRING DAMAGED OR DESTROYED UTILITIES AT NO COST TO THE OWNER.

CONSTRUCTION ACCESS

THE CONTRACTOR IS SOLELY RESPONSIBLE FOR OBTAINING ANY REQUIRED TRAFFIC CONTROL OR ACCESS PERMITS.

THE CONTRACTOR IS SOLELY RESPONSIBLE FOR PROVIDING ANY REQUIRED TRAFFIC CONTROL INCLUDING, BUT NOT LIMITED TO, SIGNAGE AND FLAGGERS.

ALL SAPLING AND TREES TO BE TRANSPLANTED OR REMOVED SHALL BE APPROVED BY THE OWNER'S REPRESENTATIVE AND CLEARLY MARKED.

ALL EQUIPMENT, MATERIALS AND PERSONNEL SHALL REMAIN WITHIN THE LIMITS OF DISTURBANCE.

THE CONTRACTOR SHALL KEEP THE WORK AREAS IN A NEAT AND SIGHTLY CONDITION FREE OF DEBRIS AND LITTER FOR THE DURATION OF THE PROJECT.

COFFERDAM

WORK AREA(S) SHALL BE ISOLATED BY COFFERDAMS INSTALLED UPSTREAM AND DOWNSTREAM OF ENHANCEMENT AREA. COFFERDAM MAY BE CONSTRUCTED WITH SAND FILLED BULK BAGS AND LINED WITH VISQUEEN ADJACENT TO ACTIVE FLOW IN THE CHANNEL.

DEWATERING OF WORK AREA(S) SHALL OCCUR CONCURRENT WITH FISH RESCUE. THE OWNER WILL BE RESPONSIBLE FOR CONDUCTING AND COORDINATING THE FISH RESCUE. THE CONTRACTOR SHALL COORDINATE DEWATERING WITH FISH RESCUE ACTIVITIES.

PUMPING SHALL BE PERFORMED TO KEEP WORK AREA DEWATERED. PUMPED DISCHARGE SHALL RELEASE SEDIMENT-LADEN WATER IN A MANNER THAT DOES NOT CAUSE CONTAMINATION OR INCREASE TURBIDITY OF SURFACE WATERS. (SEE CONTROL DEWATERING).

FISH RESCUE

COFFER DAM SHALL BE INSTALLED TO ISOLATE WORK.

INITIAL DEWATERING SHALL OCCUR SLOWLY BY INCREMENTALLY REDUCING COFFER DAMMED AREAS OVER A PERIOD OF 30 MINUTES TO ALLOW TIME FOR FISH TO FIND RESIDUAL POOLS WITHOUT RISK OF SUDDEN STRANDING.

RESIDUAL POOLS WITHIN THE DEWATERED CONSTRUCTION SITE SHALL BE PUMPED DRY USING SCREENED PUMP INTAKES. TRAPPED FISH SHALL BE RESCUED.

FISH BARRIERS AND PUMP INTAKES SHALL ADHERE TO NMFS SCREENING CRITERIA, NATIONAL MARINE FISHERIES SERVICE JUVENILE FISH SCREEN CRITERIA (REVISED FEBRUARY 16, 1995) AND ADDENDUM: JUVENILE FISH SCREEN CRITERIA FOR PUMP INTAKES (MAY 9, 1996)

ALL FISH RESCUE EFFORTS SHALL BE SUPERVISED BY A QUALIFIED FISHERIES/AQUATIC BIOLOGIST EXPERIENCED WITH THE COLLECTION AND HANDLING OF SALMONID FISHES FROM CONSTRUCTION SITES.

ALL FISH TRAPPED IN RESIDUAL POOLS WITHIN THE PROJECT AREA WILL BE CAREFULLY COLLECTED BY SEINE AND/OR DIP NETS AND PLACED IN CLEAN TRANSFER CONTAINERS WITH PORTABLE AERATION.

CAPTURED FISHES SHALL BE IMMEDIATELY RELEASED TO DOWNSTREAM OR UPSTREAM OF THE CONSTRUCTION SITE, DEPENDING ON SPECIES AND LIFESTAGE.

TREE SALVAGE

ANY REMOVED VEGETATION GREATER THAN 6 INCHES DIAMETER AND 15 FEET LONG SHOULD BE INCORPORATED INTO LOG JAM STRUCTURES. CONTRACTOR IS RESPONSIBLE FOR REMOVING SMALLER CLEARING AND GRUBBING DEBRIS FROM THE SITE AT THE END OF THE PROJECT UNLESS DIRECTED BY THE OWNER'S REPRESENTATIVE.REES THAT ARE REMOVED DURING CONSTRUCTION WILL BE USED AS PART OF THE PROJECT. TREES SHALL BE REMOVED WITH ROOT WADS ATTACHED UNLESS THEIR SIZE PROHIBITS THEIR SAFE REMOVAL WITH ROOT WAD ATTACHED. IN THESE CASES THE TREES SHALL BE FELLED AND THE ROOT WADS SALVAGED. TREE TOPS WILL BE UTILIZED AND BE CUT TO FIELD DIRECTED LENGTHS DEPENDENT ON TREE SIZE AND SPECIES.

LIVE TREES

ALL TREES NOT MARKED FOR REMOVAL SHALL BE LEFT STANDING UNDISTURBED. LOGGING ACTIVITY SHALL NOT DEBARK OR DAMAGE LIVE TREES.

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General Notes

SHEET
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SITE PLAN

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Site Plan and Access

SHEET
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LEGEND

- TEMPORARY COFFER DAM
- ACCESS ROUTE
- STAGING/STOCKPILE
- LIMITS OF DISTURBANCE
- SEDIMENT FENCE

0 100 200

SCALE IN FEET

PLAN VIEW

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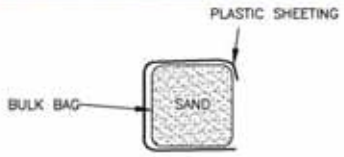

SECTION A–A'

NO SCALE

NOTES:
1. PLACE COFFER DAMS PRIOR TO PERFORMING IN-WATER WORK.

3. REMOVE COFFER DAMS AFTER IN-WATER WORK IS COMPLETE.

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Erosion and Sediment Control Plan

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PLAN VIEW

LEGEND

- WOOD
- BOULDER BALLAST
- LIDAR CONTOURS (1 FOOT INTERVALS)
- HABITAT WOOD COVER 1/7, 2/7
- LATERAL SCOUR POOL JAM 3/7, 4/7
- FLOODPLAIN WOOD 3/8, 4/8
- BAR APEX JAM 1/8, 2/8

0 100 200

SCALE IN FEET

NOTE:
SPECIFIC ORIENTATION OF LOGS AND BALLAST MATERIALS MAY VARY FROM PLAN VIEW DRAWING DEPENDING ON SIZE AND SHAPE OF MATERIAL ACQUIRED AND SITE CONDITIONS AT TIME OF CONSTRUCTION.

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Erosion and Sediment Control Plan

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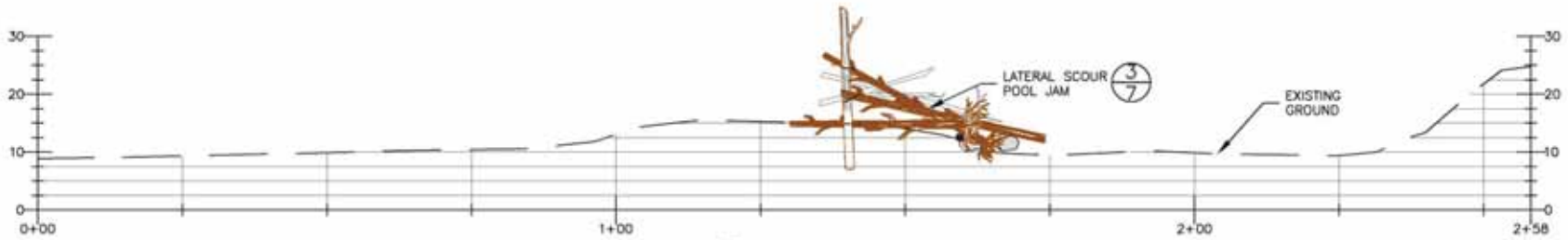

1/6 CROSS-SECTION
NOT TO SCALE

NOTE:
CROSS-SECTION INFORMATION WAS COMPILED USING SURVEY DATA CONDUCTED OCT, 2009 BY INTER-FLUVE, INC.

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Cross-Sections

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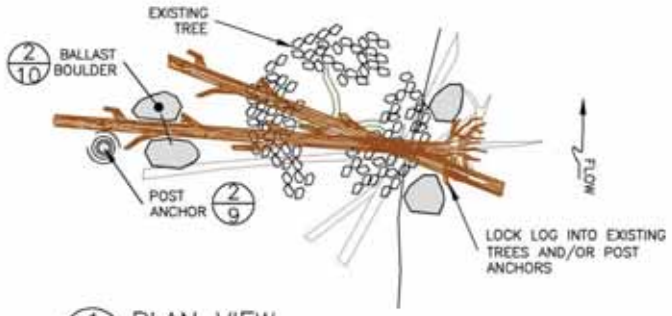
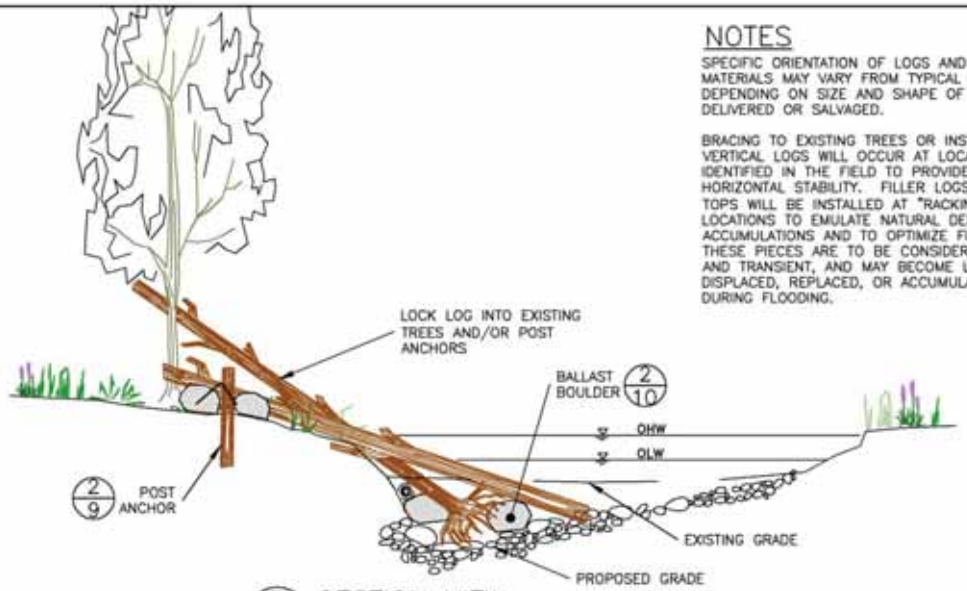


1/7 PLAN VIEW
TYPICAL HABITAT WOOD COVER
NOT TO SCALE

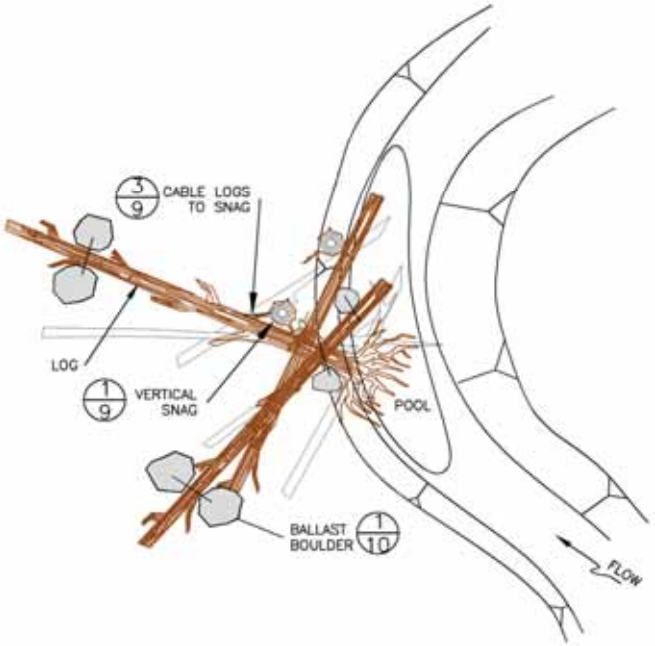
NOTES

SPECIFIC ORIENTATION OF LOGS AND BALLAST MATERIALS MAY VARY FROM TYPICAL DRAWINGS DEPENDING ON SIZE AND SHAPE OF MATERIAL DELIVERED OR SALVAGED.

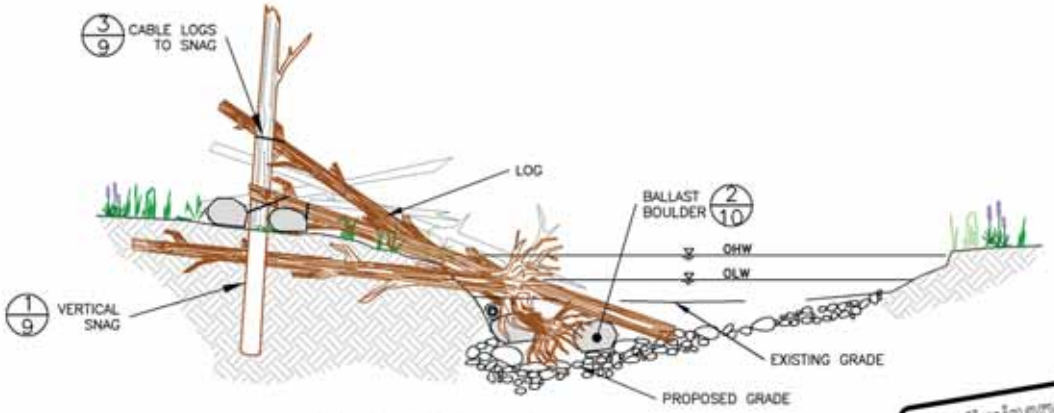
BRACING TO EXISTING TREES OR INSTALLED VERTICAL LOGS WILL OCCUR AT LOCATIONS IDENTIFIED IN THE FIELD TO PROVIDE HORIZONTAL STABILITY. FILLER LOGS AND TREE TOPS WILL BE INSTALLED AT "RACKING" LOCATIONS TO EMULATE NATURAL DEBRIS ACCUMULATIONS AND TO OPTIMIZE FISH HABITAT. THESE PIECES ARE TO BE CONSIDERED MOBILE AND TRANSIENT, AND MAY BECOME LOOSE, DISPLACED, REPLACED, OR ACCUMULATED ONTO DURING FLOODING.



2/7 SECTION VIEW
TYPICAL HABITAT COVER WOOD
NOT TO SCALE



3/7 PLAN VIEW
TYPICAL LATERAL SCOUR POOL JAM
NOT TO SCALE



4/7 SECTION VIEW
TYPICAL LATERAL SCOUR POOL JAM
NOT TO SCALE

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Typical Details

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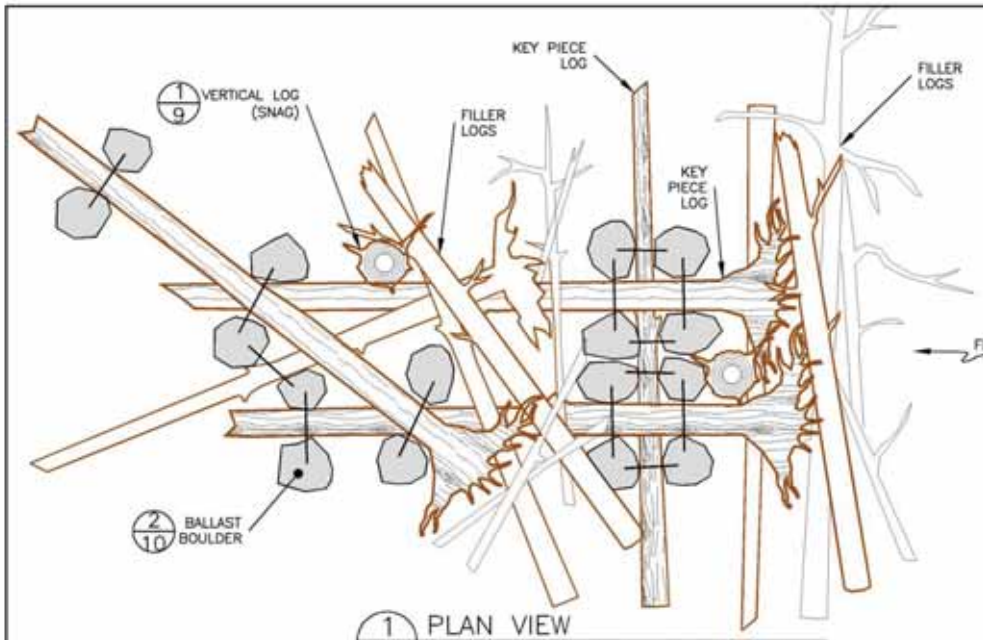
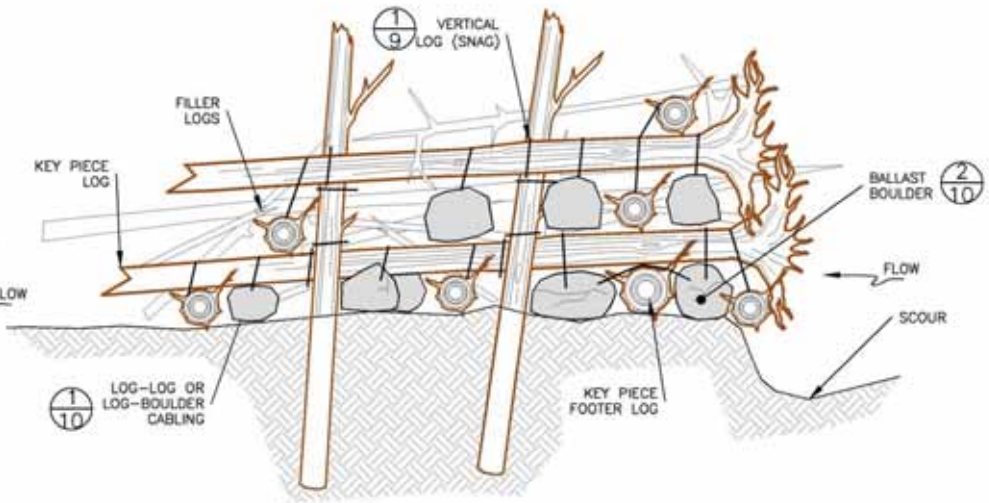


1/8 PLAN VIEW
TYPICAL BAR APEX LOG JAM
NOT TO SCALE

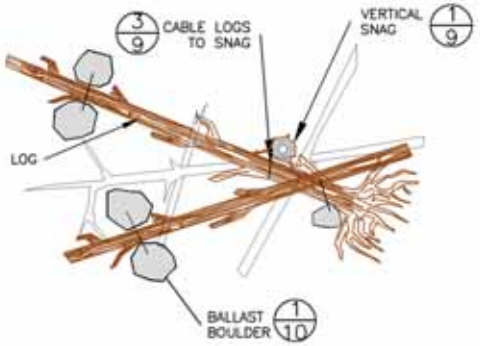


2/8 SECTION VIEW
TYPICAL BAR APEX LOG JAM
NOT TO SCALE

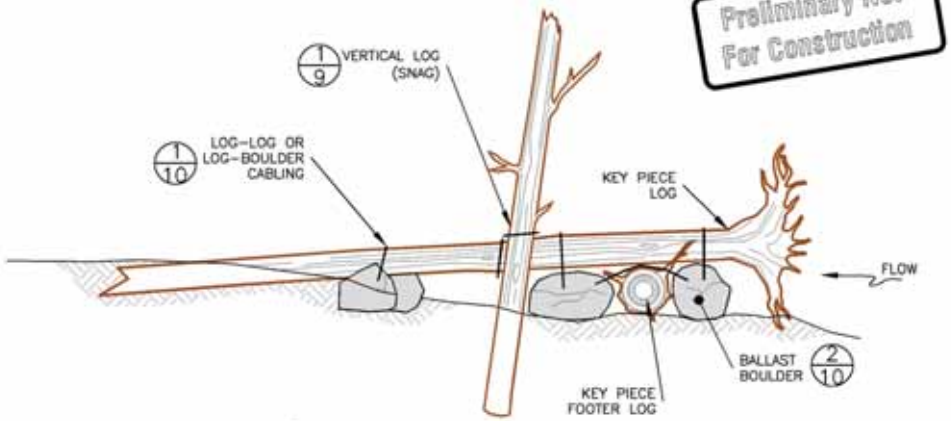
NOTES

SPECIFIC ORIENTATION OF LOGS AND BALLAST MATERIALS MAY VARY FROM TYPICAL DRAWINGS DEPENDING ON SIZE AND SHAPE OF MATERIAL DELIVERED OR SALVAGED.

BRACING TO EXISTING TREES OR INSTALLED VERTICAL LOGS WILL OCCUR AT LOCATIONS IDENTIFIED IN THE FIELD TO PROVIDE HORIZONTAL STABILITY. FILLER LOGS AND TREE TOPS WILL BE INSTALLED AT "RACKING" LOCATIONS TO EMULATE NATURAL DEBRIS ACCUMULATIONS AND TO OPTIMIZE FISH HABITAT. THESE PIECES ARE TO BE CONSIDERED MOBILE AND TRANSIENT, AND MAY BECOME LOOSE, DISPLACED, REPLACED, OR ACCUMULATED ONTO DURING FLOODING.



3/8 PLAN VIEW
TYPICAL FLOODPLAIN WOOD
NOT TO SCALE



4/8 SECTION VIEW
TYPICAL FLOODPLAIN WOOD
NOT TO SCALE

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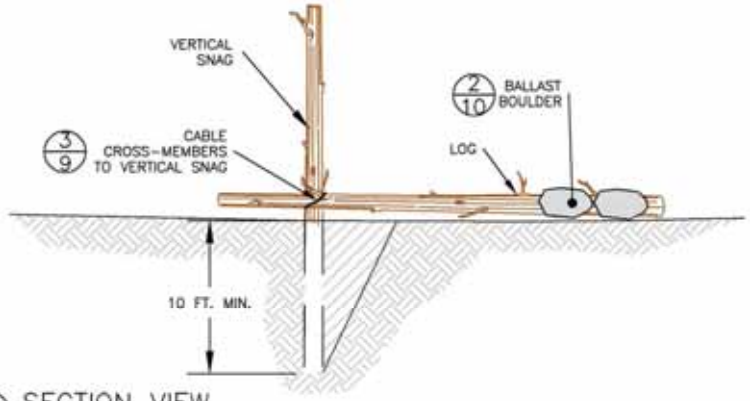
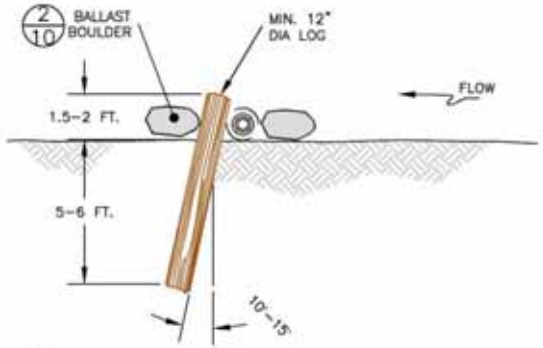
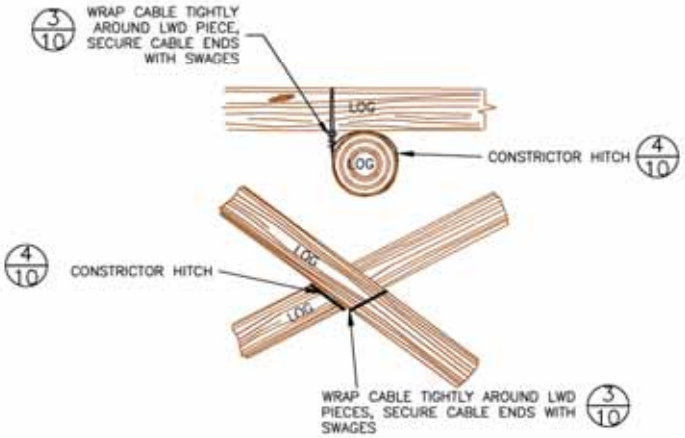


1/9 SECTION VIEW
TYPICAL LOGS SECURED AT VERTICAL SNAG
NOT TO SCALE

CABLING
USE 1/2 INCH GALVANIZED CABLE. CABLE SHALL BE CONSTRICTOR HITCHED AROUND VERTICAL SNAG WRAPPED ONCE AROUND OTHER LOG BEFORE ENDS ARE FASTENED TOGETHER. THERE SHALL BE NO SLACK IN THE CABLE AFTER IT IS FASTENED.



2/9 SECTION VIEW
TYPICAL LWD POST ANCHOR
NOT TO SCALE



3/9 DETAIL VIEWS
TYPICAL LOG CABLING
NOT TO SCALE

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Typical Details

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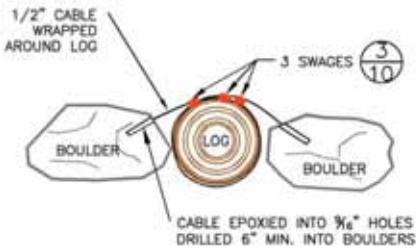
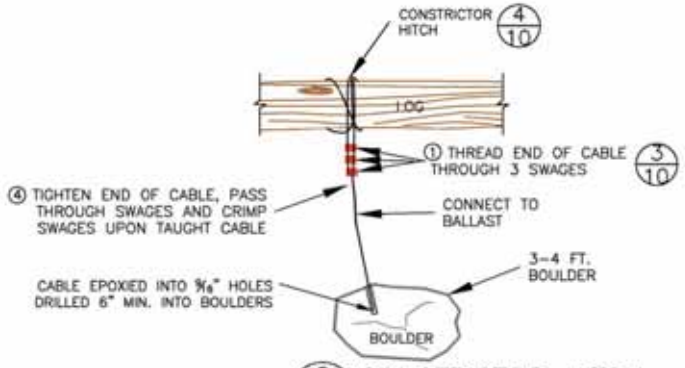
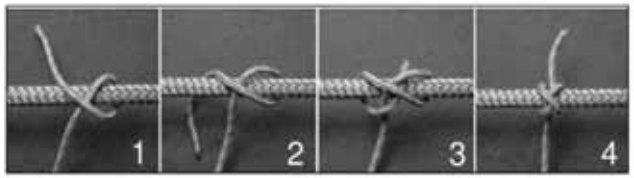


1/10 LWD INSTALLATION DETAILS



2/10 CONSTRICTOR HITCH CABLE WRAP

3/10 SWAGES CABLE SPLICE DETAIL



4/10 CONSTRICTOR HITCH CABLE KNOT DETAIL

Log Wood Buoyancy Force in Pounds Assumes Wood Specific Gravity =0.5	
DBH X Log Length (feet)	Safety Factor 1.5
1 x 30	1104
2 x 30	4416
3 x 30	9935
1 x 40	1472
2 x 40	5887
Additional Root Wad Buoyancy Force in Pounds.	
Estimate Based on 35% Void Space	
Adjust as needed based on void space in each root wad.	
2 X 2 Foot Diameter RW	64
3 X 3 Foot Diameter RW	215
4 X 4 Foot Diameter RW	510
5 X 5 Foot Diameter RW	997
6 X 6 Foot Diameter RW	1722

NOTE:
THE NUMBER OF ANCHOR ROCKS PER ANCHORED LOG STRUCTURE SHALL BE AS SHOWN ON THE TABLES PROVIDED ON THIS SHEET USING APPROPRIATE NUMBER OF BOULDERS AND THE SIZE OF LOGS.

Submerged Boulder Ballast in Pounds. Assumes Rock Density of 2.65 and lift @ 6fps	
Boulder Diameter	Ballast
3 Foot	1289
2 - Boulder Configuration	2579
4 - Boulder Configuration	3868
3.5 Foot	2085
2 - Boulder Configuration	4171
4 - Boulder Configuration	6256
4 Foot	3156
2 - Boulder Configuration	6311
4 - Boulder Configuration	9467

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BOULDER BALLAST AND WOOD CABLING:

BOULDER BALLAST NOTES

DESCRIPTION
THIS WORK CONSISTS OF INSTALLING LOGS WITH ROOT WADS INTO ANCHORED LOG STRUCTURES AS SHOWN ON THE PLANS AND AS DIRECTED BY THE OWNERS REPRESENTATIVE.

MATERIALS
ANCHORS FOR THIS WORK WILL CONSIST OF CABLED BOULDERS. BOULDERS SHALL BE NON-FRACTURED BASALT WITH A MINIMUM SPECIFIC GRAVITY OF 2.65.

CABLE SHALL BE GALVANIZED, STEEL CORE, AND SHALL HAVE A MINIMUM DIAMETER OF 1/2 INCH.

SWAGES SHALL BE ZINC PLATED COPPER AND SHALL MEET THE PERFORMANCE REQUIREMENTS OF MILITARY STANDARD MS-51844, REV. C, SLEEVES, SWAGING-WIRE ROPE. MINIMUM OF 3 SWAGES PER CONNECTION.

EPOXY FOR ANCHORING SHALL BE HILTI HIT RE 500 ADHESIVE OR APPROVED EQUAL.

CONSTRUCTION

FINAL POSITIONING OF THE ANCHORED LOG STRUCTURES SHALL BE IN THE APPROXIMATE LOCATION AS SHOWN ON THE PLANS AND AS APPROVED IN THE FIELD BY THE OWNERS REPRESENATIVE.

GENERAL NOTES , CONT'D

FINAL POSITIONING OF THE ANCHORED LOG STRUCTURES SHALL BE IN THE APPROXIMATE LOCATION AS SHOWN ON THE PLANS AND AS APPROVED IN THE FIELD BY THE OWNERS REPRESENATIVE.

BALLAST BOULDERS SHALL BE SECURED AS SHOWN ON THE PLANS.

DRILL HOLES IN SOLID ROCK AND AVOID ANY CRACKS OR FRACTURES. HOLES SHALL BE 9/16 INCH IN DIAMETER. HOLES MUST BE DRILLED 6 INCHES, MINIMUM, INTO ROCK. HOLES MUST BE CLEANED OF LOOSE ROCK FRAGMENTS AND POWDER WITH A BRUSH AND WATER. HOLES MUST BE CLEAN OF ALL DUST, DEBRIS, OIL, AND SOAP RESIDUES. THE HOLES MUST FLUSH CLEAR TO INSURE NO MATERIAL EXISTS BETWEEN THE CABLE, EPOXY, AND ROCK SURFACE. INSTALL EPOXY PER MANUFACTURER'S RECOMMENDATIONS.

CABLE SHALL BE WRAPPED ONCE AROUND LOG BEFORE ENDS ARE INSERTED INTO THE DRILLED HOLES FILLED WITH EPOXY. WIPE CABLE WITH CLEAN ACETONE SOAKED RAG TO REMOVE OILS AND GREASES PRIOR TO INSERTION INTO EPOXY FILLED HOLE. FILL DRILL HOLES ENOUGH TO ENSURE COMPLETE COVERAGE WITH EPOXY. INSERT CABLE INTO HOLE SO THAT END OF CABLE HITS THE BOTTOM OF THE HOLE. EXCESS EPOXY SHOULD COME OUT OF THE TOP OF THE HOLE AS CABLE IS SEATED IN DRILL HOLE.

MINIMUM 3 SWAGES PER CONNECTION. SWAGES SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATION, SPACING AND SWAGE TOOL DIAMETER FOR THE SIZE AND LOAD RATING OF THE CABLE BEING USED. SWAGING TOOL SHALL BE CHECKED FOR PROPER COMPRESSION, ACCORDING TO MANUFACTURER'S RECOMMENDATIONS, USING A GAUGE PROVIDED BY THE MANUFACTURER OF THE SWAGE FITTINGS BEING INSTALLED.

NO.	BY	DATE	REVISION DESCRIPTION

DRAWN	DESIGNED	CHECKED
RP	BN	BN, GJ
APPROVED	DATE	PROJECT
BN	11/10/09	

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Typical Details

SHEET
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THE CONTRACTOR IS ADVISED THAT THE PROJECT AREA DRAINS TO A SALMON BEARING STREAM AND/OR STATE WATERS AND THAT THE CONTRACTOR IS RESPONSIBLE TO PROTECT THE RECEIVING WATERS FROM DELETERIOUS EFFECTS OF CONSTRUCTION.

THE CONTRACTOR IS RESPONSIBLE FOR PROVIDING THE EROSION CONTROL MEASURES SHOWN OR DESCRIBED IN THE CONTRACT DOCUMENTS AND ANY ADDITIONAL MEASURES THAT MAY BE REQUIRED BY THE CONTRACTORS MEANS AND METHODS OF CONSTRUCTION AS NEEDED TO CONTROL EROSION AND SEDIMENT AT THE CONSTRUCTION SITE AND TO PREVENT VIOLATION OF SURFACE WATER QUALITY, GROUND WATER QUALITY, OR SEDIMENT MANAGEMENT STANDARDS. EROSION CONTROL MEASURES SHALL BE MAINTAINED THROUGHOUT THE COURSE OF CONSTRUCTION AND UNTIL ALL DISTURBED EARTH IS STABILIZED IN FINISH GRADES.

EROSION CONTROL

CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING AND MAINTAINING ALL NECESSARY EROSION CONTROL FACILITIES TO COMPLY WITH APPLICABLE EROSION CONTROL REGULATIONS.

AN APPROVED EROSION AND SEDIMENT CONTROL (ESC) PLAN IS PROVIDED IN THESE DRAWINGS. THE BID AND CONSTRUCTION CONTRACT ARE BASED UPON IT. THE CONTRACTOR SHALL BE SOLEY RESPONSIBLE FOR PROVIDING EROSION CONTROL MEASURES TO COMPLY WITH APPLICABLE REGULATIONS AND PERMITS.

THE FOLLOWING RECOMMENDATIONS FOR AN ESC PLAN WILL PROVIDE A GUIDELINE FOR THE CONTRACTOR TO DEVELOP AND IMPLEMENT AN ESC PLAN.

A. THE IMPLEMENTATION OF THESE RECOMMENDATIONS FOR AN ESC PLAN AND THE CONSTRUCTION, MAINTENANCE, REPLACEMENT, AND UPGRADING OF THESE ESC FACILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR UNTIL ALL CONSTRUCTION IS COMPLETED AND APPROVED, AND VEGETATION IS ESTABLISHED.

B. THE BOUNDARIES OF THE CLEARING LIMITS SHOWN ON THIS PLAN SHALL BE CLEARLY FLAGGED IN THE FIELD PRIOR TO CONSTRUCTION. DURING THE CONSTRUCTION PERIOD, NO DISTURBANCE BEYOND THE FLAGGED CLEARING LIMITS SHALL BE PERMITTED. THE FLAGGING SHALL BE MAINTAINED BY THE CONTRACTOR FOR THE DURATION OF CONSTRUCTION.

C. ESC FACILITIES AS APPROXIMATELY SHOWN ON THIS PLAN ARE TO BE CONSTRUCTED IN CONJUNCTION WITH ALL CLEARING AND GRADING ACTIVITIES, AND IN SUCH A MANNER AS TO ENSURE THAT SEDIMENT AND SEDIMENT LADEN WATER DO NOT ENTER THE DRAINAGE SYSTEM, OR VIOLATE APPLICABLE WATER STANDARDS.

D. THE ESC FACILITIES SHOWN ON THE ESC PLAN ARE THE MINIMUM REQUIREMENTS FOR ANTICIPATED SITE CONDITIONS. DURING THE CONSTRUCTION PERIOD, THESE ESC FACILITIES SHALL BE UPGRADED AS NEEDED FOR STORM EVENTS AND TO ENSURE THAT SEDIMENT AND SEDIMENT-LADEN WATER DO NOT LEAVE THE SITE.

E. THE ESC FACILITIES SHALL BE INSPECTED DAILY BY THE CONTRACTOR AND MAINTAINED AS NECESSARY TO ENSURE THEIR CONTINUED FUNCTIONING.

F. FROM OCTOBER 1 – APRIL 30, NO SUBSTANTIALLY UNWORKED SOILS SHALL REMAIN EXPOSED FOR MORE THAN TWO DAYS AT A TIME. FROM MAY 1 – SEPT 30 NO SUBSTANTIALLY UNWORKED SOILS SHALL REMAIN EXPOSED FOR MORE THAN SEVEN DAYS AT A TIME.

SEDIMENT FENCES

1. THE SILT FENCE SHALL BE PURCHASED IN A CONTINUOUS ROLL CUT TO THE LENGTH OF THE BARRIER TO AVOID USE OF JOINTS. WHEN JOINTS ARE NECESSARY, SILT FENCE SHALL BE SPLICED TOGETHER ONLY AT A SUPPORT POST, WITH A MINIMUM 12 INCH OVERLAP, AND BOTH ENDS SECURELY FASTENED TO THE POST, OR OVERLAP 2"X2" POSTS AND ATTACH AS APPROVED BY THE OWNER'S REPRESENTATIVE.

2. THE SILT FENCE IS TO BE INSTALLED AT LOCATIONS SHOWN ON THE PLAN ALONG THE DOWNHILL PERIMETER OF DISTURBED AREAS. THE FENCE POSTS SHALL BE SPACED A MAXIMUM OF 4 FEET APART AND DRIVEN SECURELY INTO THE GROUND A MINIMUM OF 12 INCHES.

3. THE SILT FENCE SHALL HAVE A MINIMUM VERTICAL BURIAL OF 6 INCHES. ALL EXCAVATED MATERIAL FROM FILTER FABRIC FENCE INSTALLATION SHALL BE BACKFILLED AND COMPACTED, ALONG THE ENTIRE DISTURBED AREA.

4. STANDARD OR HEAVY DUTY SILT FENCE SHALL HAVE MANUFACTURED STITCHED LOOPS FOR 2" x 2" POST INSTALLATION.

5. SILT FENCES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFUL PURPOSE, BUT NOT BEFORE THE UPSLOPE AREA HAS BEEN PERMANENTLY PROTECTED AND STABILIZED.

6. SILT FENCES SHALL BE INSPECTED BY THE CONTRACTOR IMMEDIATELY AFTER EACH RAINFALL AND AT LEAST DAILY DURING PROLONGED RAINFALL. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.

7. ON PROJECT COMPLETION THE CONTRACTOR SHALL REMOVE ALL SILT FENCES AND TEMPORARY EROSION CONTROL MEASURES FROM THE PROJECT SITE.

INSPECTION AND MAINTENANCE

ALL BEST MANAGEMENT PRACTICES (BMPs) SHALL BE INSPECTED, MAINTAINED, AND REPAIRED AS NEEDED TO ASSURE CONTINUED PERFORMANCE OF THEIR INTENDED FUNCTION. ALL ON-SITE EROSION AND SEDIMENT CONTROL MEASURES SHALL BE INSPECTED AT LEAST ONCE EVERY SEVEN DAYS AND WITHIN 24 HOURS AFTER ANY STORM EVENT GREATER THAN 0.5 INCHES OF RAIN PER 24 HOUR PERIOD.

SEDIMENT MUST BE REMOVED FROM SILT FENCES BEFORE IT REACHES APPROXIMATELY ONE THIRD THE HEIGHT OF THE FENCE, ESPECIALLY IF HEAVY RAINS ARE EXPECTED.

STABILIZE SOILS AND PROTECT SLOPES

FROM MAY 1 THROUGH SEPTEMBER 30, ALL EXPOSED SOILS SHALL BE PROTECTED FROM EROSION BY MULCHING, PLASTIC SHEETING, HYDROSEED COVERING, OR OTHER APPROVED MEASURES WITHIN ONE WEEK OF GRADING. FROM OCTOBER 1 THROUGH APRIL 30, ALL EXPOSED SOILS MUST BE PROTECTED WITHIN 2 DAYS OF GRADING. SOILS SHALL BE STABILIZED BEFORE A WORK SHUTDOWN, HOLIDAY OR WEEKEND IF NEEDED BASED ON THE WEATHER FORECAST. SOIL STOCKPILES MUST BE STABILIZED AND PROTECTED WITH SEDIMENT TRAPPING MEASURES. HYDROSEED AS SOON AS PRACTICAL ALL DISTURBED AREAS NOT INDICATED IN THE CONTRACT DOCUMENTS FOR OTHER PERMANENT STABILIZATION MEASURES.
DESIGN, CONSTRUCT, AND PHASE CUT AND FILL SLOPES IN A MANNER THAT WILL MINIMIZE EROSION. REDUCE SLOPE VELOCITIES ON DISTURBED SLOPES BY PROVIDING TEMPORARY BARRIERS. STORMWATER FROM OFF SITE SHOULD BE HANDLED SEPARATELY FROM STORMWATER GENERATED ON SITE.

AFTER FINAL SITE STABILIZATION

ALL TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE REMOVED WITHIN 30 DAYS AFTER FINAL SITE STABILIZATION IS ACHIEVED OR AFTER THE TEMPORARY BMPs ARE NO LONGER NEEDED. TRAPPED SEDIMENT SHALL BE REMOVED FROM THE SITE OR INCORPORATED INTO FINISHED GRADING. DISTURBED SOIL AREAS RESULTING FROM REMOVAL SHALL BE PERMANENTLY STABILIZED.

CONSTRUCTION ACCESS

PUBLIC RIGHTS-OF-WAY SHALL BE KEPT IN A CLEAN AND SERVICEABLE CONDITION AT ALL TIMES. IN THE EVENT MATERIALS ARE INADVERTENTLY DEPOSITED ON ROADWAYS THE MATERIAL SHALL BE PROMPTLY REMOVED. MATERIALS ARE TO BE SWEPT AND REMOVED PRIOR TO ANY STREET FLUSHING.

SILT FENCE SHALL BE PLACED ALONG ACCESS ROUTES, STOCKPILE AREA, AND DOWNSTREAM OF OUTLET COFFER DAM.

CONTROL POLLUTANTS

CONTRACTOR MUST PREPARE A SPILL PREVENTION CONTROL AND COUNTER MEASURE (SPCC) PLAN AND IMPLEMENT REQUIRED MEASURES TO CONTROL POLLUTANTS. SEE THE SPECIAL PROVISIONS.

ALL POLLUTANT DISCHARGES OTHER THAN SEDIMENT THAT OCCUR ON SITE DURING CONSTRUCTION SHALL BE HANDLED AND DISPOSED OF IN A MANNER THAT DOES NOT CAUSE CONTAMINATION OF STORMWATER, GROUNDWATER, OR SOILS TO REMAIN ON SITE.

THE USE OF LIME, FLY ASH, OR OTHER SOIL AMENDMENTS THAT COULD ALTER THE PH OF DISCHARGE WATERS IS PROHIBITED.

SEDIMENT CONTROLS

THE DUFF LAYER, NATIVE TOP SOIL, AND NATURAL VEGETATION SHALL BE RETAINED IN AN UNDISTURBED STATE TO THE MAXIMUM EXTENT PRACTICABLE. THE CONTRACTOR SHALL MARK ALL AREAS WHICH ARE NOT TO BE DISTURBED, INCLUDING SETBACKS, SENSITIVE/CRITICAL AREAS AND THEIR BUFFERS. TREES AND DRAINAGE COURSES NOT TO BE DISTURBED SHALL BE MARKED AND FLAGGED BEFORE CONSTRUCTION ACTIVITIES ARE INITIATED. THESE AREAS SHALL BE PROTECTED BY THE CONTRACTOR WITH BARRIER FENCING AS SHOWN ON THE DRAWING AND AS DIRECTED BY THE ENGINEER WHEN CONSTRUCTION ACTIVITIES ARE INITIATED.

THE CONTRACTOR MAY ELECT TO CONSTRUCT TEMPORARY SEDIMENTATION PONDS, TANKS, OR OTHER FACILITIES AS NECESSARY TO CONTROL RUNOFF AND/OR TO FILTER DEWATERING DISCHARGE.

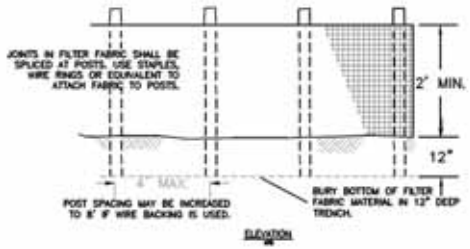
CONTROL DEWATERING

HIGHLY TURBID OR CONTAMINATED DEWATERING WATER FROM CONSTRUCTION EQUIPMENT OPERATION SHALL BE PREVENTED FROM DELIVERING SEDIMENT TO THE RIVER. DISPOSAL OPTIONS FOR DEWATERING DISCHARGE INCLUDE:

1. SEDIMENT-LADEN WATER MAY BE PUMPED TO AN UPLAND AREA AND ALLOWED TO SHEET FLOW OVER UNDISTURBED GROUND THROUGH EXISTING VEGETATION TO INFILTRATE INTO THE GROUND.

2. USE OF AN APPROPRIATELY SIZED AND MAINTAINED SEDIMENTATION BAG (DIRTBAG) OR OTHER SEDIMENTATION FACILITY WITH OUTFALL TO A DITCH OR SWALE FOR SMALL VOLUMES OF LOCALIZED DEWATERING.

NOTES:
1. FENCE SHALL NOT BE INSTALLED ON SLOPES STEEPER THAN 2:1.
2. JOINTS IN FILTER FABRIC SHALL BE OVERLAPPED 12 INCHES AT POST.
3. USE STAPLES, WIRE RINGS, OR EQUIVALENT TO ATTACH FABRIC.
4. REMOVE SEDIMENT WHEN IT REACHES 1/3 FENCE HEIGHT.



Preliminary Not For Construction

1/9 SILT FENCE DETAIL

NO.	BY	DATE	REVISION DESCRIPTION

RP DRAWN	BN DESIGNED	BN, GJ CHECKED
BN APPROVED	11/10/09 DATE	PROJECT

Lewis River – Eagle Island
Habitat Restoration – Site C
Woodland, Washington

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Erosion Control Notes and Details

SHEET 11 OF 12

PLAN VIEW

0 100 200
SCALE IN FEET

LEGEND
- WOOD
- BOULDER BALLAST
- ACCESS ROUTE
- LIMITS OF DISTURBANCE
- PLANT COMMUNITY 1 (1.00 ACRES)
- PLANT COMMUNITY 2 (1.67 ACRES)

Plant Community 1
Upland Staging Area Restoration (1.00 acres)

Common Name	Scientific Name	Plant Form	Minimum Size	Required Number
Trees – approximately 15 foot spacing on center				
Red alder	Alnus rubra	Bare root	24"	125
Big leaf maple	Acer macrophyllum	Bare root	5 gal/24"	50
Douglas-fir	Pseudotsuga menziesii	Bare root	5 gal/24"	50
			Total Trees	225
Shrubs – approximately 5 foot spacing on center				
Evergreen huckleberry	Vaccinium ovatum	Bare root	2 gal/24"	375
Beaked hazelnut	Corylus cornuta	Bare root	2 gal/24"	275
Snowberry	Symphoricarpos alba	Bare root	2 gal/24"	225
			Total Shrubs	875
Seed – Upland mix for staging area restoration – Seed at approximately 20 lbs/ acre				
Blue wildrye	Elymus glaucus	40% of composition by weight		
California brome	Bromus carinatus	40% of composition by weight		
Red fescue	Festuca rubra	20% of composition by weight		

Plant Community 2
Floodplain Tree/Shrub Community (1.67 acres)

Common Name	Scientific Name	Plant Form	Minimum Size	Required Number
Trees – approximately 15 foot spacing on center				
Oregon ash	Fraxinus latifolia	Bare root	24"	150
			Total Trees	150
Shrubs – approximately 5 foot spacing on center				
Pacific ninebark	Physocarpus capitatus	Bare root	36"	200
Red-osier dogwood	Cornus sericea	Bare root	12"	150
Douglas spirea	Spiraea douglasii	Bare root	36"	150
			Total Shrubs	500

NOTE:
SITE ACCESS ROADS AND OTHER DISTURBED AREAS TO BE SEEDED WITH NATIVE EROSION CONTROL SEED MIX.

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Revegetation Plan

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