DRAFT

LAKE CREEK

PHYSICAL HABITAT ASSESSMENT SURVEY

Prepared For

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1.0 INTRODUCTION

As part of the study to develop information to support the 401 Water Quality Certification of the Packwood Lake Hydroelectric Project (Project), Energy Northwest has agreed to take part in a collaborative scoping process to evaluate, recommend, and propose appropriate instream flows for Lake Creek below the Project drop structure for incorporation into the subsequent FERC license for the Project. A physical habitat survey was conducted to the assess fisheries habitat of Lake Creek. Information gathered will be used in conjunction with the USFS sampling, stream profile maps, hydrology and location of anadromous barriers to: 1) segment the stream into study reaches; 2) select potential transects; and 3) determine study reach and transect weighting using the Instream Flow Incremental Methodology (IFIM).

2.0 METHODS

A physical habitat survey of Lake Creek as described in the draft study protocols was conducted in April and May 2004. Lake Creek was surveyed in a downstream direction from the drop structure to quantify existing habitat conditions. Data were collected and consolidated, habitat frequencies were calculated, and the creek was segregated into distinct study reaches.

2.1 Habitat Type

Habitat was sampled every 150 feet down the stream channel. At each station, a cross-sectional habitat type was assigned, as described in Table 2-1.

2.2 Wetted and Bank Full Channel Width

A surveying tape was used to measure the wetted channel width at the observed flow. The bank full channel width was then assessed.

2.3 Mean Depth

Depths were taken at three locations across each transect (sampled at ¼, ½, and ¾ of the width). The three depths were then averaged and used as a variable in determining the habitat type.

2.4 Gradient and Elevations

A clinometer was used to determine the slope from one transect to the next and establish gradient values for each reach. A digital altimeter recorded the altitude at each transect.

2.5 Dominant and Subdominant Substrate

A proximal assessment across the width of the transects was used to determine the dominant and subdominant substrate present. Table 2-2 describes the substrate code used during the survey of Lake Creek (WDFW 2004). The substrate type comprising the highest percentage of coverage across the

transect was documented as the dominant substrate and the substrate with the second highest percentage was coded as the subdominant substrate.

2.6 Video and Photos

Narrative videos as well as cross-sectional photos were taken of each transect in an effort to provide visual representation of the various habitat types and to better document areas of Lake Creek that are difficult to access and rarely studied. Technical difficulties precluded taking still photos and video of a portion of Reaches 3 and 4 on April 5, 2004.

2.7 Distance Along Stream

A hip chain was used to verify distances between transects, measure lengths of all of the study reaches and confirm the overall length of Lake Creek from the drop structure to the Lake Creek confluence with the Cowlitz River.

2.8 Ancillary Information

Any potential fish passage barriers and chutes were documented and photographed. Any barriers deemed to have potential fish passage issues will be further surveyed during the instream flow study. Major tributaries and areas of significant inflow were also documented during the surveys.

Table 2-1. Microhabitat Type Coding and Description

Code	Habitat Name	Habitat Description
1	Pool	Slower velocity and deeper, non-turbulent flow with a strong hydraulic control.
2	Lateral pool	Pool formed on the margin of the stream as a result of structural element, substrate composition, or thalweg location. (Generally, at least ½ of the pool perimeter interfaces with the adjacent habitat unit).
3	Plunge pool	Flow at head is vertical passing over an obstruction: fast, turbulent often with a bubble plume down the center.
4	Glide	Smooth, generally unbroken surface, generally laminar flow, moderate to shallow depth, often smaller substrates.
5	Riffle	Shallow with moderate velocities (less than run), lateral bottom profile is usually uniform; surface is broken but not turbulent like a run, gradient <4%.
6	Run	Like a glide except faster velocities and somewhat more turbulent; surface may be broken by protruding rocks.
7	Boulder garden	A run with lots of randomly placed large boulders causing flow irregularities, flow is not necessarily turbulent.
8	Chute	All the flow is concentrated in a narrow area. Flow is fast to very fast.
9	Rapid	Water (rough, turbulent surface) usually with a standing wave at the hydraulic jump that occurs at the bottom as the flow rapidly decelerates into a pool, though it could merge into a riffle; water surface slope 2.5 – 4%
10	Cascade	Turbulent flow with pronounced vertical drops causing a stepped gradient, substrate often boulders and cobble.

Table 2-1. Microhabitat Type Coding and Description		
Code	**Habitat Name**	**Habitat Description**
11	Braided channel	One or more divisions of the stream channel separated by islands of substrate not well vegetated.
12	Split channel	More than one permanent channel.
13	Side Channel	A flow dependant channel separate from the permanent channel.
14	Plunge Pool Tailout	A transitional area where turbulent water from a plunge pool begins to settle out. Typically preceding a run or glide.
15	Falls	A large vertical drop. Water typically plunges into a pool, substrate often bedrock or large boulders.

Table 2-2. Substrate Coding (WDFW 2004)		
Code	**Type of Substrate**	**Dimensions**
1	Silt, Clay, or Organic	
2	Sand	
3	Small Gravel	0.1-.5”
4	Medium Gravel	.5-1.5”
5	Large Gravel	1.5-3”
6	Small Cobble	3-6”
7	Large Cobble	6-12”
8	Boulder	>12”
9	Bedrock	

3.0 RESULTS

Appendix A contains the physical habitat assessment data collected at each station along Lake Creek. Appendix B includes the photographs of the habitat units quantified during the survey. Appendix C incorporates the photos of selected transects for the instream flow study as well as documented and potential anadromous barriers. These appendices are included on a CD; full descriptions of these data sets are given below.

3.1 Habitat Assessment

Energy Northwest partitioned Lake Creek into five distinct reaches based primarily on changes in gradient along the length of the stream. Figure 3-1 graphically represents the breaks in slope and the coordinated reach segmentation. Lake Creek is a high gradient, stair-step type creek with a long series of cascades and plunge pools comprising a majority of the streams habitat. Table 3-1 summarizes reach definition, length, and mean slope for each study reach.

Table 3-1. Summary of study reaches, Lake Creek.			
Reach	**River Mile**	**Elevation (ft)**	**Mean Slope**
1	0.0-0.7	1,105-1,213	2.9%
2	0.7-1.3	1,210-1,440	7.3%
3	1.3-3.5	1,440-2,367	8.0%
4	3.5-4.9	2,360-2,680	4.3%
5	4.9-5.3	2,680-2,857	8.4%

3.1.1 Reach 1 (RM 0.0-0.7)

Reach 1 is the lowest gradient of the five reaches, rising approximately 100 feet from the mouth of Lake Creek to RM 0.7 located near the Forest Service boundary (mean gradient of 2.9%). Twenty-five transects were analyzed with cascades and plunge pools comprising a majority of the habitat types identified. Runs, trench pools, and a boulder garden made up the remaining transects documented.

Boulder and cobble were the primary substrate types identified throughout the reach. Wetted and channel widths ranged from 15-60 feet and 27-98 feet, respectively. Deep pools are lacking in this reach, with cross-sectional depths never greater than 2.1 feet.

3.1.2 Reach 2 (RM 0.7-1.3)

Reach 2 is 0.6 miles in length and rises approximately 210 feet from the Forest Service boundary. In this reach, Lake Creek courses through a narrow, bedrock controlled canyon. Twenty-one transects were analyzed. Cascades, pools, and runs made up over 95% of the transects measured. Wetted and channel widths were from 10-200 feet and 15-200 feet, respectively. The average depth of the transects ranged from 0.4-5.0 feet.

Boulder and cobble were again the two dominant substrate types present at transect locations and throughout the reach. Gravel were absent above a barrier (chute) located at approximately RM 1.05; however, gravels were present below the chute and canyon, where gradient was less. Intermediate slopes were as high as 12% on the habitat types measured. Above RM 1.0, substrates were mostly large substrates. Gravels were not apparent until below RM 1.0, where Lake Creek exited the canyon and gradients decreased.

The potential barrier at RM 1.05 will be surveyed using the methodologies described in Powers and Orsborne (1985)

3.1.3 Reach 3 (RM 1.3-3.5)

Reach 3 is a high gradient (mean gradient of 8%), 2.2 mile-long-stretch of Lake Creek through a steep canyon. Lake Creek rises approximately 950 feet in this reach. Seventy six transects were measured in Reach 3 and over 80% of the transects that were analyzed were cascades, falls, or pools. Average depths throughout this reach ranged from 0.2 to 2.6 feet with boulder and cobble predominating. Wetted and channel widths ranged from 6-200 feet and 6-245 feet, respectively, with slopes between transects reached as high as 100% at two large falls and were typically as high as 8-10%.

At RM 2.05, a 15 to 20-ft waterfall prevents any anadromous passage beyond this point. Large falls and chutes likely to be barriers to fish movement are most abundant in Reach 3; 12 potential barriers were documented in this reach (see Appendix C).

3.1.4 Reach 4 (RM 3.5-4.9)

Reach 4 rises approximately 450 feet in 1.4 miles (average gradient of 4.3%), with the upper half of the reach being steeper than the bottom half. Forty four tansects were measured in this reach and their mean depths ranged from 0.3 to 1.9 feet deep. A majority of the habitat in this reach consisted of pools, runs and cascades. Cobble and boulder were the dominant substrates, although the highest concentration of gravel present the entire length of Lake Creek was observed in the lower half of Reach 4. Wetted and channel widths ranged from 6-160 feet and 6-195 feet, respectively.

3.1.5 Reach 5 (RM 4.9-5.3)

Reach 5 is a 0.4 mile stretch extending up to the downstream edge of the drop structure. Fifteen transects were measured and consisted primarily of glides, cascades, and plunge pools. This reach rises 177 feet from RM 4.9 to the drop structure with boulders, cobble, and sand the dominate substrate types. Wetted and channel width ranged from 7-36 feet and 24-54 feet, respectively. Mean gradient for this reach is 8.4%.

Habitat frequencies for each study reach are presented in Table 3-2. Appendix A contains the raw field notes for the habitat survey. When split, braided or side channels were encountered, the habitat type found in these channel was quantified and incorporated into the calculations (i.e., run, glide). Split, braided and side channels were noted and quantified; however, the number of each of these habitat types was not included in the calculations.

3.2 Instream Flow Transect Selection

Based upon the habitat frequencies observed during the physical habitat survey, Table 3-3 summarizes the study reaches and habitat types selected for the instream flow study. Study Site 2, located at RM 1.3, is situated in a transition zone and represents habitats found in both Reaches 2 and 3. Photos of IFIM transects are included in Appendix C.

3.3 Anadromous Barrier Identification

Numerous falls and chutes that are barriers to upstream migration of resident and anadromous fish exist in Lake Creek. Previous investigations by the USFS identified a downstream anadromous fish barrier at RM 2.05. This bedrock falls, approximately 25 – 30 feet tall, is unchanged by any subsequent flood events in Lake Creek and remains a barrier. Energy Northwest also identified a potential barrier in a steep canyon near RM 1.03; a bedrock falls and chute complex that has been documented (see Appendix C). As stated earlier, further surveying and measurements will be taken in conjunction with the instream flow study to confirm if this chute is a barrier to anadromous fish.

Figure 3-1. Lake Creek Stream Gradient

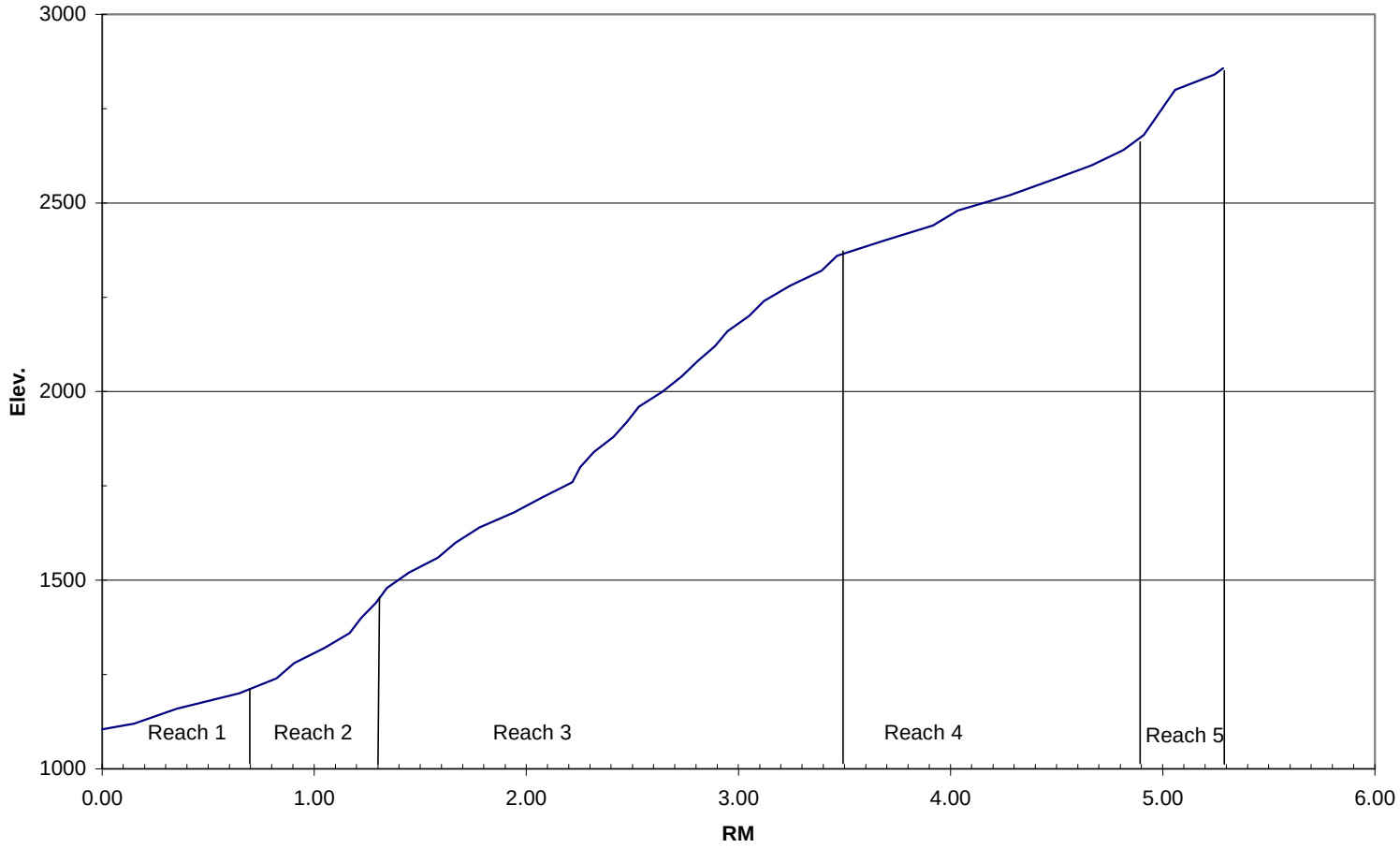

Table 3-2. Lake Creek Habitat Frequencies by Reach

Reach 1 (RM 0.0-0.7)			
Code	**Habitat Type**	**Frequency**	**% of Total**
1	Pool	0	0.0
2	Lateral Pool	0	0.0
3	Plunge Pool	3	12.0
4	Glide	4	16.0
5	Riffle	0	0.0
6	Run	10	40.0
7	Boulder Garden	0	0.0
8	Chute	1	4.0
9	Rapid	0	0.0
10	Cascade	6	24.0
11	Braided Channel	0	0.0
12	Split Channel	0	0.0
13	Side Channel (1)	0	0.0
14	Plunge Pool Tailout	1	4.0
15	Falls	0	0.0
Total Habitat Units		**25**	

Reach 2 (RM 0.7-1.3)			
Code	**Habitat Type**	**Frequency**	**% of Total**
1	Pool	2	9.5
2	Lateral Pool	0	0.0
3	Plunge Pool	4	19.0
4	Glide	2	9.5
5	Riffle	0	0.0
6	Run	6	28.6
7	Boulder Garden	0	0.0
8	Chute	2	9.5
9	Rapid	0	0.0
10	Cascade	5	23.8
11	Braided Channel	0	0.0
12	Split Channel (1)	0	0.0
13	Side Channel	0	0.0
14	Plunge Pool Tailout	0	0.0
15	Falls	0	0.0
Total Habitat Units		**21**	

Reach 3 (RM 1.3-3.5)			
Code	**Habitat Type**	**Frequency**	**% of Total**
1	Pool	3	3.9
2	Lateral Pool	1	1.3
3	Plunge Pool	12	15.8
4	Glide	10	13.2
5	Riffle	0	0.0
6	Run	8	10.5
7	Boulder Garden	0	0.0
8	Chute	8	10.5
9	Rapid	0	0.0
10	Cascade	26	34.2
11	Braided Channel	0	0.0
12	Split Channel (6)	0	0.0
13	Side Channel (3)	0	0.0
14	Plunge Pool Tailout	5	6.6
15	Falls	3	3.9
Total Habitat Units		**76**	

Reach 4 (RM 3.5-4.9)			
Code	**Habitat Type**	**Frequency**	**% of Total**
1	Pool	3	6.8
2	Lateral Pool	0	0.0
3	Plunge Pool	6	13.6
4	Glide	6	13.6
5	Riffle	0	0.0
6	Run	16	36.4
7	Boulder Garden	1	2.3
8	Chute	0	0.0
9	Rapid	0	0.0
10	Cascade	11	25.0
11	Braided Channel	0	0.0
12	Split Channel (6)	0	0.0
13	Side Channel	0	0.0
14	Plunge Pool Tailout	1	2.3
15	Falls	0	0.0
Total Habitat Units		**44**	

Reach 5 (RM 4.9-5.1)			
Code	**Habitat Type**	**Frequency**	**% of Total**
1	Pool	1	6.3
2	Lateral Pool	0	0.0
3	Plunge Pool	3	18.8
4	Glide	6	37.5
5	Riffle	0	0.0
6	Run	2	12.5
7	Boulder Garden	0	0.0
8	Chute	0	0.0
9	Rapid	0	0.0
10	Cascade	2	12.5
11	Braided Channel (1)	0	0.0
12	Split Channel (1)	0	0.0
13	Side Channel	0	0.0
14	Plunge Pool Tailout	2	12.5
15	Falls	0	0.0
Total Habitat Units		**16**	

Table 3-3. Proposed Instream Flow Study Sites and Transects

Reach 1: RM 0.0 – 0.7. Study Site at RM 0.1 – 0.3	
Transect	Transect Description
A	Glide
B	Run
C	Low Gradient Cascade/Run
D	Plunge Pool Tailout
E	Plunge Pool
F	Run
G	Plunge Pool Tailout
H	Low Gradient Cascade/Plunge Pool
I	Plunge Pool

Reach 2: RM 0.7 – 1.3. Reach 3: RM 1.3 – 3.5 Site at RM 1.25 – 1.5	
Transect	Transect Description
A	Chute
B	Plunge Pool
C	Run
D	Plunge Pool/Cascade
E	Plunge Pool Tailout
F	Plunge Pool
G	Pool Tailout/Glide
H	Wide Run

Reach 4: RM 3.5 – 4.9. Study Site at RM 4.03	
Transect	Transect Description
A	Glide Narrow Chute (cobble/boulder)
B	Narrow Cascade/Plunge Pool (boulder w/perched gravel)
C	Narrow Run (boulder w/perched gravel)
D	Pool Tailout/Glide (boulder/cobble)
E	Pool
F	Head of Pool below Cascade

Reach 5: RM 4.9 – 5.4. Study Site at RM 5.3	
Transect	Transect Description
A	Plunge Pool
B	Narrow Run (boulder and cobble)
C	Pool (bedrock on sides; cobble/gravel on margins)
D	Split Channel Glide (boulder/cobble)
E	Run (below plunge pool)
F	Split Channel Run w/lateral pool
G	Wide Glide
H	Wide Pool
I	Riffle (gravel/cobble)

4.0 REFERENCES

Powers, P.D. and J.F. Orsborn. 1985. Analysis of barriers to upstream fish migration. An investigation of the physical and biological conditions affecting fish passage success at culverts and waterfalls. Part 4 of 4. Bonneville Power Administration. Contract DE-A179-82BP36523. Project 82-14.

Washington Department of Fish and Wildlife. 2004. Draft Instream Flow Guidelines. June, 2004.

APPENDIX A

STATION DATA

APPENDIX B

PHOTOGRAPHS

APPENDIX C

SELECT TRANSECT PHOTOGRAPHS