

Revised

**Large Wood 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



**Watershed GeoDynamics
14145 97th Ave NE
Bothell, WA 98011-6905**

August 22, 2005

TABLE OF CONTENTS

Section	Title	Page
1.0	INTRODUCTION	1
1.1.	Study Goals and Objectives	1
2.0	AGENCY AND TRIBE RESOURCE MANAGEMENT GOALS AND OBJECTIVES ..	1
3.0	EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION	2
3.1	Large Wood in Packwood Lake.....	2
3.2	Previous Large Wood Surveys in Lake Creek.....	3
3.3	Need for Additional Information	3
4.0	NEXUS BETWEEN PROJECT OPERATIONS AND EFFECTS ON RESOURCES	3
5.0	STUDY AREA AND METHODS	4
5.1	Study Area	4
5.2	Summary of Modifications to Study Methods Requested by the Forest Service	4
5.3	Large Woody Debris Survey in Lake Creek.....	4
5.4	Assess Potential Large Wood Transport in Lake Creek	5
5.5	Feasibility Study of Moving Large Wood into Lower Lake Creek	6
5.6.	Develop Wood Management Plan	6
5.7	Products.....	7
5.8	Consistency with Generally Accepted Scientific Practice.....	7
6.0	CONSULTATION WITH AGENCIES, TRIBES AND OTHER STAKEHOLDERS	7
7.0	PROGRESS REPORTS, INFORMATION SHARING AND TECHNICAL REVIEW ...	7
8.0	SCHEDULE.....	8
9.0	LEVEL OF EFFORT AND COST	8
10.0	LITERATURE CITED	8

LIST OF TABLES

Table	Title	Page
5-1	Size Class Criteria for Large Woody Debris	4
5-2.	Large Woody Debris Source Criteria	5
5-3	Large Woody Debris Decay Class Criteria.....	5

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 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.

1.1. Study Goals and Objectives

The goal of this study is to develop sufficient information regarding large wood in Lake Creek to support Energy Northwest's application to FERC for relicensing the Packwood Lake Hydroelectric Project. The large wood study will assess how operation of the Packwood Lake Hydroelectric Project affects the supply and transport of large woody debris in Packwood Lake and in Lake Creek downstream of the drop structure. A wood management plan will be developed. The work will be conducted in consultation with members of the Water Quality and Aquatic Resources Committee (currently Energy Northwest, EES Consulting, Watershed GeoDynamics, Washington Department of Fish and Wildlife, Washington Department of Ecology, NOAA Fisheries, U.S. Fish and Wildlife Service, USDA Forest Service, the Cowlitz Indian Tribe, and the Yakama Nation).

Study objectives include:

- Inventory large wood in Lake Creek downstream of the drop structure.
- Assess large woody debris that collects behind the log boom.
- Assess wood recruitment and transport processes in Lake Creek downstream of the drop structure.
- Develop a wood management plan for the Packwood Lake Project.

2.0 AGENCY AND TRIBE RESOURCE MANAGEMENT GOALS AND OBJECTIVES

The USDA Forest Service requested this study (USDA Forest Service 2005). The Forest Service provided their resource management goals and objectives, which are presented below.

The Aquatic Conservation Strategy (ACS), a core component of the Northwest Forest Plan, provides Forest Service management direction aimed at maintaining or restoring the ecological health and function of watersheds (defined as HUC 5th field) and the aquatic ecosystems contained within them. Lake Creek drainage area is one subwatershed (defined as a HUC 6th

field) of the Upper Cowlitz River Watershed. Specifically, objectives 5, 6 and 9 are the most relevant to the large wood study. These objectives are stated as follows:

- Objective 5 – Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.
- Objective 6 – Maintain and restore in-stream 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.

The Forest Service's desired future condition is the maintenance of a sediment and flow regime in Lake Creek similar to pre-development conditions.

- Mimic the flow and sediment regimes which provide for the maintenance and enhancement of channel structure and habitat for aquatic and riparian dependent species.
- Re-establish and maintain the connectivity of the creek and lake system including physical and biological processes so that native aquatic species in the Lake Creek Subwatershed can utilize all available habitats and maximize their productivity levels.

3.0 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Large woody debris in aquatic systems can perform a number of important functions, including shaping channel morphology, storing sediment and organic matter, and providing habitat diversity for aquatic species. The size of wood necessary to function in a particular system depends on the size and dynamics of the stream.

Operation of the Packwood Lake Hydroelectric Project potentially can have two effects on large wood routing through the Lake Creek system:

1. Altering the movement of large wood through Packwood Lake by lowering lake levels and stranding floating large wood during portions of the year; and
2. Altering the transport of large wood through Lake Creek if peak flows capable of transporting large wood are not reached.

3.1 Large Wood in Packwood Lake

Packwood Lake was formed by a large landslide that blocked Lake Creek approximately 1100 years ago (Swanson 1996). Large wood transported from upstream reaches can either be transported through the lake by wind or water currents or can become lodged on lake shorelines under natural conditions. Large quantities of wood have accumulated along the shoreline at the head (southeastern end) of the lake. This can occur if the dominant wind direction is up the lake. Strong northwesterly winds would be needed to move large wood to the outlet of the lake. Packwood Lake levels are lowered at times between September 16 and April 30 for Project

maintenance and use of winter runoff. When lake levels are lowered, large wood that is lodged along the full pool shoreline is stranded and cannot be moved by wind or water currents. If lowered lake levels coincide with the only periods of northwesterly winds, Project alterations of lake levels could affect large woody debris movement through the lake.

Project operators collect all wood that reaches the log booms and place the logs along the shore of Packwood Lake, unless pieces are too large to be handled by two people. Operators report that approximately 20 logs 6-10 inches in diameter reach the drop structure in an average year. Larger logs are very rare (Baker 2005).

3.2 Previous Large Wood Surveys in Lake Creek

The USFS conducted a Level II stream survey in 1993, which included an inventory of large woody debris in Lake Creek downstream of the drop structure (Lofgren et. al, 1983). Wood within the wetted channel that was over 36 inches diameter measured at breast height (DBH) and 50 feet long (or twice the bankfull width in length) was counted. Smaller pieces of wood, and wood outside of the wetted channel were not counted. Large wood levels ranged from 0 to 16.5 pieces/mile. The USFS rated wood conditions as poor because wood levels were below the desired conditions of 80 pieces/mile.

Large wood was not inventoried during the Lake Creek Physical Habitat Assessment Survey (EES 2004). However, field personnel who conducted the survey report that although there is some large wood within the bankfull channel, larger quantities of downed wood span the incised channel above bankfull height.

3.3 Need for Additional Information

Discussions with agency representatives indicate that most large wood likely moves in lower Lake Creek during very large, infrequent high flow events. Based on observations in other natural lakes, it is hypothesized that prior to the installation of the drop structure, wood piled up in a log jam at the outlet of Packwood Lake and was transported into lower Lake Creek during high flow events when the log jam was fully or partially dislodged. Information on wood movement through Lake Creek is needed to determine if the Project affects wood movement, and if so, the best way to manage wood under the new license.

4.0 NEXUS BETWEEN PROJECT OPERATIONS AND EFFECTS ON RESOURCES

The study results will document existing instream large wood habitat characteristics in Lake Creek below the drop structure and assess how operation of the Project under the present operational plan affects large wood characteristics in Lake Creek during the period of the new license.

5.0 STUDY AREA AND METHODS

5.1 Study Area

The study area encompasses the outlet area of Packwood Lake and Lake Creek from the drop structure to the confluence with the Cowlitz River.

5.2 Summary of Modifications to Study Methods Requested by the Forest Service

The following deviations from the Forest Service study request are proposed in the present study plan. Additional information on large wood (source and decay class) is proposed to be collected during the field inventory to increase understanding of wood storage in the Lake Creek system. Large wood will be mapped and tagged at five study sites, rather than all large wood in Lake Creek. The Forest Service suggested tagging and locating all large wood in the creek using GPS. However, it is extremely unlikely that GPS will work within the steep, incised canyon in Lake Creek. One study site will be located in each of the five reaches delineated during the Physical Habitat Assessment Survey (EES Consulting 2004). If there is large wood present in the stream at the study sites chosen for the Gravel Transport Study, the large wood study sites will be in those locations because hydraulic modeling will provide information on water depths at high flows that could transport large wood. If large wood is not found at the gravel study sites, other areas with instream wood will be chosen. Tagging and mapping wood at five study sites will provide the necessary information for the wood transport study.

5.3 Large Woody Debris Survey in Lake Creek

A survey will be made of existing instream wood throughout Lake Creek downstream of the drop structure in conjunction with the gravel transport study. Wood with at least one end in the bankfull channel (as indicated by substrate and vegetation) will be counted as “in channel.” Wood that spans the channel or is leaning over the bankfull channel will be counted in the “potential input” category to provide a measure of future wood loading potential. Wood size classes will be assessed as small, medium or large based on the following criteria:

Size Class	Diameter	Length
Small	12 – 24 inches	> 25 feet
Medium	24 – 36 inches	> 50 feet
Large	>36 inches	> 50 feet

The Forest Service’s proposed length classes included pieces that were less than the prescribed length category, but more than twice bankfull width. This makes sense in extremely small channels. However, based on the Physical Habitat Assessment survey, the average bankfull width in Lake Creek is 53 feet, so the “twice bankfull” length condition would not apply very often, therefore this length class was not included.

Wood will be counted within 100-foot-long channel segments to provide information about longitudinal distribution of wood. Each wood piece that is counted will be assigned a source

category and a relative decay category to provide information on wood source areas and storage time in the system as follows:

Source Category	Criteria (based on May and Gresswell 2003)
Mass wasting	Deposit associated with landslide at the root end
Mortality or windthrow	Broken bole or uprooted tree (bole/roots on slope)
Bank erosion	Undercut trees; roots on bank
Fluvial transport	Bole within bankfull channel; cannot trace bole or roots to adjacent hillside
Unknown but local	Bole extends into adjacent forest, but no recruitment process can be identified

Decay Class	Criteria
Fresh	Bark intact, full limbs visible
Old	Bark over 50% gone or over 50% moss covered; many limb stubs visible
Very old	Bark gone, covered with moss, few or no limb stubs visible

Data collected during the large wood survey will provide information on the amount of large wood in Lake Creek as well as the source of wood (transported from upstream reaches or local) and persistence in the stream. This will aid in the assessment of potential wood transport in the creek.

5.4 Assess Potential Large Wood Transport in Lake Creek

Large wood transport dynamics in streams and rivers is very difficult to predict and model (Braudrick and Grant 2001). Most studies have found that there is little transport of large wood in small channels. Wood lengths must be shorter than the bankfull width to be transported (Flanagan 2004, Wohl 2000) and moving wood tends to be deposited in locations where the channel depth was less than the buoyant depth, at channel constrictions, and at bends (Braudrick and Grant 2001).

A qualitative assessment of the potential for large wood to be transported in Lake Creek under current conditions will be made based on the results of the large wood survey and an assessment of widths and depths under peak flow conditions. In addition, wood will be tagged at five study sites, one site in each of the five reaches delineated during the Physical Habitat Assessment Survey (EES Consulting 2004), to help assess transport following any flows that overtop the drop structure (natural or planned) during the 2-year study period.

Beginning in September 2005 and continuing through August 2007, large wood (over 12 inches in diameter and 25 feet long) that reaches the log boom will be tagged by plant operators and left in Packwood Lake. Records of the size (diameter, length) and timing of the large wood that reaches the log boom will be kept to provide information on movement of logs through Packwood Lake.

During the field inventory, all wood over 12 inches in diameter and 25 feet long at five study sites will be tagged and mapped. These study sites may coincide with some of the gravel study sites described in the Gravel Transport Study Plan located in Reach 1, 2, 3, and 4. A large wood study site will also be located in Reach 5. At each location, all wood of appropriate size within a 100-foot-long channel reach that has at least one end within the bankfull channel will be tagged and mapped. Photos will be taken to further document the current location of each piece. The height of both ends of each piece of wood above the streambed will also be noted and compared to bankfull water surface elevation and modeled high flow water surface elevations to estimate the flow needed to reach the wood pieces (modeling described in Spawning Gravel Study Plan).

When a flow with a magnitude similar to a bankfull event (285 cfs) overtops the drop structure (either natural or planned event) within the 2-year study period, the study sites will be re-visited to determine if any of the tagged wood has moved, or if any wood has moved in from upstream reaches.

Energy Northwest has agreed to attempt a planned spill tentatively scheduled for spring 2006 (weather dependent) to address flow needs for this study as well as the barrier survey, gravel transport study, and Lake Creek instream flow and habitat assessment study.

Energy Northwest will coordinate with the agencies and tribes to schedule the flows at a time that would have the least impact on spawning anadromous salmonids or emerging fry. Flows will also need to be coordinated with lake levels and power delivery schedules.

5.5 Feasibility Study of Moving Large Wood into Lower Lake Creek

A feasibility study will be conducted to determine the potential for moving wood into lower Lake Creek. The study will include the feasibility of moving wood from Packwood Lake around the drop structure as well as placing wood at other locations in lower Lake Creek. Different methods for placement that were discussed in formation of this study plan include: fixed boom to move wood over drop structure; some type of highline/cable system to move wood over drop structure; moving wood from lake to below drop structure using some type of wheeled vehicle; helicopter movement of wood over drop structure; helicopter placement in other areas of lower Lake Creek; or cutting selected downed trees that are currently spanning lower Lake Creek so they are engaged in Lake Creek.

The feasibility study will include an analysis of the different methods possible to move wood, engineering requirements, costs, permitting, access and land use constraints. This will be conducted in coordination with Forest Service logging engineering personnel.

5.6 Develop Wood Management Plan

A wood management plan to address wood that reaches the log boom and wood in Lower Lake Creek will be developed in consultation with the Forest Service and other members of the Water Quality and Aquatic Resources Committee. The wood management plan will include:

- Where wood should be moved or placed (moved around drop structure or placed at specific points in creek)
- Method to move wood (based on feasibility analysis)
- When wood movement should take place (frequency and timing)
- Criteria for size of wood to be moved or placed
- Methods to determine flows that move wood in lower Lake Creek
- Monitoring plan/adaptive management plan

A draft of the wood management plan will be developed following analysis of the field work and feasibility study. It is anticipated that a final wood management plan may require supplemental consultation and revision.

5.7 Products

A report summarizing the results of the field inventory and tagging and movement of wood downstream of the drop structure will be prepared. A wood management plan based on the results of the study will also be prepared.

5.8 Consistency with Generally Accepted Scientific Practice

The methods described for the large wood inventory and analysis are similar to those used for the Baker River Project Relicensing (Large Woody Debris Management Study Plan A20), Carmen-Smith FERC Project No. 2242 (Large Woody Debris Dynamics), North Umpqua Project FERC No. 1927, Lewis River Hydroelectric Projects (Aquatic Habitat Survey), and studies reported in the scientific literature (see Literature Cited).

6.0 CONSULTATION WITH AGENCIES, TRIBES AND OTHER STAKEHOLDERS

Energy Northwest initiated agency consultation in December 2003. Agency, tribe, and stakeholder representatives will be invited to provide information for the study and technical reviews of the draft report. Agency, tribe, and stakeholder representatives will be invited to provide technical expertise for the feasibility study, and will be consulted with on the draft management plan.

7.0 PROGRESS REPORTS, INFORMATION SHARING AND TECHNICAL REVIEW

Technical reports, including the draft and final Large Wood Report, Feasibility Study, and Wood Management Plan will be shared with stakeholders. Energy Northwest and its consultant will also report on the methods, progress, and results of the study at stakeholder meetings.

Energy Northwest will provide copies of the draft reports to agencies, tribes, and interested stakeholders for review. Review periods will be 30 days, after which Energy Northwest and its consultant will take review comments into consideration when making revisions and producing a final report.

8.0 SCHEDULE

Tagging of large wood collected behind the log booms will begin in September 2005. The large wood inventory will be conducted in conjunction with the gravel transport survey in fall 2005. A planned overtopping of the drop structure is tentatively scheduled for June 2006, if a natural event has not occurred. A preliminary draft report, feasibility study, and wood management plan will be prepared in mid-September 2006. Final results of the large wood tagging will be reported in 2007 along with a final report, feasibility study, and wood management plan.

9.0 LEVEL OF EFFORT AND COST

The level of effort includes finalization of the study plan, study implementation, and report preparation as well as consultation with agencies, tribes and stakeholders.

The large wood field inventory and agency meetings will be conducted in conjunction with the gravel transport study; level of effort and costs for the field inventory are included in that study. Level of effort to compile field data, assess large wood transport, analyze the feasibility of moving large wood, write a draft and final wood management plan and consult with stakeholders is estimated to be 15 days.

Total level of effort for all tasks in this study plan is 15 person days with a total estimated study cost of approximately \$12,220.

10.0 LITERATURE CITED

- Baker, Jerry. Packwood Lake Hydroelectric Project. Personal communication with K Dubé of Watershed GeoDynamics, April 7, 2005.
- Braudrick, D.A. and G.E. Grant. 2001. Transport and deposition of large woody debris in streams: a flume experiment. *Geomorphology* 41:263-283.
- EES Consulting, Inc. 2004. Draft Lake Creek Physical Habitat Assessment Survey. June 2004.
- Flanagan, S.A. 2004. Woody debris transport through low-order stream channels of northwest California – implications for road-stream crossing failure. M.S. Thesis, Humboldt State University. August 2004.
- Lofgren, T., H. Handy, and C. Grace. 1983. Lower Lake Creek, PIG Watershed #2524, R-6 Stream Survey Level II. Report prepared for Gifford Pinchot National Forest.
- May, C.L., and R.E. Gresswell. 2003. Large wood recruitment and redistribution in headwater streams in the southern Oregon Coast Range, U.S.A. *Can. Journ. For. Res.* 33:1352-1362.
- Swanson, D.A. 1996. Geologic Map of the Packwood Lake Quadrangle, Southern Cascade Range, Washington. USGS Open-File Report 96-704.

USDA Forest Service. 2005. Comments on PAD and Scoping Document 1 and Study Requests
Packwood Lake Project No. 2244-012. March 11, 2005.

Wohl, E. 2000. Mountain Rivers. AGU:Washington D.C. 320 pp.