CRW Aquatic Restoration LWD Project Plan: Rock Creek above the 10 road (2004)

Seattle Public Utilities, Cedar River Watershed
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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.

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. Our intent, therefore, is to restore 2 100m long sections within segment 4 (GMU 9) of Rock Creek to their natural range of conditions for LWD distribution. The natural range of conditions for two key indicators are listed in Tables 1 and 2 (below).

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	7.0	29.2-63.4 (mean of 52/100 m)
LWD Key Piece Freq. (per 100m)	4	0	11/100 m
Pool Frequency (per 100 m)	1.9	1.4	6-24 (or 0.5-2/Channel Width)
Ave. Residual Pool depth	1.0 ft	0.95	?

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):	< 29.2 m^3/ 100m	29.2-63.4 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)	<u>3</u>	<u>6</u>	<u>3</u>
Rock Creek Total LWD Volume (m^3)(Current Condition): No. of 100m long reaches within each category	2	0	0
Rock Creek Key Pieces (Current Condition): No. of 100m long reaches within each category	2		0
2004 Restoration Goal: No. of 100m reaches to be restored within their natural range of conditions for *LWD and Key Piece Frequency*			**2**

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 1m3 (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 jam (at approx. station 300) shall be stable during flows up to a recurrence interval of 100 years and limit the conveyance of LWD to the bridge below the project site.

4. Methodology

During the summer of 2004, 54 large pieces of coniferous wood, ranging between 32 and 40 feet in length or approximately 1.5 times the bankfull width and with a minimum volume of 1 m^3 will be placed along 500 feet of Rock Creek above the 10 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 primarily hand-built techniques using wire rope, griphoists, chokers and other hand-operated gear to obtain mechanical advantage. Where feasible, large equipment may be used to move large pieces into the stream immediately above the 10-road bridge.

4.1. Project Implementation

We will placement up to 60 key pieces of wood along 200 meters of Rock Creek above the 10 road. In addition, within the 8 alloted days for wood installation, wood will also be placed on adjacent floodplains within the upper 400 feet of the project area. Wood placement will consist of the following:

- 4.1.1. Up to 60 total pieces of wood exceeding 8m (approx. 25 feet) in length and 10 cm minimum diameter will be placed at least partially within the active channel.
- 4.1.2. 11 pieces will be key pieces, having a minimum volume of between 1 and 2.5 m^3.
- 4.1.3. Up to 20 pieces will be placed on adjacent floodplains, time permitting.
- 4.1.4. Due date*:* October 1, 2004.

4.2. Restoration Designs

Five general wood placement strategies or design typicals were used during 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. The objectives and typical design of each is discussed below:

Single Piece Ramps and Steps: These structures are intended to promote local scour at moderate to high flows as well as promote bank complexity and in-channel cover.

3-Piece Structures:

Multiple-Piece Structures:

Floodplain Pieces:

4.3. Outcomes (section added following implementation)

The following table summarizes the amount of wood we were able to place in August of 2004 using hand built techniques. While we placed roughly as many pieces as planned, for operational reasons we could not place the largest pieces in our log decks, namely those exceeding 40 feet in length and over 16 inches in diameter.

Table 3: Amount of LWD placed in the Rock Creek project site during August of 2004.

Placed LWD	
Number:	54
Number/100m	35.43
Total Volume:	27.45
Volume/100m	18.01
Project length: 500 feet or 152 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.

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 (10 road bridge) and

1300 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 400 and 650 feet upstream of the 10 road bridge, 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 will be separated 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) Well sorted pebbles, D50≅16mm, Dmax≅ 128mm; 2) Sand w/ gravel, D50≅2mm, Dmax≅ 64mm; 3) Large cobble gravel with boulders, D50≅96mm, Dmax≅ 512mm; 4) Large gravel and cobble, D50≅64mm, Dmax≅ 256mm; 5) Sand, gravel and cobble, D50≅24mm, Dmax≅ 256mm; 6) Well sorte gravel and small cobble (spawing gravels), D50≅16mm, Dmax≅ 128mm.

Facies		Total Area		Percent of Reach
Description	No.	ft^2	m^2	
Well sorted pebbles, D50≅16mm, Dmax≅ 128mm	1	97.15	9.03	0.8
Sand w/ gravel, D50≅2mm, Dmax≅ 64mm	2	10	0.93	0.1
Large cobble gravel with boulders, D50≅96mm, Dmax≅ 512mm	3	6408	595.32	52.2
Large gravel and cobble, D50≅64mm, Dmax≅ 256mm	4	4458.6	414.22	36.3
Sand, gravel and cobble, D50≅24mm, Dmax≅ 256mm	5	804.4	74.73	6.5
Well sorted gravel and small cobble (spawing gravels), D50≅16mm, Dmax≅ 128mm	6	506.95	47.10	4.1
				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 10 road bridge (300 feet below the project area) for a distance of 1300 feet. Though the project area stops at 800 feet, the profile will extend an additional 500 feet in order to include an area of chronic bank erosion and minor sloughing above the project site. 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 residul 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 10 feet downstream.	More than 25% of placed LWD has been transported greater than 10 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 10 road bridge from LWD accumulations?	Frequency and size of placed LWD deposited below the downstream jam (station 300 ft above the bridge).	Signs of significant scour at the downstream jam (station 300), any LWD deposited below this jam (either above or below the bridge) exceeding 20 feet in length. 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 10 road bridge.	SPU lead hydrologist