CRW Aquatic Restoration LWD Project Plan: Rock Creek above the 40 road (2005)

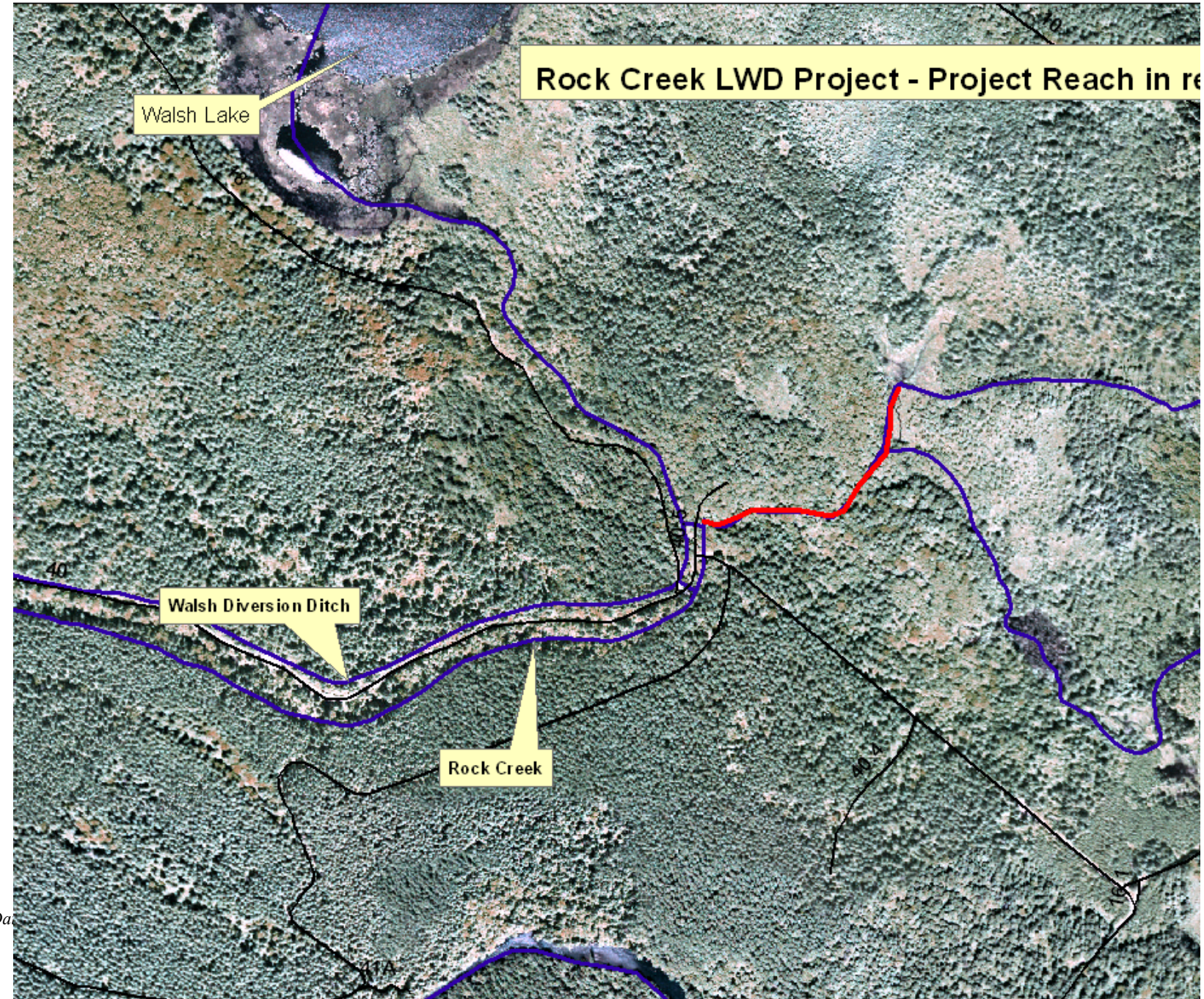
Seattle Public Utilities, Cedar River Watershed
By: Todd Bohle
July, 2005
(Revised Jan., 2006)

1. General Background

The Cedar River (King County, WA) is the major river in the Lake Washington watershed supporting a run of Chinook salmon that is part of the federally threatened Puget Sound Chinook Evolutionarily Significant Unit. Coho, sockeye, and steelhead also use this migration corridor from the slopes of the Cascade Mountains down to Puget Sound. More than half of the Cedar River watershed is owned by the City of Seattle and managed by Seattle Public Utilities both for the municipal water supply of 1.3 million people and for the conservation of natural resources. At the Landsburg Dam, where some flow is diverted to supply drinking water, fish passage has been blocked, denying fish access to twelve miles of habitat on the mainstem of the Cedar River and five miles of habitat on tributaries. In the fall of 2003, with the completion of a fish ladder around the Dam, all anadromous fish, except for sockeye, have access to this upstream habitat for the first time in a century. In fact, less than a month after completion of the fish ladder, 65 chinook and 3 coho salmon had passed over the dam!

More than half the new tributary habitat for these fish is found in the lower three miles of Rock Creek. An independent assessment of fish habitat conditions (Foster and Wheeler, 1995) found that most of this reach had the potential for extensive spawning areas and could provide outstanding rearing and overwintering habitat for salmonids. The presence of wood in the channel was identified as the single most important input that would create and maintain these habitat features. However, wood is noticeably absent from this stream. Trees are not naturally falling into the channel as this sub-basin was logged in the 1920's and 1930's and the riparian vegetation is not yet mature or diverse enough to supply adequate quantities of large wood. While Seattle Public Utilities is taking action to accelerate the development of coniferous riparian vegetation, the work proposed here would meet the interim need for wood in this portion of the channel. As the new salmonid migrants are now arriving in this portion of the watershed, we have an immediate window during which to restore this stream ecosystem so it can provide and maintain excellent habitat.

Pre-project **Post-project**


Rock Creek LWD Project - Project Reach in re
Walsh Lake
Walsh Diversion Ditch
Rock Creek
40
40A
41A

Da

2. General Goal

Improve habitat complexity and productivity over the short-term and facilitate the recovery of important physical and riparian processes critical to the long-term maintenance of aquatic conditions. Restoring currently very low levels of instream LWD to within their natural range of variability should result in increases in the frequency and depth of pools, increased bank stability and the creation and maintenance of off-channel habitat important for coho salmon.

3. Project Specific Objectives

Channel surveys conducted in the 2003 indicate system-wide degradation with very poor habitat. Indicators of this are shown in Table 1 (below), which summarize conditions within the entire length (9900-ft) of segment 4 as well as within the proposed project area of Rock Creek. Specific project objectives have been established which focus primarily on the formation of natural aquatic habitat characteristics using the geomorphic processes currently controlling these habitat elements:

1) Restore a 280m long section within segment 4 (GMU 9) of Rock Creek to a natural range of conditions for LWD distribution. The natural range of conditions for several key indicators are listed in Tables 1 and 2 (below).
2) Restore LWD Volume and Key Piece Frequency using Modified criteria as defined in Table 3.
3) Restore pool frequencies and residual depths to within their natural range of variability.

Table 1: Comparison of natural range of variation for key habitat indicators: Unmanaged streams vs. current conditions within Rock Creek .

Habitat Indicator	**Current Condition of segment 4**	**Current Condition of Restoration Area**	**Desired Future Condition or Range of Natural Variability**
LWD Frequency (per 100 m)	3.6	19.1	28-99 (mean of 52/100 m)
LWD Key Piece Freq. (per 100m)	4	0.4	11/100 m
Pool Frequency (per 100 m)	1.9	3.8	6-24 (or 0.5-2/Channel Width)
Ave. Residual Pool depth	1.0 ft	1.1	?

Table 2: Comparison of natural range of variation for LWD key indicators: Unmanaged streams vs. current conditions within Rock Creek . For this analysis, stream inventory data was summarized for each 100m long reach. A total of 12 100m long reaches were surveyed in Rock Creek.

	Frequency Distribution of LWD		
	Poor Habitat: <25th Percentile	**Fair Habitat: 25th to 75th Percentile**	**Good Habitat: >75th Percentile**
Natural Range of Conditions (Unmanaged Streams):	< 28 m^3/ 100m	28-99 m^3/ 100m	>63.4 m^3/ 100m
LWD Pieces (all qualifying pieces) per 100m Key Pieces (>1m^3) per 100m	<4	4-11	>11
Rock Creek Desired Future Conditions (No. of 100m long reaches within each category)	3	0	0
Rock Creek Total LWD Volume (m^3)(Current Condition): No. of 100m long reaches within each category	3	0	0
Rock Creek Key Pieces (Current Condition): No. of 100m long reaches within each category	3		0
2005 Restoration Goal: No. of 100m reaches to be restored within their natural range of conditions for *LWD and Key Piece Frequency*			**3**

Table 3: Proposed modifications to the DFC's developed in the Draft Aquatic Restoration Strategic Plan (used to design the 2004 Rock Creek LWD Project):

Habitat Indicator	**Potential DFC's**			**Range of Natural Variability in Comparable Unmanaged Streams**
	Target using Fox (2003)	**Modification 1 (using Key Piece and LWD volume criteria)**	**Justification**	
LWD Volume (m^3 per 100 m)	Good: 110 Fair: 63 Poor: <28	Good: 110 Fair: 63 Poor: <28	Retain existing targets	*Volume (m^3) per 100 m:* Upper Quartile(good): >99 2nd and 3rd Quartiles (fair): 28-99 Lower Quartile(poor): <28
LWD Frequency (pieces per 100 m)	Good: 70 Fair: 52 Poor: <29	Good: **55** Fair: **32** Poor: <29	Attaining a DFC of 70 (rating of Good) would result in an LWD volume of between 130 to 143 m^3 per 100m. This is substantially higher than the corresponding DFC LWD Volume value (110). Using a target of 55 pieces, with an average volume of 1.99m^3 per piece, the resultant LWD Volume would be 109.5 m^3	*LWD Frequency per 100 m:* Upper Quartile(good): >63.4 2nd and 3rd Quartiles (fair): 29.2-63.4 Lower Quartile(poor): <29.2
LWD Key Piece Freq. (LWD >2.5 m^3 per 100 m)	Good: 15 Fair: 8 Poor: <4	Good: 15 Fair: 8 Poor: <4	Retain existing targets	*LWD Key Piece Frequency per 100m:* Upper Quartile(good): >11 2nd and 3rd Quartiles (fair): 4-11 Lower Quartile(poor): <4
Pool Frequency: All pools (per 100 m)	Good: >18 Fair: 6-18 Poor: <6	same		Interim DFC's: 6-24 (or 0.5-2/Channel Width)
Ave. Residual Pool depth (m)				

3.1. Design Criteria

To achieve the above specific habitat elements, the following design criteria have been established:

3.1.1. Placed individual pieces of woody debris with volumes greater than 2 m^3 (approx. key pieces) shall be stable during flows up to a recurrence interval of 50 years.

3.1.2. Increase habitat quality by increasing pool frequency, pool depths, and area of spawning gravels.

3.1.3. Minimize disturbance to the soil and riparian vegetation during implementation.

3.1.4. The downstream most LWD (approximately 200 ft upstream of the 40 road) shall be stable during flows up to a recurrence interval of 100 years in order to limit the conveyance of LWD to the 40 road culverts below the project site

4. Methodology

During the summer of 2005, 103 large pieces of coniferous wood, ranging between 20 and 40 feet in length or approximately 1.5 times the bankfull width and with a minimum volume of .5 m^3 will be placed along 280 m of Rock Creek above the 40 road. A combination of Douglas Fir and Western Hemlock logs, which blew down during the November 2003 windstorm, will be relocated to staging sites along the project area. To minimize disturbance to riparian vegetation and floodplain features, wood will be transported from staging areas along the 10.6 roads and positioned in the channel using a helicopter. Additional adjustments to placement will be made using hand-built techniques using wire rope, griphoists, chokers and other hand-operated gear to obtain mechanical advantage.

4.1. Project Implementation

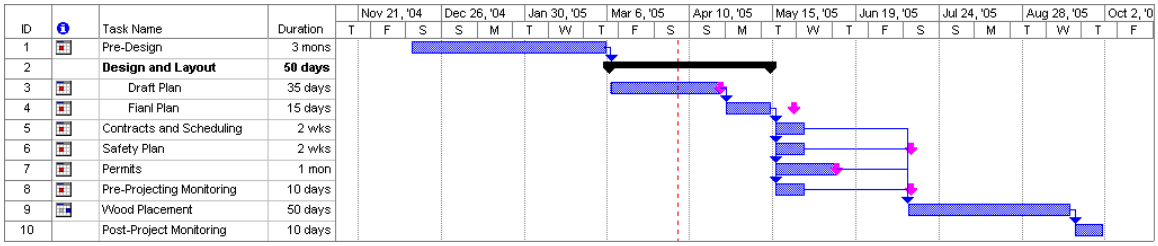
We will place up to 15 key pieces of wood along 280 meters of Rock Creek above the 40 road. Wood placement will consist of the following:

4.1.1. Up to 86 pieces of wood exceeding approximately 25 feet in length and 10 inches minimum diameter will be placed at least partially within the active channel.

4.1.2. 15 pieces will be key pieces, having a minimum volume of greater than 2.0 m^3.

4.1.3. Up to 17 pieces will be placed on adjacent floodplains.

4.1.4. Implementation date: July, 2005.



4.2. Restoration Designs

Four general wood placement design typicals will be used in this project. These strategies include installing single pieces to function as ramps and steps, 3-piece structures, multiple-piece channel-spanning structures, and single pieces on low floodplains. A few drawings of structures we will likely be installing are shown below.

4.3. Outcomes (section added following implementation)

The following table summarizes the amount of wood we were able to place in July of 2005 a helicopter as well as hand built techniques to make minor adjustments to wood position.

Table 3: Amount of LWD placed in the Rock Creek project site in July of 2005.

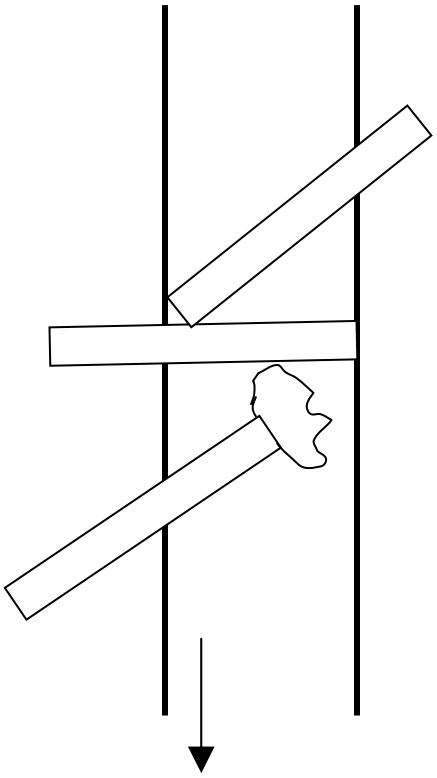
Placed LWD	
Number:	103
Number/100m	36.8
Total Volume (m^3):	122.0
Volume/100m	43.6

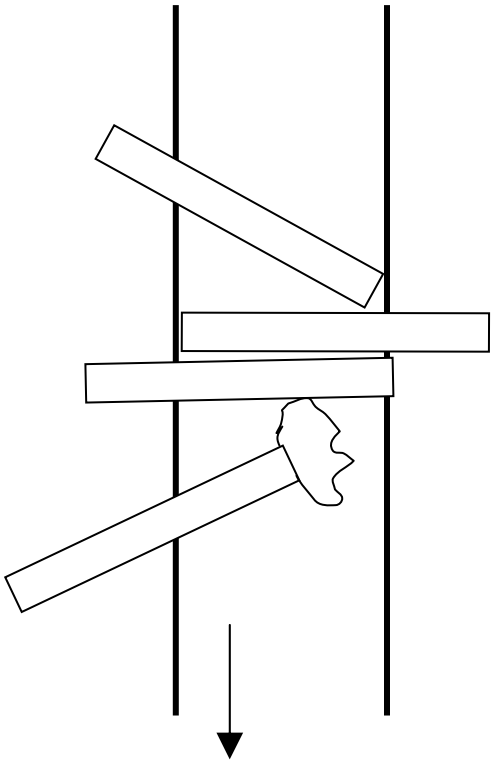
Project length: 920 feet or 280 meters

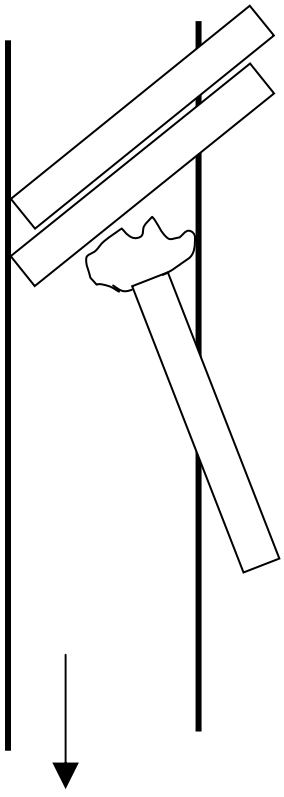
5. Monitoring Plan

The fundamental goal of LWD effectiveness monitoring, using a comparison of pre- and post-treatment conditions, is to assess if the LWD had the prescribed physical effect on aquatic habitat structure and physical process. Project monitoring will focus on a few key parameters which serve as either direct indicators of project success or as measures of channel processes needed to understand trends in channel conditions and reasons for project success or failure. Key indicators of success, identified and discussed in the Draft Aquatic Restoration Strategic Plan (2006), include LWD frequency, LWD key piece Volume (or frequency), pool frequency, average residual pool depth. In addition, a channel profile survey, permanent cross sections, particle size distributions, and documenting wood functions and movement are also needed to understand trends in channel conditions and assess the stability of wood with respect to size and placement strategies (e.g., single pieces, multiple piece jams, rootwads). Table 4 summarizes the processes we are striving to either maintain or restore and the parameters used to assess them.

Design Typicals:







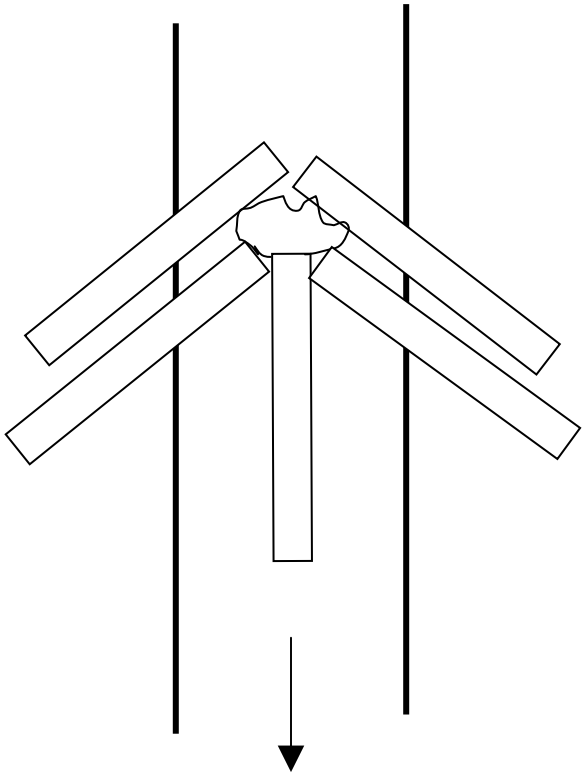


Table 4: Key processes which will be directly and indirectly monitored using one or more parameters.

Process	**Parameter**	**Unit of Measure**	**Time Interval**
Pool Formation	Pool Frequency	Pools/100 m	Years 1, 2, and 5 (and after 10year recurrence interval flow if possible)
Wood Stability	Wood position	Distance along channel	
	Wood Angle	Angle	
	LWD frequency	Frequency of pieces >10 cm diam and 2 m length per 100 m	
	LWD Key Piece Volume	Volume of LWD pieces > 1m3 per 100 m	
	Decay Class	Categories 1-5	
Sediment Sorting/storage	Longitudinal Profile	Ft/ft	
	Geomorphically stratified sampling	Delineation of reach morphology into bed material particle size distributions. Sample particle sizes within each unit.	
	4 permanent cross sections (1 below, 2 within, and 1 above the project site)	Bankful cross sectional area	
Habitat quality	Undercut bank	Lineal feet of cover	
	Bank Erosion	Lineal feet of eroding bank	

Using well established stream survey protocols (CRW Stream Inventory Handbook, 2003; J:\SSW\WS541\Secure\Hydrology\Protocols\Stream Inventory\Final Verision 1.0), standard methods will be used to monitor habitat elements. Habitat data to be collected includes the following: Habitat Unit (type, length, width), Pool forming factors, Pool max and crest depths, Pocket pool (max depth and forming factor), Substrate particle size, and Banks (Length of sloughing and undercutting). Using these protocols, Rock Creek will be inventoried throughout the reach between station 0 (upstream edge of 40 road) and 940 feet upstream. The completion of this inventory will provide data needed to assess the status of habitat conditions following the restoration effort.

5.1. LWD Stability and Functions

As wood stability is strongly linked with function and hydraulic effectiveness, the movement of LWD within the reach will be tracked. This effort will also provide information on the size and placement of pieces which resulted in the greatest hydraulic effectiveness and stability. To facilitate tracking of individual pieces, each piece greater than 10cm diameter and 2 m in length within the bankful zone (in addition to those pieces placed on the floodplain) will be tagged in 2 planes using numbered aluminum tags. For each piece, observations and measurements of the following attributes will be made:

LWD Dimensions: Midpoint diameter (nearest inch), length (tenths of feet)
Orientation: 0° (pointing upstream parallel to bankful) to 180° (pointing downstream parallel to bankful).
Reach position: Reference point, distance, azimuth (+/- 0 to 180°)
Age of trees growing on wood? 0, 1-2, 2-5, 5-10, >10
Origin? Placed, Streamside, Non-streamside, Fluvial, Unknown
Rootwads and Rootwads Attached? Rootwads (for pieces w/ less than 2 m long boles): Yes/No Qualifying pieces w/ attached rootwads: Yes/No
Decay Class: 1 through 5 based on presence of bark and twigs, texture, shape and wood color. Based on TFW Ambient Monitoring Protocol (1994)from Robison and Beschta (1991).
Wood Functions Pool Type: plunge (step), flow constriction, flow deflection, none Sedimentation: upstream bar, downstream bar, lateral bar, island, none Erosion: causing bank erosion, stabilizing bank, n/a Wood debris: forming logjam, currently trapping flotsam, future trap, none
Key stability factor (holding wood in place): Bank, rootwad, partially buried in bank, partially buried in substrate, pinned(boulder, trees, bedrock), cabled, none
Trapping Small LWD and Organic Matter: Areal extent of small LWD (<10 cm diameter and 2 m in length)

Using permanent markers (nails at base of trees) stationed at 335, 541, 766, 1012, and 1110 feet upstream of the 40 road, distance and direction (from true north) to the center of each piece of LWD will be made using a standard tape (to the nearest tenth of a foot) and compass. Orientation of each piece will also be documented relative to the nearest bankful edge. Orientation (angle to the nearest 5 degrees) along the piece will be measured while looking from the widest to the narrowest end. In addition, trees pointed upstream (crown pointing upstream) parallel to the bankfull edge have an orientation of 0 degree's while those pointing directly downstream parallel to bankful have an orientation of 180's. Finally, positive angles will be assigned to trees pointing towards the northeast and southeast quadrants and negative angles for trees pointing towards the southwest and northwest quadrants.

5.2. Sedimentary Stratified Sampling

Another restoration objective related to habitat quality and complexity concerns increased sorting of bed material and, in particular, increasing the quality and extent of spawning gravel. Currently bed material is poorly sorted with very few well sorted patches of gravel which coho need for spawning. In order to characterize the spatial heterogeneity of surface grains, the streambed has been delineated into areas or facies with no systematic variation of bed material size.

The size of each patch or facies is not fixed but rather is dependent on the degree of spatial heterogeneity of the bed. The delineation of homogenous sedimentary units will

be done visually (Section 6.3.2.1 of Bunte and Abt, 2001). Within the project site, 6 distinct facies have been identified and mapped. The facies include: 1) Poorly sorted cobble and large gravel with variable fines, D50≅21mm, Dmax≅ 125mm; 2) Well sorted small to medium gravel, D50≅20mm, Dmax≅ 113mm; 3) Small to medium gravel with no sand, D50≅10mm, Dmax≅ 81mm; 4) Moderate to poorly sorted small gravel to small cobble. D50≅35mm, Dmax≅ 274mm; 5) Silt and fine sand, D50 ,<1mm, Dmax <2mm; 6) Well sorted gravel with sand, D50≅2mm, Dmax≅ 28mm.

Facies		Total Area		Percent of Reach
Description	No.	ft^2	m^2	
Poorly sorted cobble and large gravel with variable fines, D50≅21mm, Dmax≅ 125mm	1	2188	203.2	16
Well sorted small to medium gravel, D50≅20mm, Dmax≅ 113mm	2	1963	182.3	14
Small to medium gravel with no sand, D50≅10mm, Dmax≅ 81mm	3	2706	251.4	19
Moderate to poorly sorted small gravel to small cobble. D50≅35mm, Dmax≅ 274mm	4	2294	213.1	17
Silt and fine sand, D50 ,<1mm, Dmax <2mm	5	3550	329.8	26
Well sorted gravel with sand, D50≅2mm, Dmax≅ 28mm	6	1088	101.0	8
				100.0

Sampling schemes for these facies are dictated by patch size and homogeneity of particle sizes. Given the variability in size of each facies, a separate grid system will be used to sample each unit. For larger, channel spanning facies such as 3 and 4, pebble count transects will be used, randomly sampling between 10 and 15 particles per transect. Within smaller facies, smaller grids will be established along which point counts will be conducted. Grid spacing for pebble counts will be roughly equivalent to the Dmax of that facie. Given that facies 3 and 4 are relatively heterogeneous and intended precision of estimates is roughly 10%, a minimum of 400 particles will likely need to be sampled from each. Given the general paucity of sand and small gravel, methods using areal adhesives or photographs will not be employed.

5.3. Stream Profile

Using an abney level, stadia road and tape, a profile of the wetted edge of channel will be completed from the 40 road bridge (approx. 200 feet below the project area) for a distance of about 900 feet. Profile measures will include obvious slope breaks (often corresponding to changes in habitat units) and station markers.

5.4. Permanent Cross Sections

4 permanent cross sections will be installed, including 1 below the project area (but above the bridge), 2 within the project area and 1 above. Standard protocols for establishing permanent cross sections will be used.

6. Summary of Adaptive Management Strategy				
Question	**Indicator and Comparison**	**Trigger Point**	**Possible Actions**	**Who will Respond**
Has the large woody debris placed within the active channel improved the quality of instream habitat for Coho Salmon?	Pre- and post-project comparison of pool frequencies and an increase in mean residual pool depths.	Pool frequency of less than 0.5 per channel width by 2009 or following a greater than 10 year recurrence interval flow	Assess trigger mechanisms contributing to low pool frequencies or volumes. Consider additional restoration treatments which would address the underlying processes.	SPU lead hydrologist
	Pre- and post-project comparison of LWD frequency.	LWD piece frequency between 29-63 per 100 m by 2010 or following a greater than 10 year recurrence interval flow	Assess trigger mechanisms contributing to low LWD frequencies. Consider additional restoration treatments which would address the underlying processes.	SPU lead hydrologist
	Pre- and post-project analysis of area of sediment facies (discrete patches of well sort particles) within the active channel.	Less than 10% increase in area comprises of facies 1 within the active channel through the project reach by 2009 or following a greater than 10 year recurrence interval flow	Assess trigger mechanisms contributing to a lack of fining and sorting of active channel substrate. Consider additional restoration treatments which would address the underlying processes (e.g. upstream sediment supply, a change in upstream hydraulics or movement and export of LWD).	SPU lead hydrologist
Have the wood placement strategies resulted in stable, functional pieces within the project site?	Extent of post-project remobilization of placed LWD greater than 50 feet downstream.	More than 25% of placed LWD has been transported greater than 50 ft by 2009 or following a greater than 10 year recurrence interval flow.	Assess trigger mechanisms contributing to significant movement of placed LWD. Consider additional restoration treatments which would address the underlying processes (e.g. upstream sediment supply or altered reach hydraulics).	SPU lead hydrologist
	Extent of current LWD functionality within the active channel.	Less than 50% of placed LWD providing pool formation, sediment or wood storage, and bank protection functions by 2009 or following a greater than 10 year recurrence interval flow.	Assess trigger mechanisms contributing to a lack of LWD functionality. Consider additional restoration treatments which would address the underlying processes.	SPU lead hydrologist
Have we adequately protected the 40 road culverts from LWD accumulations?	Frequency and size of placed LWD deposited within 50 feet of the 40 road culverts.	Any pieces of lwd exceeding 20 feet in length and 1 foot in diameter deposited within 50 feet of the culvert inlets. Should assess annually prior to winter high flows.	Assess trigger mechanisms contributing to significant movement of placed LWD. Consider removal or transport of readily transported pieces to reaches below the 40 road.	SPU lead hydrologist