

*Revised*

**Lake Creek Instream Flow and  
Habitat Assessment Study Plan  
for  
Energy Northwest's  
Packwood Lake Hydroelectric Project  
FERC No. 2244  
Lewis County, Washington**

Submitted to



**P.O. Box 968  
Richland, Washington 99352-0968**

Submitted by



**1155 North State Street Suite 700  
Bellingham, Washington 98225  
360.734.5915 phone, 360.734.5918 fax**

**August 22, 2005**

## TABLE OF CONTENTS

<b>Section</b>	<b>Title</b>	<b>Page</b>
1.0	INTRODUCTION .....	1
2.0	AGENCY AND TRIBE RESOURCE MANAGEMENT GOALS AND OBJECTIVES .	1
2.1	Washington Department of Ecology Goals and Objectives .....	1
2.2	USDA Forest Service.....	2
2.3	USFWS .....	2
2.3.1	Goals for Aquatic Ecosystems .....	2
2.3.2	Goals for Endangered, Threatened and Proposed Species.....	3
3.0	EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION .....	3
3.1	Existing Information .....	3
3.2	Need for Additional Information .....	4
4.0	NEXUS BETWEEN PROJECT OPERATIONS AND EFFECTS ON RESOURCES .....	4
5.0	STUDY AREA AND METHODS .....	4
5.1	Study Area .....	4
5.2	Methods.....	4
5.3	Products.....	5
5.4	Consistency with Generally Accepted Scientific Practice.....	5
5.5	Relationship with Other Studies .....	5
6.0	CONSULTATION WITH AGENCIES, TRIBES AND OTHER STAKEHOLDERS .....	5
7.0	PROGRESS REPORTS, INFORMATION SHARING, AND TECHNICAL REVIEW ..	6
8.0	SCHEDULE.....	6
9.0	LEVEL OF EFFORT AND COST .....	6
10.0	LITERATURE CITED .....	6

ATTACHMENT 1: Draft Study Plan, Lake Creek Instream Flow Study and Habitat Assessment

## **1.0 INTRODUCTION**

Energy Northwest's Packwood Lake Hydroelectric Project, FERC No. 2244, received its initial license in 1960. The majority of the Project is located within the Gifford Pinchot National Forest and consists of an intake canal, a concrete drop structure (dam) and intake building on Lake Creek located about 424 feet downstream from the outlet of Packwood Lake, a 21,691-foot system of concrete pipe and tunnels, a 5,621-foot penstock, a surge tank, and powerhouse with a 26,125 kW turbine generator.

The source of water for the Project, Packwood Lake, is a natural lake situated at an elevation of approximately 2,857 feet above mean sea level (MSL), about 1,800 feet above the powerhouse. Water is diverted from Lake Creek immediately below the drop structure at River Mile (RM) 5.3; water discharged from the Project is released to the Cowlitz River via a tailrace channel. Power from the Project is delivered over an 8,009-foot 69 kV transmission line to the Packwood substation.

This study will assess the relationship between flow and aquatic habitat in lower Lake Creek. The project can divert up to 260 cfs and modify the hydrology of lower Lake Creek. Flow and the rate of change are both significant aspects of stream habitat that are among the major effects of a hydroelectric project.

## **2.0 AGENCY AND TRIBE RESOURCE MANAGEMENT GOALS AND OBJECTIVES**

Washington Department of Ecology (Ecology), USDA Forest Service, and the U.S. Fish and Wildlife Service (USFWS) requested this study (WDOE 2005, USDA Forest Service 2005, USFWS 2005). Their resource management goals and objectives, as stated in their study requests, are provided below.

### **2.1 Washington Department of Ecology Goals and Objectives**

The goals of Ecology are explained in their governing laws and regulations and in federal laws and regulations governing water quality. Under the Federal Water Pollution Control Act (also known as the Clean Water Act, or CWA) a major objective is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Ecology is responsible for issuing a Water Quality Certification under section 401 of the CWA for the hydroelectric project, certifying that the licensee of the Project has provided reasonable assurance that State of Washington water quality standards will be met. The Washington water quality standards specifically include an anti-degradation standard to protect fish rearing, spawning, and migration, among the other listed beneficial instream uses. The Washington State Water Pollution Control Act (Revised Code of Washington 90.48) and the Water Quality Standards (Washington Administrative Code 173-201A) set out the requirements that must be met to protect water quality. These include protection of designated uses of the aquatic resource; compliance with narrative and numeric water quality criteria; and the application of all known, available, and reasonable methods of pollution control.

## 2.2 USDA Forest Service

The Aquatic Conservation Strategy (ACS), a core component of the Northwest Forest Plan, provides management direction aimed at maintaining or restoring the ecological health and function of watersheds and the aquatic ecosystems contained within them for the USDA Forest Service. Objectives 6 and 9 are stated as follows:

*Objective 6 – Maintain and restore instream flows sufficient to create and sustain riparian, aquatic and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.*

*Objective 9 – Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.*

## 2.3 USFWS

The USFWS seeks the accomplishment of several resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Recover federally proposed and listed species.
3. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.
4. Ensure that once the licensing process is complete, there is an adaptive management plan to allow the use of new information or new management strategies over the term of the license, bringing us closer to the desired level of protection for fish and wildlife resources. The adaptive approach is particularly appropriate where there are insufficient data and/or biological uncertainties about those measures that will be most effective for meeting ecosystem goals and objectives.

### 2.3.1 Goals for Aquatic Ecosystems

1. Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Maintain and/or restore aquatic habitat connectivity in the watershed to provide movement, migration, and dispersal corridors for salmonids and other aquatic organisms and provide longitudinal connectivity for nutrient cycling processes.
3. Restore naturally reproducing stocks of native anadromous and resident fish to historically accessible riverine habitat, using stocks that are native to the Cowlitz River basin where feasible, with priority given to the restoration of listed native stocks.

4. Provide an instream flow regime that meets the spawning, incubation, rearing, and migration requirements of wild salmonids and other resident fish and amphibian species, throughout the project area.
5. Meet or exceed federal and state regulatory standards and objectives for water quality in the basin.
6. Minimize current and potential negative project operation effects on water quality and downstream fishery resources.

### ***2.3.2 Goals for Endangered, Threatened and Proposed Species***

1. Reduce project effects on bald eagles, spotted owls, and other threatened, endangered, and proposed species.
2. Explore opportunities for potential protection, mitigation and enhancement measures for threatened, endangered, and proposed species.
3. If bull trout are discovered within the Cowlitz River basin, gain a better understanding on bull trout population trends, migration, habitat loss, present usage and continuing impacts as related to the Project.

In addition, an overarching USFWS goal for the new licensing of the Project is to succeed in having the Commission include as license conditions, protection, mitigation and enhancement measures that sustain normal ecosystem functional processes, including geomorphic, hydrologic and hydraulic patterns, and water chemical and physical parameters. Maintaining and improving these functional processes throughout the term of the new license will, in turn, provide the habitat to support healthy fish and wildlife populations.

USFWS study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop conservation measures, reasonable and prudent measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. § 1531 *et seq.*), the Fish and Wildlife Coordination Act (48 Stat. 401), as amended, (16 U.S.C. § 661 *et seq.*), and the Federal Power Act (FPA) (16 U.S.C. § 791a, *et seq.*).

## **3.0 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION**

### **3.1 Existing Information**

Lake Creek supports resident rainbow, and possibly cutthroat trout and other fish species, as well as several species of amphibians. Lower reaches of Lake Creek are accessible to anadromous salmonids, including Chinook salmon, coho salmon, steelhead, and sea-run cutthroat trout. All of these fishes and amphibians depend on aquatic habitat that is modified by changes in flow.

Existing information describing Lake Creek flows is contained in the Pre-Application Document (PAD), filed by Energy Northwest, pages 34-60 (Energy Northwest 2004). The Physical Habitat Assessment report and appendices are available on Energy Northwest's website at: <http://www.energy-northwest.com/gen/packwood/aquatic.html>.

### **3.2 Need for Additional Information**

Information is needed to discern whether the current level of flow in Lake Creek below the drop structure, at different times of the year, is adequate to protect and enhance fish and amphibian populations.

## **4.0 NEXUS BETWEEN PROJECT OPERATIONS AND EFFECTS ON RESOURCES**

The current license requires a minimum instream flow in Lake Creek of 3 cfs below the drop structure, with a flow at the mouth of Lake Creek of 15 cfs. Pre-project flows were higher. The reduced flows have the potential to limit the viability of resident fish and amphibian populations as well as the spawning and rearing success of anadromous fish near the mouth of Lake Creek.

## **5.0 STUDY AREA AND METHODS**

### **5.1 Study Area**

The Study area is Lake Creek from the drop structure downstream to its confluence with the Cowlitz River.

### **5.2 Methods**

An Instream Flow Study was initiated in 2004, conducted according to the Instream Flow Study Guidelines of the Washington Department of Fish and Wildlife and the Washington Department of Ecology (<http://www.ecy.wa.gov/programs/wr/instream-flows/Images/pdfs/isfgdraft%206-03.pdf>). The study results will include wetted area and wetted width, to examine refuge habitat for young-of-year in relation to different flow levels. Information regarding the drainage area and the confluence river mile of the major tributaries that flow into Lake Creek will be provided in order to determine the flow quantity contributed by the tributaries. Field calibration data have already been collected.

A total of 11 falls and 23 chutes were identified by the Forest Service in 1993 and confirmed by EES Consulting in 2004. Study of potential barriers on Lake Creek is being conducted under the Fish Passage Barriers and Fish Population Characterization Near the Drop Structure study plans.

Energy Northwest has been consulting with the agencies and tribes for over a year on the instream flow study, with consultation continuing on an ongoing basis. The protocol developed in consultation with the Water Quality and Aquatics Resources Committee is included as Attachment 1.

The Instream Flow Study was conducted in 2004; however, the highest flows that could be released by the Project downstream of the drop structure were 32 – 34 cfs. Flows of that level allow modeling hydraulically up to approximately 80 – 90 cfs at the drop structure. The agencies and tribes requested a release of higher flows in an effort to potentially model up to 260 cfs at the drop structure, which is equal to the certificate of surface water right issued to the Project.

Energy Northwest has tentatively scheduled a planned overtopping of the drop structure for June 2006 (weather and inflow dependent) to address flow needs for this study as well as the Fish Passage Barriers, Gravel Transport, and Large Wood study plans. June is the month in which the inflow to Packwood Lake is the greatest and when most overtopping events have occurred naturally; therefore, impact on spawning anadromous salmonids or emerging fry should be minimized.

EES Consulting is continuing to collect preference curve data to be used in the Lake Creek hydraulic models.

### **5.3 Products**

The products of the Instream Flow Study will be draft and final reports. Draft copies of the Instream Flow Study will be provided to the agencies and tribes for review and comments. The final study report will be provided to the agencies and tribes.

### **5.4 Consistency with Generally Accepted Scientific Practice**

The Instream Flow study is being conducted according to established protocols agreed to by the agencies and tribes as part of the Water Quality and Aquatics Resources Committee consultations.

### **5.5 Relationship with Other Studies**

Results from the Lake Creek Instream Flow and Habitat Assessment, Fish Population Characterization Near the Drop Structure, Fish Distribution and Species Composition, Anadromous Salmonids Habitat and Spawner Survey, Amphibian Survey, Fish Passage Barrier, Large Wood, Gravel Transport, and Water Quality studies will be considered in determining impacts to Lake Creek from the Project.

## **6.0 CONSULTATION WITH AGENCIES, TRIBES AND OTHER STAKEHOLDERS**

Energy Northwest initiated agency consultation in December 2003. A Water Quality and Aquatic Resources Committee was formed in March 2004. Current representatives include staff from Energy Northwest, EES Consulting, Watershed Dynamics, WDFW, USFWS, NOAA Fisheries, Department of Ecology, the Forest Service, the Cowlitz tribe, and the Yakama Nation. The Committee was consulted on the Draft Study Plan, Lake Creek Instream Flow Study and Habitat Assessment (Attachment 1) and the transect selections, and was provided with the results of the physical habitat assessment. Consultation is expected to continue throughout the relicensing period. Draft copies of the study will be provided to the agencies and tribes for review and comments. The final study report will be provided to the agencies and tribes.

## **7.0 PROGRESS REPORTS, INFORMATION SHARING, AND TECHNICAL REVIEW**

Technical reports, including the draft and final Instream Flow reports will be shared with agencies, tribes, and other stakeholders. Energy Northwest and its consultant will also report on the methods, progress, and results of the study at Water Quality and Aquatic Resources Committee meetings.

## **8.0 SCHEDULE**

Instream flow study hydraulic data collection was completed in 2004 for release flows at the drop structure of 3 cfs, 13 cfs, and 33 cfs. Data collection for preference curve development and verification is ongoing. An additional high flow water surface elevation survey is tentatively planned for June 2006. Model calibration and agency consultation regarding preference curves and model calibration will be conducted in fall/winter 2006 and spring 2007. Study site weighting is pending the results of the Fish Passage Barriers report for study site segmentation.

## **9.0 LEVEL OF EFFORT AND COST**

Approximately \$67,210 was spent on Lake Creek Instream Flow studies, including the Physical Habitat Assessment in 2004. Remaining tasks include completion of preference curve data, transect calibration, hydrologic analysis, consultation with the agencies and tribes, and draft and final report writing. Energy Northwest has also agreed to attempt a planned spill, tentatively in spring 2006, to get an additional measurement at a higher flow. It is estimated that it will take three days of releases to secure the necessary measurements at the four sites, plus the time to develop site-specific hydrology, calibrate the models, develop preference curves from collected data, and to write the report. Estimated costs for completing this task are approximately \$39,131, excluding the cost of lost generation.

## **10.0 LITERATURE CITED**

EES Consulting. 2004. Draft Lake Creek Physical Habitat Assessment Survey. June, 2004.  
Available at: <http://www.energy-northwest.com/gen/packwood/aqautic.html>.

Energy Northwest. 2004. Pre-Application Document, Supplement No. 1 and Notice of Intent. Richland WA. December 6, 2004.

USDA Forest Service. 2005. Letter dated March 11, 2005 from Claire Lavendal to Magalie R. Salas, Comments on PAD and Scoping Document 1 and Study Requests Packwood Lake Project No. 2244-012.

US Fish and Wildlife Service (USFWS). 2005. Letter dated March 11, 2005 from Ken S. Berg to Magalie R. Salas, U.S. Fish and Wildlife Service Comments on the Pre-Application Document, Scoping Document 1, and Study Requests for the Packwood Lake Hydroelectric Project, Federal Regulatory Commission Project # P-2244-012.

Washington Department of Ecology. 2005. Attorney General of Washington, Ecology Division. Study Plan Request: Lake Creek Instream Flow and Habitat Assessment. March 11, 2005.

Washington Department of Fish and Wildlife/Washington Department of Ecology. WDFW and WDOE. 2003. Draft Instream Flow Guidelines: Technical and Habitat Suitability Issues. 64 pp. <http://www.ecy.wa.gov/programs/wr/instream-flows/Images/pdfs/isfgdraft%206-03.pdf>.

Washington Department of Fish and Wildlife (WDFW). 2005. Letter dated March 9, 2005 from Lauri Vigue to Magalie R. Salas, Packwood Lake Hydroelectric Project, FERC No. P-2244-012 “Comments on the Pre-Application Document”, “Study Requests”, and “Comments on Scoping Document 1”.

**ATTACHMENT 1**

**Draft Study Plan  
Lake Creek Instream Flow and Habitat Assessment**

**ENERGY NORTHWEST  
PACKWOOD LAKE HYDROELECTRIC PROJECT**

**DRAFT STUDY PLAN  
LAKE CREEK INSTREAM FLOW STUDY AND  
HABITAT ASSESSMENT**

**401 WATER QUALITY CERTIFICATION**



**Prepared for**

**Energy Northwest  
For the Packwood Lake Hydroelectric Project  
(FERC No. 2244)**

**Prepared by**

**EES Consulting, Inc.**

**June 2004**



## Table of Contents

<b>Section</b>	<b>Title</b>	<b>Page</b>
1.0	Introduction.....	1
1.1	Study Purpose .....	2
1.2	Study Consultation.....	2
1.3	Existing Relevant Information.....	3
	1.3.1 Packwood Lake/Lake Creek Watershed .....	3
	1.3.2 Lake Creek Hydrology.....	5
	1.3.3 Physical Habitat Surveys .....	5
	1.3.4 Fish Species Composition and Abundance Surveys.....	6
	1.3.5 Cowlitz River Settlement Agreement .....	7
1.4	Relation to Other Studies .....	8
2.0	Study Objectives .....	8
3.0	Study Area .....	9
3.1	Study Reaches .....	9
4.0	Methods.....	10
4.1	Characterization of Reach Hydrology .....	10
4.2	Physical Habitat Assessment .....	10
	4.2.1 Physical Habitat Survey.....	10
4.3	Fisheries Population Assessment.....	13
	4.3.1 Electro-Fishing Surveys.....	14
	4.3.2 Snorkeling Surveys .....	15
	4.3.3 Anadromous Salmonid Spawner Surveys.....	15
4.4	Instream Flow Study Methods .....	15
	4.4.1 Instream Flow Incremental Methodology (IFIM) and Measurements .....	15
	4.4.2 Plunge Pool Methodology.....	17
	4.4.3 Preference Curve Development .....	18
4.5	Ramping Rates for Project Tailrace.....	19
4.6	Evaluation of Packwood Lake Level Manipulations on Aquatic Habitat in Tributaries .....	20
5.0	Actions .....	20
6.0	Schedule.....	21
7.0	References.....	22

## List of Tables

<b>Table</b>	<b>Title</b>	<b>Page</b>
1-1	Packwood Lake Hydroelectric Project Fish, Aquatics and Instream Flow Committee .....	3
1-2	Lake Creek Meristics per USFS Survey, 1993 .....	5
1-3	Lake Creek Relative Fish Abundance by Reach.....	6
1-4	Rainbow Trout Spawner Surveys, Tributaries to Packwood Lake .....	7
4-1	Habitat Type Coding and Description .....	11
4-2	Preliminary Fish Utilization and Target Species and Life Stages by Location within the Packwood Lake Study Area.....	14

## List of Figures

<b>Figure</b>	<b>Title</b>	<b>Page</b>
1-1	Packwood Lake Project Area.....	4
1-2	Lake Creek Longitudinal Profile .....	6

# **PACKWOOD LAKE HYDROELECTRIC PROJECT**

## **DRAFT STUDY PLAN LAKE CREEK INSTREAM FLOW STUDY AND HABITAT ASSESSMENT**

### **1.0 INTRODUCTION**

Energy Northwest, a municipal corporation and joint operating agency of the State of Washington, operates the Packwood Lake Hydroelectric Project (Project) near the town of Packwood in Lewis County, Washington. The Federal Energy Regulatory Commission (FERC) licensed the Project on July 7, 1960 (effective March 1, 1960), designated as Federal Power Commission License No. 2244. As owner of the Project, Energy Northwest intends to file an application for a new license pursuant to the regulations issued by FERC in 2003, which established the Integrated Licensing Process (ILP). Under the ILP regulations, a license applicant must file a Notice of its Intent (NOI) to file a license application no less than five years before the current license expires. At that time, the licensee must also submit to FERC and the resource agencies, a Pre-Application Document, containing existing, relevant, and reasonably available information describing the existing environment and the potential effects of the licensee's intended project proposal, including proposed project facilities and operations. Based upon resource information and potential impacts, the licensee must provide a preliminary list of studies that relate to the identified resource issues.

Among the purposes of the ILP is to foster an efficient and collaborative approach to determining project effects and appropriate protective measures. In that spirit, Energy Northwest has taken a proactive approach to relicensing its Packwood Lake Hydroelectric Project by initiating collaborative scoping of studies to develop the data and analyses that will be required for issuance of the water quality certification by the Washington Department of Ecology (WDOE) under Section 401 of the Clean Water Act.

The Project is located east of the community of Packwood in the Cascade Mountains (see Figure 1-1). Packwood Lake lies within the Gifford Pinchot National Forest. The Project includes: a drop structure, which regulates lake surface elevation and is located a short distance downstream from the natural outlet of the Lake; an intake structure; an approximately 23,000 ft-long, partially subterranean flowline; a surge tank; a 6,000 ft-long penstock; and a powerhouse (turbine-generator rated at 27,500 KVA). The powerhouse is located at the base of the mountain adjacent to the community of Packwood. The powerhouse tailrace flow discharges into a constructed stilling basin. It then travels through a lined tailrace channel about 8,000 ft in length to its confluence with the Cowlitz River. The tailrace includes a 200 ft highway culvert and 360 ft flume over Hall Creek.

The Project is operated in a baseload manner depending upon water availability and power contracts. The Project has a water right for 260 cfs but the Project does not operate at capacity at

all times. Average power production is 10 Mw relative to a turbine generator rated at 27,500 KVA.

The total area drained by Lake Creek and Packwood Lake amounts to approximately 12,288 acres (19.2 square miles) at the drop structure and 16,960 acres (26.5 square miles) upstream of the confluence of Lake Creek and the Cowlitz River. The total surface area of the lake is 452 acres (0.7 square miles). The natural lake elevation (El) is 2,857 ft MSL, which is approximately 1,800 ft above the powerhouse. The Project seasonally regulates the lake level so that it is at El 2,857 ft  $\pm$ 6" in summer recreation months and drawn down to no lower than El 2,849 ft MSL during winter months. This provides 8 ft vertical storage usable by the project. When lake level rises above the drop structure crest elevation and the intake is at capacity (or not operative), the flow passes over the drop structure into Lake Creek downstream of the lake. Currently, the FERC license for the Project requires a minimum instream flow of 3 cfs, at the drop structure immediately downstream of the outlet of Packwood Lake. There is also an instream flow requirement of 15 cfs at the confluence of Lake Creek with the Cowlitz River. Energy Northwest is not currently required to measure this flow.

## **1.1 Study Purpose**

The purpose of this study is to develop information to support the 401 water quality certification, to be issued by the Washington Department of Ecology (WDOE), necessary for operation of the Project under a new FERC license. The Parties taking part in this collaborative scoping process will use the results of these studies 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.

## **1.2 Study Consultation**

This study plan is prepared for the Packwood Lake Hydroelectric Project Fish, Aquatics, and Instream Flow Committee (Committee), which is an informal group formed to collaboratively design and implement aquatic studies that will support the application for 401 water quality certification of the Project. Table 1-1 lists Committee members and their respective representatives. Membership of the committee is composed of technical representatives who can commit to attend planned meetings. Other representatives will be informed of all technical meetings and are invited to attend.

**Table 1-1  
Packwood Lake Hydroelectric Project Fish, Aquatics and Instream Flow Committee**

<b>Organization</b>	<b>Representative</b>
Energy Northwest	Ms. Laura Schinnell
U.S. Forest Service (USFS)	Ms. Bernice Kasko
	Mr. John Roland
	Ms. Ruth Tracy
	Mr. Carl Corey
	Mr. Ken Wieman
Washington Department of Fish and Wildlife (WDFW)	Ms. Margaret Beilharz
	Mr. Dean Grover
	Ms. Lauri Vigue
Washington Department of Ecology (WDOE)	Dr. Hal Beecher
	Ms. Deborah Cornett
NOAA-Fisheries	Mr. Rusty Post
US Fish and Wildlife Service	Mr. Blane Bellerud
Cowlitz Tribe	Ms. Lou Ellyn Jones
Confederated Tribes and Bands of the Yakama Nation	Mr. Mike Iyall
	Mr. George Lee
FERC	Mr. Ken Hogan
	Dr. Frank Winchell
EES Consulting (EESC)	Mr. John Blum
	Mr. Kent Doughty

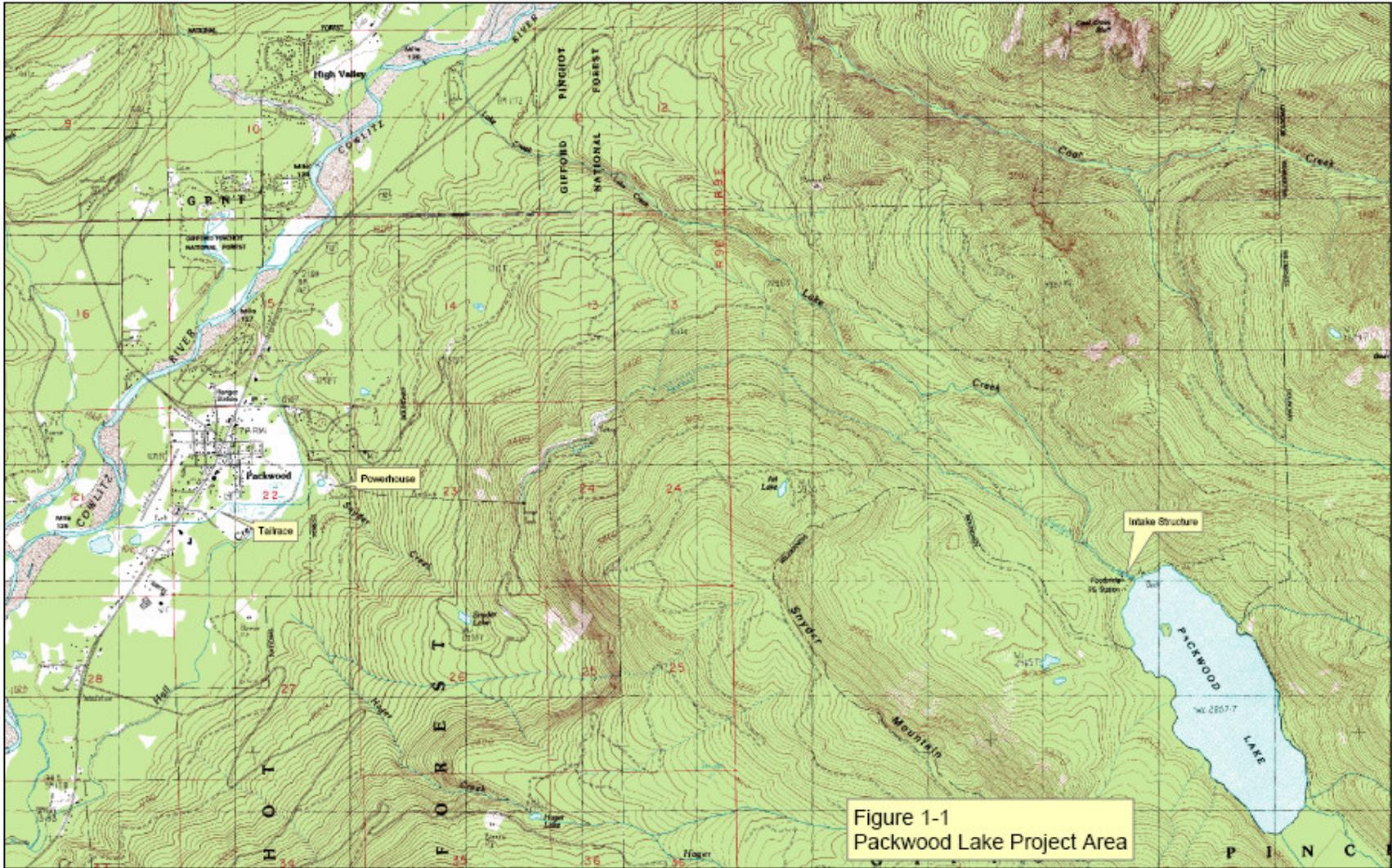
### **1.3 Existing Relevant Information**

#### ***1.3.1 Packwood Lake/Lake Creek Watershed***

The natural elevation of Packwood Lake lies at 2,857 ft, approximately 1,800 ft above the Project powerhouse. Packwood Lake and Lake Creek are bounded on the southwest by Snyder Mountain, elevation 5,030 ft, and on the northwest by mountain ridges with elevations ranging to 5,300 ft (Washington Public Power Supply System 1971).

Originating as rainfall and snowmelt in the Goat Rocks Wilderness Area and the Cascade Mountains draining into Packwood Lake (surface area of 452 acres), Lake Creek flows to the northwest approximately 5.3 miles to the upper Cowlitz River, Lewis County, Washington. Lake Creek empties into the upper Cowlitz River at approximately River Mile 129.2. The Packwood Lake drainage is mostly contained within the Gifford Pinchot National Forest boundary (the first 0.7 miles are private lands).

The gradient of Lake Creek is relatively high, averaging about 6.3% from the lake to its confluence with the Cowlitz River. Segment gradients range from a low of about 2% immediately upstream the confluence of Lake Creek with the Cowlitz River to 20% in the canyon reach.



### 1.3.2 Lake Creek Hydrology

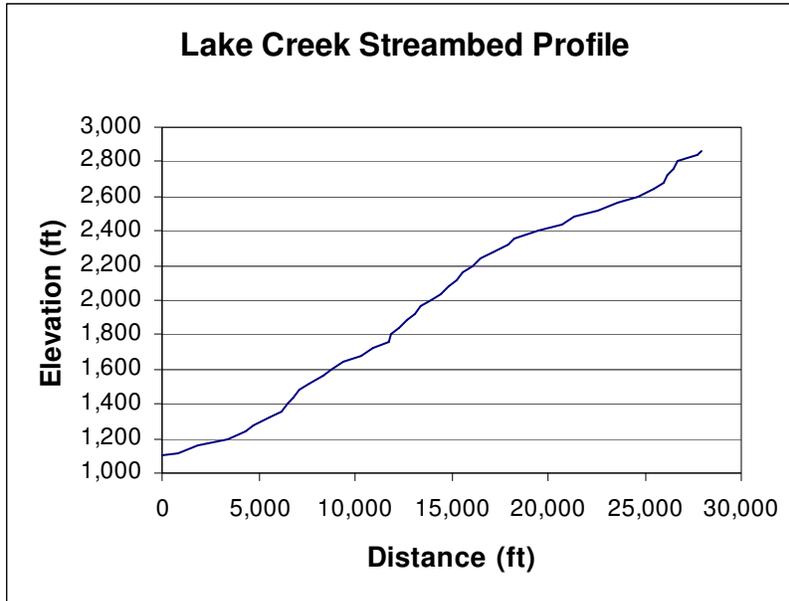
Two USGS gaging stations have been operated on Lake Creek. The gage immediately downstream of the drop structure (No. 14225500 – El. 2,844.62 ft – 18,555 daily flows) operated from October 1, 1911 through September 30, 1980, with a drainage area of 12,288 acres (19.20 square miles). Another gage was operated from September 1, 1907 through November 22, 1977, upstream from the confluence of Lake Creek with the Cowlitz River (No. 14226000 – El. 1,190.0 ft – 7,798 daily flows), with a drainage area of 16,960 acres (26.50 square miles). Mean annual flow as measured at the drop structure was 101.5 cfs. Details concerning hydrology for Lake Creek are included in a separate hydrology report published in June 2004.

### 1.3.3 Physical Habitat Surveys

In 1993, the USFS conducted physical habitat surveys of Lake Creek from the outlet of Packwood Lake downstream to its confluence (USFS 1993). USFS divided Lake Creek into six reaches based upon the geomorphology of the creek. In the surveys, the USFS indicated the presence of numerous falls (11) and chutes (23) throughout the entire reach. The USFS determined that Lake Creek has 1.9 miles of potential anadromous habitat, and 5.4 miles of resident rainbow habitat.

Table 1-2 summarizes study reach meristics as evaluated by the Forest Service. Figure 1-2 depicts the longitudinal gradient of Lake Creek from its mouth to Packwood Lake.

<b>Table 1-2 Lake Creek Meristics per USFS Survey, 1993</b>						
<b>Meristic</b>	<b>Reach 1</b>	<b>Reach 2</b>	<b>Reach 3</b>	<b>Reach 4</b>	<b>Reach 5</b>	<b>Reach 6</b>
Length (miles)	0.7	0.9	0.9	0.9	1.8	0.5
Gradient (%)	3	10	8	8	5	8
Bankfull Width (ft)	10.81	15.63	17.62	28.91	10.90	23.64
Substrate	Sm. Bldr, cobble	Sm, Lg bldr.	Sm bldr, gravel	Lg bldr, cobble	Cobble, gravel	Cobble
Pools/Mile	37.1	40.0	28.9	41.1	31.7	44.0
LWD/Mile	0.0	6.3	9.2	18.1	16.5	7.4
Fish Species	Rainbow Tr.	Rainbow Tr.	Rainbow Tr.	Rainbow Tr.	Rainbow Tr.	Rainbow Tr.



**Figure 1-2. Lake Creek Longitudinal Profile**

#### 1.3.4 Fish Species Composition and Abundance Surveys

The USFS, as part of the physical habitat surveys, conducted snorkeling surveys of Lake Creek in 1993. Results indicated that only rainbow trout (*Oncorhynchus mykiss*) were present in Lake Creek, with a total of 464 observed (28% adult; 72% juvenile). Table 1-3 summarizes the results of this survey. Surveys by the USFS and others were conducted prior to the reintroduction of anadromous salmonids in the upper Cowlitz River watershed. Information regarding the current distribution and species composition of the fish assemblages downstream of the anadromous barrier is lacking.

<b>Table 1-3 Lake Creek Relative Fish Abundance by Reach<sup>1/</sup></b>				
Reach	Species	Adult	Juvenile	Total
1	Rainbow	3	1	4
2	Rainbow	14	40	54
3	Rainbow	16	39	55
4	Rainbow	52	116	168
5	Rainbow	28	90	118
6	Rainbow	18	47	65
Total		131	333	464

<sup>1/</sup> From USFS snorkeling surveys 1993

WDFW has also conducted rainbow trout spawner surveys in tributaries to Packwood Lake. These include Osprey Creek, Trap Creek, Muller Creek, and a tributary to Upper Lake Creek (WDFW 1999, 2000). Table 1-4 summarized information from WDFW regarding rainbow trout spawner surveys of tributaries to Packwood Lake from 1979 – 2003.

**Table 1-4  
Rainbow Trout Spawner Surveys, Tributaries to Packwood Lake<sup>1/</sup>**

Date	Osprey Creek	Trap Creek	Muller Creek	Tributary to Upper Lake Creek	Beaver Bill Creek	Small Trib.SE of Trap Creek	Total
1979	-	-	194	-	-	-	194
6/18/81	16	18	67	5	-	-	106
6/29/82	-	0	0	0	-	0	0
6/20/83	0	-	0	-	-	-	0
1984	-	-	55	317	-	40	412
6/26/85	3	0	14	200	-	0	217
6/27/86	-	-	13	112	-	-	125
6/9/87	-	-	78	332	-	-	410
6/16/88	-	180	61	721	-	4	966
6/14/89	490	160	180	405	82	5	1322
6/15/90	24	5	149	60	-	-	238
6/19/91	314	94	399	363	-	0	1170
6/20/95	1	0	86	166	-	-	253
6/28/96	0	3	299	238	-	-	540
6/25/97	29	13	590	214	-	-	846
6/24/98	28	9	374	220	-	-	631
7/6/99	19	30	155	107	-	-	311
6/29/00	355	27	249	153	-	-	784
6/25/02	138	60	414	265 <sup>2/</sup>	-	8	885
6/25/03	181	6	201	305	-	0	693

<sup>1/</sup>From WDFW spawner surveys

<sup>2/</sup>An estimated 150 were grouped at the mouth; these were not counted.

A dash indicates no survey

### **1.3.5 Cowlitz River Settlement Agreement**

Tacoma Public Utilities entered into a Settlement Agreement on August 10, 2000, to resolve natural resource issues associated with the relicensing of its Cowlitz River Project (consisting of Barrier, Mossyrock and Mayfield dams), located downstream of the Packwood Lake Hydroelectric Project. Parties to the Settlement Agreement include the City of Tacoma, Washington, Department of Public Utilities, Light Division; Washington Department of Fish and Wildlife (WDFW), Washington Department of Ecology (WDOE), Washington State Parks and Recreation Commission; United States Fish and Wildlife Service (USFWS), National Marine Fisheries Service (now NOAA Fisheries), United States Forest Service (USFS) - Gifford Pinchot National Forest, Interagency Committee for Outdoor Recreation (IAC), Lower Columbia Fish Recovery Board, Lewis County, Confederated Tribes and Bands of the Yakama Nation (CRITFC), Trout Unlimited, and American Rivers.

As part of the Cowlitz River Project Settlement Agreement, anadromous fish are to be reintroduced into the upper Cowlitz River above Barrier, Mayfield, Mossyrock and Cowlitz Falls dams via trap-and-haul. The target species are Chinook (*O. tshawytscha*) and coho (*O. kisutch*)

salmon, and steelhead trout (*O. mykiss*). There are also plans to release cutthroat trout (*O. clarki*) above the dams. Fish are also passed above the Cowlitz Falls Hydroelectric Project, owned and operated by Lewis County PUD.

#### **1.4 Relation to Other Studies**

Information relevant to evaluating instream flow issues for this reach will also be incorporated into the 401 Water Quality Certification Study.

Information on rainbow trout spawning timing and access to habitat in Packwood Lake tributaries can be gathered while collecting Packwood Lake water quality data.

## **2.0 STUDY OBJECTIVES**

Currently, the FERC license for the Project requires a minimum instream flow of 3 cfs, at the drop structure immediately downstream of the outlet of Packwood Lake. There is also an instream flow requirement of 15 cfs at the confluence of Lake Creek with the Cowlitz River. Energy Northwest is not currently required to measure the instream flow. The overall objective of this study is to develop information that supports the continuation of these instream flow requirements (issued as part of the 401 certification) for Project operation under a new FERC license. Specific study objectives are:

- Document the location and physical attributes of the most downstream barrier in Lake Creek to upstream anadromous fish passage.
- Quantify the rate of water elevation (stage) change in the Cowlitz River side channel that receives the Project tailrace flow resulting from Project startup and shutdown as well as variable flows due to normal Project operations, and document the associated rate of change in stage and other key physical attributes of this side channel, and
- Quantify the relationship between flow and habitat for all life stages of target species by conducting an instream flow study. In order to quantify this relationship, Energy Northwest will:
  - Use existing hydrologic records for Lake Creek downstream of Packwood Lake to define the seasonal and annual hydrologic regime, including estimates of accretion.
  - Use existing habitat survey data and data from supplemental habitat surveys to define study reaches and study transects that are representative of the habitat variability within Lake Creek downstream of the drop structure at the lake outlet.
  - Use existing information and supplemental surveys to document the relative abundance, distribution and species composition for resident and anadromous fish in Lake Creek between the outlet at Packwood Lake and the stream's confluence with the Cowlitz River.
  - Identify target species for conducting instream flow studies in Lake Creek downstream of the drop structure at the lake outlet.

- Evaluate the effect of Project manipulation of the level of Packwood Lake on aquatic habitat in lake tributaries and aquatic connectivity between the lake tributaries.

### **3.0 STUDY AREA**

The Lake Creek Instream Flow Study Area will extend from the drop structure, a short distance downstream of Packwood Lake (RM 5.3) downstream to the confluence of Lake Creek with the Cowlitz River (approximate RM 129.2). This study will also address ramping rates for the Project tailrace (including the backwater slough). The tailrace carries water about 8,000 ft from the Powerhouse to where it joins the Cowlitz River at approximately RM 125.2.

Rainbow trout are known to inhabit Lake Creek and Packwood Lake. The Cowlitz River Project Settlement Agreement includes the upstream passage of spring Chinook and coho salmon, as well as steelhead and cutthroat trout to areas above the City of Tacoma and Lewis County PUD dams. Currently, only rainbow trout are known to utilize Lake Creek. Coho salmon have been observed in the Project tailrace and salmonid fingerlings were observed in Lower Lake Creek during an April 22 site visit.

The study area for Lake Creek includes only Lake Creek and its associated habitats (i.e., edge and mid-channel). This study area does not encompass any of Lake Creek's tributaries or their associated habitats.

#### **3.1 Study Reaches**

As mentioned above, USFS conducted physical habitat surveys of Lake Creek in 1993. The information was very detailed and provided baseline data from which to compile habitat frequencies for the instream flow study transect selection and study site and transect weighting. Physical habitat surveys were conducted in April and May of 2004; a physical habitat assessment report was published in June 2004.

Energy Northwest has segmented Lake Creek below the drop structure into five study reaches:

- Reach 1: Lake Creek from confluence of the Cowlitz River upstream to RM 0.7 (FS boundary)
- Reach 2: From the FS boundary upstream to RM 1.3 (upper end of lower canyon)
- Reach 3: RM 1.3 – 3.5
- Reach 4: RM 3.5 – RM 4.9, and
- Reach 5: RM 4.9 to the Packwood Lake drop structure

Reach segmentation is described in physical habitat assessment report distributed in June 2004.

### **4.0 METHODS**

The methods for the instream flow study are designed to compile and acquire information on:

- Hydrologic regimes in Lake Creek downstream of Packwood Lake
- Distribution of geomorphic channel types and meso-habitat types and barriers to upstream migration of anadromous and resident species
- Fish relative species composition, distribution and abundance including life history periodicity of rainbow and cutthroat trout\*, spring chinook and coho salmon\* and steelhead trout\* (\*depending upon species reintroduction per the Cowlitz River Project Settlement Agreement).
- Hydraulic and habitat geometry relationships (stage, depth, wetted perimeter, velocity, substrate and cover as a function of discharge) over the range of flows modeled and habitat suitability indices (HSI) for salmonid species/life stage of interest (depth, velocity, substrate, cover)

#### **4.1 Characterization of Reach Hydrology**

Hydrologic records and project operations will be analyzed to create hydrographs showing baseflows and effects of project operation by season. Overlapping data from both the upper gage station (No. 14225500) and the lower gage station (No. 14226000) will be correlated to determine the relative rate of inflow through the study reach.

#### **4.2 Physical Habitat Assessment**

##### **4.2.1 Physical Habitat Survey**

Physical habitat data are used to designate stream reaches and study transects. The habitat survey data also provide a basis for weighting the results from individual transects and study reaches when compiling habitat – flow relationships for the study stream.

The USFS surveyed habitat in this reach in 1993. Data from this survey, along with a ground-truthing, verification survey will be used to refine the descriptions of the physical habitats and the study reaches. Table 4-1 describes habitat type coding used in this survey.

**Table 4-1  
Habitat Type Coding and Description**

<b>Code</b>	<b>Habitat Name</b>	<b>Habitat Description</b>
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 standing wave at the hydraulic jump that occurs at the bottom as the flow rapidly decelerates into a pool, although 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.
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.

The purpose of the habitat assessments is to provide data in order to stratify the stream into study reaches and to select transects that represent the habitat types found within Lake Creek below the drop structure. A limited physical habitat survey of Lake Creek, beginning at the drop structure and proceeding downstream for the purpose of verifying current habitat condition was conducted in April and May 2004. Habitat was sampled every 150 ft down the stream thalweg. At each station, the following information was collected:

- Habitat type and description of sampled site
- Wetted channel width
- Bank full channel width
- Mean depth (sampled at ¼, ½, and ¾ of the width)
- Dominant and subdominant substrate
- Photographs of each habitat sampled

- Distance along stream (measured from drop structure or from the Lake Creek confluence with the Cowlitz River)
- Notations or comments of interest (i.e., presence of spring or inflow into creek)

Information gathered will be used in conjunction with the USFS sampling, stream profile maps, hydrology and location of anadromous barriers to segment the stream into study reaches, select potential transects, and determine study reach and transect weighting.

#### Anadromous Barrier Survey and Confirmation

Under the Settlement Agreement for the Cowlitz River Projects, anadromous salmonids are currently being re-introduced into the upper Cowlitz River. There is the potential for anadromous salmonids to utilize the lower portions of Lake Creek. A barrier survey was conducted concurrently with the physical habitat surveys to identify barriers to upstream passage for anadromous salmonids. The criteria, as established by Powers and Orsborn (1985) are proposed for use. Using the criteria in Powers and Orsborn (1985), steelhead trout have the greatest leaping ability, followed by Chinook and coho salmon.

The first total barrier to anadromous fish will be surveyed, photographed and measured, and its location noted. Other barriers (i.e., falls and chutes) will be documented on the physical habitat surveys; measurements of these barriers were previously collected by the USFS. Results will be presented to the Committee for review and approval.

#### Transect Selection and Segment Consolidation

Consolidation of stream segments is necessary to integrate the physical and biological attributes identified in the physical habitat surveys and to define a reasonable number of study sites for instream flow analysis.

Transect selection will be based primarily upon the results of habitat surveys. Transects are used to model fish habitat available or habitat important or critical to a species or life stage of interest. Criteria for transect selection include the following:

- a) The transect is representative of habitat types, respective micro-habitat features and/or critical habitat for target species and life stages within the study reach;
- b) Presence of physical features, such as vertical banks, which may hinder or facilitate measurements;
- c) Stream hydraulics amenable to accepted computer modeling methods; and
- d) Accessibility and safety.

A map showing stream reach delineations and transect locations is included in the physical habitat assessment report distributed in June 2004.

### 4.3 Fisheries Population Assessment

The Committee will consider the needs of the anadromous and resident salmonid species present in the Lake Creek and Project tailrace areas. Target species, or species of specific concern, and associated life stages of interest, have not yet been identified by the Committee.

The USFS snorkeled Lake Creek in 1993. Rainbow trout was the only species observed above and within the diversion reach of Lake Creek during snorkeling surveys. These surveys, however, were conducted before the Settlement Agreement was implemented for the Cowlitz River Project. Energy Northwest proposes to verify the presence (absence) of salmonids below the drop structure on Lake Creek.

Table 4-2 is a *preliminary* identification of fish utilization within the study area as well as target species and life stages for which flow-habitat relationships will be quantified. Target species, life stages and life-stage periodicity will be finalized after completion of population surveys and consultation with the natural resource agencies and tribes.

**Table 4-2  
Preliminary Fish Utilization and Target Species and Life Stages by Location Within the Packwood  
Lake Study Area<sup>1/</sup>**

Location	Species Present		Target	
	Species	Life Stage	Species	Life Stage
Packwood Lake and Tributaries	Rainbow Trout	Juvenile/adult Rearing Spawning	N/A	
Lake Creek from first anadromous barrier upstream to drop structure	Rainbow Trout	Juvenile/adult Rearing Spawning	Rainbow Trout	Juvenile/adult Rearing Spawning
Lake Creek from Cowlitz Confluence to first anadromous barrier	Rainbow Trout Coho Salmon <sup>2/</sup> Steelhead Trout <sup>2/</sup> Cutthroat Trout <sup>2/</sup> Spring Chinook Salmon <sup>2/</sup>	Juvenile/adult Rearing Spawning Juvenile Rearing <sup>2/</sup> Spawning <sup>2/</sup> Juvenile Rearing <sup>2/</sup> Spawning <sup>2/</sup> Juvenile/adult Rearing <sup>2/</sup> Spawning <sup>2/</sup> Juvenile Rearing <sup>2/</sup> Spawning <sup>2/</sup>	Rainbow Trout	Juvenile/adult Rearing Spawning
Project Tailrace <sup>3/</sup>	Rainbow Trout Coho Salmon <sup>2/</sup> Steelhead Trout <sup>2/</sup> Cutthroat Trout <sup>2/</sup> Spring Chinook Salmon <sup>2/</sup>	Juvenile/adult Rearing Spawning Juvenile Rearing <sup>2/</sup> Spawning <sup>2/</sup> Juvenile Rearing <sup>2/</sup> Spawning <sup>2/</sup> Juvenile/adult Rearing <sup>2/</sup> Spawning <sup>2/</sup> Juvenile Rearing <sup>2/</sup> Spawning <sup>2/</sup>	Rainbow Trout <sup>3/</sup>	

<sup>1/</sup> Preliminary Only. Species present and target species have not been agreed to. Final target species will be determined after consultation with the natural resource agencies and tribes.

<sup>2/</sup> Subject to implementation of the Cowlitz River Project Settlement Agreement.

<sup>3/</sup> Not subject to instream flow study; will be included in ramping rate evaluation.

A draft periodicity chart of salmonid species that may use the Project study area will be developed after consultation with the natural resource agencies and tribes.

Energy Northwest proposes to verify the presence and relative distribution of salmonids in Lake Creek downstream of the drop structure. A combination of electrofishing, snorkel surveys and spawner foot surveys will be conducted.

#### 4.3.1 Electro-Fishing Surveys

Where the creek is accessible and conditions are conducive to sampling at and below the first anadromous barrier, Energy Northwest will use an electro-fisher to determine relative species composition, distribution and abundance of salmonids in the potential anadromous zone. Habitat types associated with salmonids captured during these surveys will also be identified. Fish will be measured to the nearest mm and released. Electrofishing surveys are contingent upon securing the necessary permits from the appropriate natural resource agencies.

### **4.3.2 Snorkeling Surveys**

In areas above the first identified and confirmed anadromous barrier, Energy Northwest will sample accessible habitat types and estimate the length of the rainbow trout observed as well as any other identified resident salmonid species.

### **4.3.3 Anadromous Salmonid Spawner Surveys**

After consultation with the natural resource agencies and tribes, Energy Northwest will conduct spawner surveys for anadromous species that could potentially utilize Lake Creek. The purpose of these surveys will be to document presence or absence of spring Chinook, coho salmon or steelhead trout, as well as their spawning timing, if present.

## **4.4 Instream Flow Study Methods**

The primary method used to study the Lake Creek Study Area will be the standard USFWS Instream Flow Incremental Methodology (IFIM). Generally, instream flow study procedures will follow the WDFW Instream Flow Guidelines (WDOE and WDFW 2003). If the IFIM is found not to be applicable due to complex hydraulics, the Plunge Pool Methodology, initiated by Dr. Hal Beecher of WDFW, may be used.

### **4.4.1 Instream Flow Incremental Methodology (IFIM) and Measurements**

The IFIM is based on the premise that stream dwelling fish prefer a certain range of depths, velocities, substrates and cover types, depending on the species and life stage, and that the availability of these preferred habitat conditions varies with stream flow. With input from stream flow, substrate, and cover type measurements, the IFIM uses a set of computer programs developed by USFWS to quantify habitat availability over a range of flows. It is important for the water manager to recognize that the result of the study is not a set value but a range of values to be used as a tool for determining relative amounts of habitat available at various stream flows.

An instream flow study utilizing the IFIM will be conducted in the applicable reaches of Lake Creek. Protocols will follow those outlined in, “A Guide to Instream Flow Setting in Washington State” (WDOE and WDFW 2003).

Once transects and study reaches are approved by the natural resource agencies, Energy Northwest will employ the “three-flow” method for evaluating transects. In the “three-flow method,” three separate calibration flows are measured, with a full set of depth and velocity measurements at each flow. Water surface elevations and channel cross-sections will be surveyed, relative to benchmarks and headpins, at each flow with an auto-level and stadia rod. Where feasible, benchmarks of transects in each study site will be “tied together” by surveying their relative elevation.

Energy Northwest will hydraulically model the entire cross section of all transects in the Lake Creek Study Area. Water surface elevations will be taken at all calibration flows.

## Study Reaches

Study reaches were identified subsequent to the physical habitat surveys. A physical habitat assessment report, detailing study reaches and transects, was submitted to the committee in June 2004; study reaches and transects are being selected in consultation with and the approval of these parties prior to initiation of the instream portion of the study.

## Calibration Flows

Three calibration flows will be measured at each transect. Calibration flows will be referenced to releases from the drop structure located below the Packwood Lake outlet. Subject to further review of existing hydrologic information, Energy Northwest recommends a range of calibration flows, as shown below:

High Flow Measurement:	35 – 40 cfs <sup>1/</sup>
Middle Flow Measurement:	15 – 18 cfs
Low Flow Measurement:	6 cfs

<sup>1/</sup> Flow pattern and weather dependent.

## Target Modeling Range

When using the “three-flow” regression model, the goal is to be able to model 2.5 times the high-flow calibration measurement, and to 0.4 of the low-flow calibration measurement. Therefore, the target modeling range would be from approximately 3 cfs – 100 cfs at the upper end of the study reach (downstream of the drop structure); the model range would expand for downstream measurements to account for accretion. Existing hydrologic data will be analyzed to determine average seasonal accretion rates within the diversion reach of Lake Creek. Concurrent measurements will be taken at each study site during calibration flows.

## Water Surface Elevations

Water surface elevations (WSE) will be measured for each of the three calibration flows at each transect. WSE will be referenced to a benchmark for each transect. A stage/discharge relationship for each transect will be determined by the IFIM Subroutine, PHABSIM.

## Verticals/Velocity Measurements

Energy Northwest proposes three full velocity set measurements. As a general rule of thumb, there will be a minimum of 20 – 25 depth and velocity measurements taken at the low calibration flow, with correspondingly more measurements taken at both the middle and high calibration flows, due to more of the channel bed being inundated at higher flows.

Water Surface Elevations will be recorded at every flow measured, and the bottom profile will also be determined through surveying and depth measurements at each cell.

## Surveying Methods

Transect measurements will be tied to a semi-permanent benchmark at each transect. Where feasible, groups of transects will be tied together and/or referenced to a USGS benchmark if any are available in the vicinity. Thalweg depth will be noted. Slope and stage of zero flow will also be determined in the field. [Note: when the IFG4 Program is given three stage/discharge measurements, the model determines the slope of the reach from these measurements rather than from the input of slope in the data deck].

## Substrate and Cover Codes

WDOE and WDFW have standard substrate and cover codes in the Instream Flow Guidelines Report (2003). Energy Northwest will use these substrate and cover codes in the instream flow study and will include these in the final study plan.

## Modeling Parameters

As a rule of thumb, attempts are made to generally extrapolate to 40% of the low-flow calibration measurement and 250% of the high-flow calibration measurement in order to model a range of flows sufficient for analysis. Model performance and model calibration, use and extrapolation will be approved by the IFIM experts on the Committee. Energy Northwest will use standard and approved methods to calibrate models; calibration will be approved by WDFW and WDOE instream flow experts.

### ***4.4.2 Plunge Pool Methodology***

Where possible, instream flow studies using the IFIM will be employed. Where hydraulics are complex, this method may not work effectively. One circumstance where an alternative method may prove a more effective evaluation tool, is where the habitat consists mainly of plunge pools. In some high-gradient boulder or bedrock-channel streams, the only fish habitat is found in pools. If a plunge pool study is needed to address instream flows, methods can be found in WDOE and WDFW (2003).

The basic assumptions about habitat quality in pools are described below and in WDOE and WDFW (2003).

- Surface turbulence/bubble plume should cover about half the pool surface, and as plume coverage increases beyond, or decreases below, half the pool area, habitat quality will decline rapidly;
- Pools that are not covered by surface turbulence/bubble plume are valuable as habitat when depth equals or exceeds 0.5 feet or 10% pool width, whichever is greater, but any depth over 3.0 feet should be considered usable, subject to preference curve verification; and
- Spawning habitat response to changes in flow in pools is best assessed by using standard IFIM transects with depth, velocity, and substrate measurements near the tail of the pool.

Pool habitat for juvenile and adult trout should be calculated as:

$$\text{Habitat} = \text{area of calm, deep water} \times \text{preference for ratio of plume area to calm, deep area.}$$

Methods for the plunge pool study will follow protocols described in WDOE and WDFW (2003).

### Targeted Measured Flows

Generally, more calibrated flow measurements are required in the field to determine habitat relationships when using the Plunge Pool Method. If the Plunge Pool method is selected as part of the instream flow evaluation, Energy Northwest proposes to target flows similar to the calibration flow measurements in the IFIM study.

High Flow Measurement	35-40 cfs <sup>1/</sup>
Middle – High Measurement	25 - 28 cfs <sup>1/</sup>
Middle Flow Measurement	15-18 cfs
Low –Mid Flow Measurement	6 cfs
Low Flow Measurement	3 cfs

<sup>1/</sup> Flow pattern and weather dependent.

### Targeted Modeling Range

Energy Northwest proposes a similar extrapolation range as for the IFIM study. The targeted range of flows would be 3 cfs – approximately 100cfs, if a plunge pool study were to be required.

The Plunge Pool methodology is currently not being recommended for Lake Creek, since habitat types present can be effectively modeled using the Instream Flow Incremental Methodology.

#### ***4.4.3 Preference Curve Development***

WDOE and WDFW (2004) require that IFIM studies attempt to verify preference curves (also known as Habitat Suitability Indices (HSI) curves) during instream flow studies. Under ideal conditions, preference curves developed on site would be utilized in conjunction with state-wide (i.e. “fallback”) preference curves for species and life stages of interest.

It is anticipated that rainbow trout in the juvenile and adult life stages will be the targeted species for preference curve development, subject to consultation and agreement with the natural resource agencies and tribes. Energy Northwest will collect rainbow trout juvenile and adult rearing HSI data in Lake Creek during the summer 2004. Preference curve collection methodologies will be agreed upon by the Committee and will be presented in the Final Study Plan.

#### 4.5 Ramping Rates for Project Tailrace

Water leaves the powerhouse and is discharged into the tailrace, which extends approximately 8,000 ft until it reaches the upper Cowlitz River at approximately RM 125.2. The majority of the tailrace is lined with asphalt, in a trapezoidal-shaped channel that is 29 ft wide at the top and 9 ft wide at the base. In 1979, the lower portion of the tailrace was washed out in a storm event, when the main river channel carved a new channel and eroded the tailrace. In recent years, the Cowlitz reverted to its previous channel, transforming this lower portion of the tailrace into a very shallow backwater slough prior to emptying into the Cowlitz River. Screens, which had previously excluded fish from the tailrace, were washed out as well during the storm event. Coho salmon have been observed in the tailrace immediately below the powerhouse.

Plant shutdown results in significant changes in stage throughout the channelized portion of the tailrace. The changes in stage over time have not been quantified in the tailrace or in the backwater slough immediately above the confluence with the Cowlitz River. Flow fluctuations resulting in rapid decreases in stage can result in fish stranding, particularly in the slough below the channelized tailrace.

Energy Northwest proposes to conduct a ramping rate study in the slough below the channelized tailrace. In consultation with the natural resource agencies and tribes, Energy Northwest will:

- Install 2 stage recorders in the backwater slough to record changes in stage over the course of normal project operations.
- Survey transects in the vicinity of the stage recorders in order to define the bed profile.
- Water surface elevations will be surveyed and flows will be calculated at a range of discharges from the powerhouse.
- A stage-discharge relationship will be developed for each transect.
- During plants shut down for maintenance in October and other periods when flows may fluctuate significantly, rates of change in stage and wetted perimeter will be documented and examined.
- The stage recorders will be downloaded and data examined to determine rates of change in stage relative to tailrace flow and flow in the Cowlitz River.

These are the established ramping rates for systems with anadromous salmonids (Hunter 1992).

<b>Time Period</b>	<b>Day Time Rates</b>	<b>Night Time Rates</b>
February 16 – June 15	No ramping	2 in/hr
June 16 – October 31	1 in/hr	1 in/hr
November 1 – February 15	2 in/hr	2 in/hr

#### **4.6 Evaluation of Packwood Lake Level Manipulations on Aquatic Habitat in Tributaries**

The Project seasonally regulates the lake level so that Packwood Lake is at El 2,857 ft  $\pm$ 6" in summer recreation months and drawn down to no lower than El 2,849 ft MSL during winter months. This provides 8 ft vertical storage usable by the Project. Concern has been expressed that the lake level manipulation may affect aquatic habitat in lake tributaries and aquatic connectivity between the lake and tributaries. Rainbow trout are known to spawn in these tributaries to the lake. It is unknown what effect Project operations may have on the habitat within these tributaries and the movement of fish into and out of these tributaries. Questions that have been asked include:

- Are spawning and other important habitats at tributary mouths or in the fluctuation zone inundated or drained at times that may cause adverse affects to aquatic organisms?
- Does lake level manipulation restrict or prevent fish or other aquatic organisms access to and from the tributaries at times of year that are important to their life history?
- Does lake level manipulation result in excessive buildup of sediment at tributary mouths?

Energy Northwest proposes to survey the mouths of the creeks entering Packwood Lake during the first week in October when the lake is drawn down to its minimum level. Bed profiles will be surveyed from 1 ft below the minimum pool level to 4 ft above the maximum pool level to determine if upstream migration would occur if pool levels were low or intermediate. Surveyed profiles will be provided to the natural resource agencies and tribes. Energy Northwest will also note if there is excessive sediment buildup at the mouths of the tributaries that might prevent fish access to the tributaries at the range of lake levels experienced during Project operation.

#### **5.0 ACTIONS**

- Conduct physical habitat surveys (completed)
- Delineate study reaches (completed)
- Determine habitat type weighting
- Select preliminary transects for agency/tribal review (completed)
- Determine methods to be used to evaluate instream flows (completed)
- Complete draft periodicity chart
- Determine needs for site-specific HSI curves and which species
- Produce final study plan for agency and tribal approval
- Conduct instream flow studies

## 6.0. SCHEDULE

Milestone/Event	Date
Preliminary Agency/Tribal Meeting	March 22, 2004
Conduct Physical Habitat Surveys	April 14 – May 19, 2004
Produce final study plan	June 4, 2004
Agency Meeting to Discuss Comment Letters, Habitat Assessment; Site Visit to Approve Study Reaches and Transects	April 22, 2004
Meeting to Discuss Final Study Plans, Published Reports; site visit to Lake	June 24, 2004
Transect Setup	July 2004
High Flow Calibration Measurement (IFIM/PP*)	July 2004
Middle Flow Calibration Measurement (IFIM/PP*)	July – August 2004
Low Flow Calibration Measurement (IFIM/PP*)	July – August 2004
Ramping Rate Studies	May– October 2004
Tributary Studies	October 2004

\*Dependent upon flows and operational constraints. Plunge Pool measurements may not be required, contingent upon the habitat assessment and scoping.

## 7.0 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.
- Hunter, M.A. 1992. Hydropower flow fluctuations and salmonids: A review of the biological effects, mechanical causes, and options for mitigation. State of Washington Department of Fisheries, Technical Report No. 119, Olympia, WA.
- United States Forest Service (USFS). 1993. R-6 Stream Survey Level II. Lake Creek. Gifford Pinchot National Forest. Randle/Packwood Ranger Districts.
- Washington Department of Ecology (WDOE) and Washington Department of Fish and Wildlife (WDFW) (2004). Draft instream flow guidelines. Technical and habitat suitability issues.
- WDFW. 1999. Memo from Bob Lucas to John Weinheimer re: Packwood Lake rainbow trout spawner surveys.
- WDFW. 2000. Memo from Bob Lucas to John Weinheimer re: Packwood Lake rainbow trout spawner surveys.
- Washington Public Power Supply System (WPPSS). 1971. Environmental Report for Packwood Lake hydroelectric Project. No. 73.