Revised

Packwood Lake Drawdown 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

and

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

August 22, 2005

TABLE OF CONTENTS

LIST OF TABLES

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 identify impacts to fish, wildlife, shorelines, and associated wetlands, due to Project related drawdowns and associated fluctuating reservoir levels.

Objectives of the Packwood Lake Drawdown Study are to:

- Determine acres of drawdown zone exposed at various seasonal pool levels and evaluate impacts to fish and wildlife.
- Determine if the wetland is hydrologically connected to the lake level.
- Determine if Project operations are impacting the wetland complex near Upper Lake Creek.
- Investigate shoreline erosion associated with Project operations.
- Evaluate the rate in which the reservoir is drawn down and if resources are being impacted.
- Assess direct and indirect effects of Project drawdown on fish and wildlife.

2.0 AGENCY AND TRIBE RESOURCE MANAGEMENT GOALS AND OBJECTIVES

Washington Department of Fish and Wildlife (WDFW) and the USDA Forest Service requested this study (WDFW 2005, USDA Forest Service 2005). Their resource management goals were provided by these agencies and are presented below.

2.1 WDFW

The WDFW has the following resource management goals that are applicable to this study:

- Maintain or enhance the structural and functional integrity of riparian habitat and associated aquatic systems needed to support fish and wildlife populations on both site and landscape scales.
- No net loss of wetland acreage, value or function.
- Preserve exiting wetland habitat.

- Maintain and enhance special wildlife features in wetlands such as standing water, snags, down logs, and overlapping priority habitats and species.
- Enhance degraded wetland habitat.
- Mitigate the loss of wetlands through acquisition and enhancement.

2.2 USDA Forest Service

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 functioning of watersheds and the aquatic ecosystems contained within them. Those objectives most pertinent to this study include:

> *Objective 1 – Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.*
>
> *Objective 2 – Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.*
>
> *Objective 3 – Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.*
>
> *Objective 4 – Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.*
>
> *Objective 5 – Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, character of sediment input, storage and transport.*
>
> *Objective 7 – Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.*
>
> *Objective 9 – Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.*

3.0 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

3.1 Existing Information

Packwood Lake was formed by the Snyder Mountain landslide that blocked the valley and caused the lake impoundment. Radiocarbon dates from two snags near Agnes Island indicate that the lake was impounded approximately 1,100 years ago (Swanson 1996). Although the lake owes its current appearance to the Snyder Mountain landslide, erosion by alpine glaciers and interglacial streams common to the Cascade Mountains are responsible for the overall look of the Packwood Lake basin and Upper Lake Creek valley.

Water that originates as rainfall and snowmelt in the Goat Rocks Wilderness Area and the Cascade Mountains, approximately 19.2 square miles, drains into Packwood Lake, with a surface area of about 452 acres based on the natural elevation of Packwood Lake at approximately 2,857 feet MSL. The natural high water level for Packwood Lake had been established by the Forest Service to be 2,859.01 feet MSL (Hurd 1964). A study conducted in the early 1960s indicated that the lake fluctuation for the May 1 to September 15 period from 1960 through 1963 was 1.2 to 2.1 feet, with the differences for the annual maxima and minima ranging from 2.3 to 3.4 feet (Royce 1965). The length of the shoreline is approximately 4.26 miles (Washington Department of Ecology 1991).

The Pre-Application Document (PAD) (Energy Northwest 2004) filed December 6, 2004, provides information on project operations and the regulation of water level in Packwood Lake. Table 3 in the PAD provides data on monthly maximum, minimum, and average lake elevation for the period January 1999 through December 2003. The PAD also provides historical inflow data for Packwood Lake. The Project is controlled from the powerhouse and is operated depending upon license conditions, water availability, and power contracts. The Project has a water right for 260 cfs but does not operate at capacity at all times. The volume of water passing through the project varies with generator load and can range from a maximum of 260 cfs to a minimum of about 17 cfs. Average power production is 10 MW relative to a turbine generator rated at 26,125 kW. During the summer months, the Project's generation is dictated by the FERC license lake level requirement of 2,857 feet MSL plus or minus 6 inches.

From May 1 to September 15, the Project operates with Project generation flow adjusted to match lake inflow to hold the lake elevation relatively constant. After mid-September, the lake level may be drawn down up to 8 feet to a level no lower than 2,849 feet MSL. The 8 feet of vertical storage allows the Project to store and utilize winter runoff for power generation. When seasonal high runoff exceeds the Project capacity and the ability of the lake to absorb peak discharges, the drop structure is overtopped (at elevation 2,858.5 feet MSL) and excess runoff is directed down Lake Creek.

EES Consulting (2005) prepared a draft report on the direct effects of lake drawdown on upstream fish passage for tributaries to Packwood Lake that support adfluvial populations of rainbow trout. The major rainbow trout spawning tributaries are Osprey, Muller, Crawford, and Upper Lake creeks. Rainbow trout are also known to spawn in Trap Creek and occasionally in

Beaver Bill Creek (a tributary to upper Lake Creek) and a small tributary southeast of Trap Creek.

Surveying of major tributaries to Packwood Lake indicate that a drawdown of Packwood Lake to 2,849 ft would not impact upstream fish passage into Upper Lake Creek or Muller Creek; a drawdown to less than 2,851.2 ft could impact upstream fish passage into Osprey Creek; and any drawdown to less that approximately 2,856 ft could impact upstream fish passage into Crawford Creek, if fish were volitionally attempting to ascend this creek and spawn. Since Beaver Bill Creek is a tributary to Upper Lake Creek, any fish able to ascend Upper Lake Creek would also be able to access Beaver Bill Creek, provided there are no barriers present in between the two. Data are unavailable for Trap Creek or the small tributary southeast of Trap Creek.

Based upon the data provided by WDFW, peak spawning apparently occurs from mid-June through early July. According to Article 37 of the license, Packwood Lake levels are to be at full elevation (2,857 ft +/- 6 in) by May 1 of each year. Although the exact timing of when rainbow trout enter Packwood Lake tributaries for spawning is unknown, it appears reasonable to assume that current Project operations, as dictated by the license, would have the lake full prior to upstream migration. It is also unknown at what time of year the juvenile rainbow trout leave the tributaries to forage in Packwood Lake or what impact Project operations could have on their migration if it were to occur during the drawdown.

3.2 Need for Additional Information

Studies have not been completed that document the relationship between lake water surface elevation and hydrologic condition with wetlands adjacent to Packwood Lake. The wetland community near Upper Lake Creek may provide important habitat for ranid frogs, toads, Cascade frogs and red-legged frogs (M. Hayes, 2005).

Detailed bathymetry of the littoral habitats within Packwood Lake that are subject to dewatering during Project lake drawdown have not been completed.

4.0 NEXUS BETWEEN PROJECT OPERATIONS AND EFFECTS ON RESOURCES

This study will provide information on the potential effects of Packwood Lake reservoir fluctuations and drawdowns on shoreline and wetland habitats. The annual drawdowns and daily water level fluctuations on Packwood Lake from Project operations have the potential to affect wetland and riparian habitat quality, and fish and wildlife use.

5.0 STUDY AREA AND METHODS

5.1 Study Area

The study area includes Packwood Lake and wetlands adjacent to the lake.

5.2 Methodology

The methods are consistent with the agency study requests with the exception that the Forest Service requested a determination of the natural pre-project drawdown zone and timing and magnitude of lake level fluctuations. Analysis of pre-project lake levels is reported in Hurd (1964) and Royce (1965). Energy Northwest is not aware of any other information sources or photos that could provide quantitative information on pre-project lake levels. WDFW recommends using existing lake bathymetry to prepare detailed maps of the area subject to dewatering and the seasonal pattern of dewatering. The existing bathymetry does not have sufficient resolution to meet the study objectives. Therefore, methods include bathymetric mapping of littoral habitats.

5.2.1 Mapping Littoral Areas Subject to Dewatering

Bathymetric data will be collected at an estimated 25 transects that are perpendicular to the shoreline. This number of transects will result, on average, a spacing of one transect per 1,000 ft of shoreline. Shorelines will include Agnes Island in Packwood Lake. The placement of transects along the shoreline will be determined in the field based on variability of littoral habitat. Transect density will be greater in areas with broad littoral habitats and areas with more complex shallow littoral habitat.

The data collection system consists of a Trimble Pathfinder Pro XRS differential GPS receiver, an interfaced digital depth sounder, and an electronic Total Station. This system provides real-time, map-grade locations. Depth and coordinate data are stored in a Trimble TSC1 data logger and later exported to a computer for analysis and creation of map products. The data collection system will be mounted in a rowboat.

Transect end points are geo-referenced using a Trimble Pathfinder Pro XRS differential GPS receiver. A two-person shoreline survey crew will use an electronic Total Station to survey an upland position, water's edge, and topographic breaks within shallow (<1.5 ft) near-shore habitat. The water surface elevation will be assigned an arbitrary elevation of 100.0 feet in the field, which can then later be corrected to reflect actual ground elevations at the transect point and at the measured lake elevation.

The transects will traverse a range of elevations from approximately 2,859 ft MSL (natural high water elevation as established by the Forest Service (Hurd 1964) to an elevation no more than 2,849.0 ft MSL (minimum Project regulated water level).

Substrate size composition will be noted along each transect using WDFW substrate codes (WDFW 1996 – Table 5-1). Substrate coding uses the WDFW convention of *xy.z* where:

x = the dominant substrate
y = the subdominant substrate
z = the percentage of the dominant substrate as compared to the subdominant substrate.

For example, a substrate coded 36.8 would denote a dominant substrate of small gravel, a subdominant substrate of small cobble, with 80% of the two substrates being small gravel. A substrate that was exclusively one substrate type would be coded XX.9. For example, substrate, which was all small cobble would be coded 66.9.

Table 5-1. Substrate Codes

Code	Substrate Description	Mm	Inches
0	Organic Detritus	*A*	*A*
1	Silt, Clay	<2	< 0.1
2	Sand	<2	< 0.1
3	Small Gravel	2 – 12	0.1 – 0.5
4	Medium Gravel	12- 38	0.5 – 1.5
5	Large Gravel	38 – 76	1.5 - 3.0
6	Small Cobble	76- 152	3.0 – 6.0
7	Large Cobble	152 – 306	6.0 – 12.0
8	Boulder	> 305	> 12.0
9	Bedrock		

The integrated depth sounder and Trimble Pathfinder GPS unit will be used to map bathymetry along the transect starting at a buoy (at a depth of approximately 1.5 ft), which is set out by the bank-survey crew.

All locations will be recorded using state plane coordinates by the Trimble Pathfinder GPS unit. This GPS system, with independent satellite subscription, will allow us to record accurate locations in real-time without the need of post-processing the data relative to a base station. This system also will be used to interface with the depth sounder, accurately recording depth and location.

An underwater video camera may be deployed to determine substrate composition if water clarity is insufficient to see the bottom along the transect. The underwater camera is connected to the GPS unit, giving real time coordinates for both the depths and substrate.

The transect data is then plotted within a GIS environment to create a bathymetric map of the littoral habitats.

5.2.2 Seasonal Area Dewatered

The lake bathymetric GIS layer for littoral areas can be used to compute the area below elevation 2,857 ft MSL that is dewatered relative to water elevation within the operational range (2857 ft MSL to 2849 ft MSL). The area dewatered due to Project operation will be reported as monthly maximum, minimum and mean values. An annual exceedence curve for the dewatered area will also be computed based on the period of record (June 20, 1967 to present). Maps of the lake will be prepared that show the area dewatered during typical drawdown and at 2849 ft MSL, which is the maximum drawdown level specified in the current FERC license.

5.2.3 Shoreline Erosion

Energy Northwest will attempt to locate copies of the historical aerial photos previously filed with the agencies and FERC that describe historic shoreline erosion as affected by Project operation. If these photos can be located, the erosion features (area, severity and process type) will be mapped on the GIS bathymetric layer. Rates of shoreline erosion will also be estimated if possible. If these photos are not available, then other sources of aerial photos (Washington Department of Natural Resources, Forest Service, Washington Department of Ecology, Terraserver), as well as oblique photos of the shoreline will be evaluated to assess historic shoreline erosion rates and locations.

A survey of the Packwood Lake drawdown zone and shoreline will also be conducted during low lake levels. The survey will be conducted by boating and walking around the lake shoreline. This ground survey will include observations of indicators of erosion in the drawdown zone (exposed tree roots, rills, etc.), as well as observations of erosion on the lake shoreline (steep banks of exposed soil, tree toppling, landslides, etc.) These features will be mapped on the bathymetric map of the lake. The height/length of shoreline erosion features will be noted along with observations of likely factors contributing to the erosion at each site. Depth of exposed tree roots or rills will be measured and noted.

The bathymetry data and substrate data will be compared to information on historical shoreline erosion to prepare a map of erosion potential for shorelines of Packwood Lake. The map will evaluate erosion rates (high, moderate and low) as well as erosion potential (high, moderate and low). Areas subject to various erosion processes (bank slumping, wave action, channel downcutting, etc.) will also be documented. Erosion information will be analyzed relative to information from other studies to determine the impact of Project-induced erosion on spawning habitat, tributary fish passage, riparian habitat, recreation features and cultural sites.

5.2.4 Drawdown Effects on Wetlands

Vegetation cover-type mapping is being completed as part of the Revised Vegetation Cover Type Mapping Study Plan. The cover- type mapping will delineate the approximate boundaries and classifications for wetlands adjacent to Packwood Lake. In general, cover-type mapping information can be used to provide the location, abundance, extent, and distribution of habitat types within a given area. The information collected during this wetland study will provide information on wetland vegetation composition and structure, soil composition, observed and potential wildlife use, wetland hydro-period and supporting wetland hydrology source, position of wetland within the watershed, habitat structures, and educational and cultural opportunities of the wetlands.

Vegetation maps for the lands surrounding Packwood Lake as prepared for the Revised Vegetation Cover Type Mapping Study Plan will provide the basis for identifying wetlands potentially affected by Project regulation of lake level. Only those wetlands that are adjacent to Packwood Lake and have a reasonable potential to be hydrologically connected to Packwood Lake by either surface or shallow subsurface hydrology will be addressed by this wetland study.

Probable wetland features identified on the vegetation maps will be field verified as wetlands adjacent to Packwood Lake with a hydrologic connection.

In addition to plotting information defining plant association and dominant plant community types, identifying habitats of special concern and special habitat features (e.g., snags and coarse woody debris), and documenting observed wildlife, information will be collected within those polygons supporting jurisdictional wetland habitat to document soil conditions, hydrology source, and function and value information using the Semi-quantified Assessment Method (SAM) (Cooke Scientific Services, Inc. 2000). This will include information on sources of supporting hydrology for the wetland, empirical evidence of water level fluctuations and observed effects, and an initial hydrogeomorphic classification (e.g., depressional outflow, depressional closed, etc.). General wetland function and value information (e.g., natural biological support, floodwater/stormwater storage capabilities, base flow/groundwater support, erosion/shoreline protection, etc.) will also be collected. During fieldwork, the actual on-the-ground wetland boundary will be reviewed as practical and the polygons on the orthophotographs will be revised as necessary. For the purposes of this study, the approximate wetland boundaries will be determined following the wetland delineation methodology defined in the 1987 Corps of Engineers Wetland Delineation Manual (COE Technical Report Y-87-1) and Ecology's 1997 *Washington State Wetlands Identification and Delineation Manual*. Although the approximate wetland boundary will be reviewed in the field to refine the boundary identified on the orthophotograph, no wetland boundaries will be formally delineated in the field under this study plan.

Soils will also be inspected at each sample plot in hand-dug soil pits 15 to 20 inches deep. At each sample plot, soil texture, matrix color, presence of mottles or gleying, and saturation levels will be recorded, and this information will be included on each datasheet. Soil and mottle colors will be determined through the use of the Munsell Soil Color Charts (Gretag 1998). Hydrologic indicators, including drainage patterns, presence of surface water, depth of ground water, and evidence of inundation (i.e., drift lines, water marks, oxidized root zones, etc.) will also be noted at each sample plot.

The following information will be recorded for each wetland polygon identified in the vegetation habitat mapping and field verified by this study:

- Soil Texture (e.g., sand, sandy loam, loam, silt loam, etc.) and soil profile information;
- Hydrogeomorphic (HGM) classification of the wetland based on Brinson (1993);
- Wetland function and value information based on SAM (CSS 2000);
- Source of hydrologic support for the wetland lake, shallow ground water levels associated with lake level, shallow ground water associated with streams; upgradient seepage, etc.; and
- Classification of the dominant wetland habitat type(s) (>30% cover) based on the U.S. Fish and Wildlife Service (USFWS) wetland classification system (Cowardin et al., 1979).

5.2.5 Water Level Monitoring

There are at least two known wetland complexes that merit studying the hydrologic connection between lake level and soil inundation. A large wetland complex is located at the upper end of Packwood Lake and adjacent to Upper Lake Creek and Muller Creek. A second wetland complex that is smaller in size occurs along the south shore of the lake near Osprey Creek.

Four piezometers will be installed within the Upper Lake Creek wetland to a minimum depth of 2.25 feet below the ground surface (bgs). Two piezometers will be installed in the wetland complex along the south shore of Packwood Lake. Additional sites may be identified during the vegetation mapping. Each piezometer includes a Campbell screened well point, associated steel piping, and well cap. A Solinst Levellogger f30 (electronic datalogger) will be installed within each of the established piezometers and a Solinst Baralogger f5 (barometer) will be deployed at the Packwood intake site (it may be possible to add a barometric pressure gage to the existing climate station at the Project intake). Water level data will be collected by each datalogger at 30-minute interval. Instruments will be installed in September 2005 and remain deployed through May 2007 unless the first year of data defines resource effects relative to Packwood Lake drawdown. Each datalogger will be downloaded periodically during the study period to ensure proper functioning and facilitate storage of the collected data. Weather conditions may preclude maintenance trips during winter months. The top elevation of each piezometer will be surveyed relative to a benchmark and lake level. Absolute elevations can then be computed based on the known lake level at the time of survey. The planar position of each wetland will also be mapped by either GPS if forest canopy allows or with a Trimble total station.

Energy Northwest records lake level daily; a plot record of lake level is also maintained. A Design Analysis H350-355 gas bubbler dry pressure transducer (or similar equipment) will be installed in the intake canal to monitor lake level during this study. Water level in the intake canal will be recorded at 15-minute intervals.

A DH-21 level logger will be deployed within a 6 ft * 2.5 in. diameter steel housing on Upper Lake Creek for the purpose of monitoring water level in Upper Lake Creek. Water level in the stream will be recorded at 15-minute intervals. This stream is braided near its mouth; there is no suitable location to accurately measure discharge so only water level will be collected for Upper Lake Creek. Stream water level data will be compared to water level within the wetland to determine hydrologic connectivity between the stream and wetlands.

5.3 Products

Study products include GIS-produced maps of the area affected by drawdown, a table of the monthly or seasonal area affected by drawdown, percent exceedence tables for drawdown area, and a report describing the effects of drawdown on riparian vegetation, wildlife, fish, and fish habitat.

Rates of historic erosion due to Project regulation of lake level will be reported and a map produced showing areas and types of erosion occurring along the shoreline of Packwood Lake due to Project operation.

A report will be produced that describes the geographic extent, character and function of wetlands adjacent to Packwood Lake and an analysis of their hydrologic connection to lake levels. The report will include a discussion of Project effects to these wetlands.

5.4 Consistency with Generally Accepted Scientific Practice

The methods are consistent with methods used on other reservoir projects undergoing FERC licensing. QA/QC review of data will be completed to ensure its accuracy and completeness. The methods are being developed in consultation with the resource agencies and tribes.

5.5 Relationship with Other Studies

The lake drawdown study will be implemented in coordination with the stream connectivity study. The thalweg profiles surveyed as part of the connectivity study will be added to the database for mapping the drawdown zone in the lake and maps for both studies will be referenced to the same spatial coordinates. Calculations of the amount of aquatic habitat affected by the drawdown will be coordinated so that lacustrine and stream habitats are distinquished and not duplicative. The point of distinction between stream habitat and lacustrine habitat will be based on topography of adjoining shorelines; i.e. that portion of the stream channel that is backwatered by the lake at the natural, full pool elevation that is upstream of the lake shoreline contour will be considered to be part of the stream environment. The data will also be used in coordination with the Revised Fish Distribution and Species Composition Study Plan, which will investigate if the outmigration ability of stream-dwelling salmonids found in Packwood Lake tributaries is potentially affected. Fish passage during drawdown is being investigated as part of another study plan. Turbidity monitoring as described in the Water Quality Study Plan focuses on the drawdown period. Water quality modeling will evaluate Project effects on water quality as a result of lake drawdown including a comparison to water quality in absence of lake drawdown. A cultural resources survey will be conducted when the lake is drawdown; erosion information will be evaluated relative to cultural resources sites.

6.0 CONSULTATION WITH AGENCIES, TRIBES AND OTHER STAKEHOLDERS

Energy Northwest initiated agency consultation in December 2003. The integrated licensing process plan provides for numerous meetings with stakeholders to discuss, revise and finalize the proposed study plan. Stakeholder representatives will also be invited to provide information for the study and technical reviews of the draft reports.

7.0 PROGRESS REPORTS, INFORMATION SHARING, AND TECHNICAL REVIEW

Technical reports, including the draft and final reports will be shared with stakeholders and will discuss the progress of the studies. Energy Northwest and its consultant will also report on the methods, progress, and results of the study at stakeholder meetings. After the data collected through May 2006 has been analyzed by Energy Northwest and its consultant, and no later than July 1, 2006, a draft report will be issued so that consultation with the agencies and tribes may

occur to review the results and determine whether the data defines resource effects relative to Packwood Lake drawdown

Energy Northwest will provide copies of the draft reports to 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 final reports.

8.0 SCHEDULE

Data collection will be initiated in fall 2005 and continue through the summer of 2006. A draft report will be issued after the data collected through May 2006 has been analyzed by Energy Northwest and its consultant, and no later than July 1, 2006 so that consultation with the agencies and tribes may occur to review the results and determine whether the data defines resource effects relative to Packwood Lake drawdown. A second season has been scheduled for mid-September 2006 through May 2007, unless the data from the first season defines resource effects. The final report will be issued no later than August 31, 2007.

9.0 LEVEL OF EFFORT AND COST

The estimated level of effort includes data collection, GIS analysis, data analysis, report preparation and consultation. The estimated costs are listed in Table 9-1. This estimate is based on one season of field studies.

Table 9-1. Study Costs

Task	Total Cost (Labor and Expenses)
Consultation	$1208
Mapping drawdown area	$7,636
Shoreline Erosion	$15,744
Wetlands	$46,629
Total	$71,217

10.0 LITERATURE CITED

Brinson, M.M. 1993. A hydrogeomorphic classification for wetlands: Technical Report WRPDE- 4. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Cooke Scientific Services Inc. 2000. Wetland and Buffer Functions Semi-Quantitative Assessment Methodology (SAM), Final Working Draft User's Manual; February 2000.

Corliss, J.F. 1971. Letter to Lloyd Gillmor from Forest Service dated October 22, 1971 regarding the Packwood Lake shoal stability. USDA Forest Service Gifford Pinchot National Forest.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service Publication FWS/OBS-79/31.

EES Consulting. 2005. Packwood Lake tributary fish passage. Preliminary Report. Prepared for Energy Northwest.

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

Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual: Technical Report Y-87-1. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Gretag, Macbeth. 1998. Munsell Soil Color Charts.

Hayes, Marc. 2005. Personal communication noted in WDFW's Study Plan Request. Washington Department of Fish and Wildlife Habitat Program; Olympia, WA.

Hoffman, T. 1971. Memo dated October 12, 1971 to files, regarding spawner access at Packwood Lake with lake elevation at 2854 ft. Washington Department of Fish and Wildlife.

Hurd, Owen W. 1964. Letter from Owen W. Hurd (Washington Public Power Supply System) to F. Stewart Brown (Federal Power Commission), dated November 27, 1964. http://www.energy-northwest.com/gen/packwood/reference/hurd-owen-1964.htm

Reed, P.B., Jr. 1988. National list of plant species that occur in wetlands: Northwest (Region 9). U.S. Fish and Wildlife Service Biological Report 88(26.9). 89 pp.

Reed, P.B., Jr. 1993. Supplement to the national list of plant species that occur in wetlands: Northwest (Region 9). 11 pp.

Royce, William F. 1965. "Effect of changes in lake level on fishing in Packwood Lake." University of Washington, Seattle, Washington. http://www.energy-northwest.com/gen/packwood/reference/roycewilliam1965a. pdf

Swanson, D.A. 1996. Geologic Map of the Packwood Lake Quadrangle, Southern Cascade Range, Washington. USGS Open-File Report 96-704.

Tokarczyk, R.D. 1977. Letter to S.K. Billingsley, Washington Public Power Supply System dated December 15, 1977 regarding Packwood Lake Study for the USDA Forest Service Gifford Pinchot National Forest.

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.

Washington Department of Ecology. 1991. Lake Water Quality Assessment Project, 1989. Document 91-60, November 1991. http://www.energynorthwest.com/gen/packwood/reference/wadeptecology1991.htm

Washington Department of Ecology. 1997. Washington State wetlands identification and delineation manual: Publication 96-94. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 1996. Instream flow guidelines.

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".