Engineering Needs for Access Routes Study Report
for
Energy Northwest's
Packwood Lake Hydroelectric Project
FERC No. 2244
Lewis County, Washington

Submitted to

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1.0 INTRODUCTION

Energy Northwest operates the Packwood Lake Hydroelectric Project (Project) near the town of Packwood in Lewis County, Washington. On November 12, 2004 Energy Northwest filed a Notice of Intent (NOI) to file an application for a new license to operate the Project. Energy Northwest also concurrently filed with the Federal Energy Regulatory Commission (FERC) and the resource agencies, a Pre-Application Document (PAD), containing existing, relevant, and reasonably available information describing the existing environment and the potential effects of Project facilities and operations. Additional studies of the potential effects of Project operations on large wood in Lake Creek were requested to supplement information contained in the PAD (USFS 2005).

Energy Northwest, in consultation with tribes and agencies, developed and has implemented a study to evaluate Project access roads (EES and Watershed GeoDynamics 2005). This report provides results for the engineering needs for access routes study.

1.1 Project Area and Study Area

1.1.1 Project Area

Energy Northwest's Packwood Lake Hydroelectric Project, FERC No. 2244, received its initial license in 1960. The majority of the Project is located in the Gifford Pinchot National Forest, east of the town of Packwood (Figure 1.1). The Project 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.

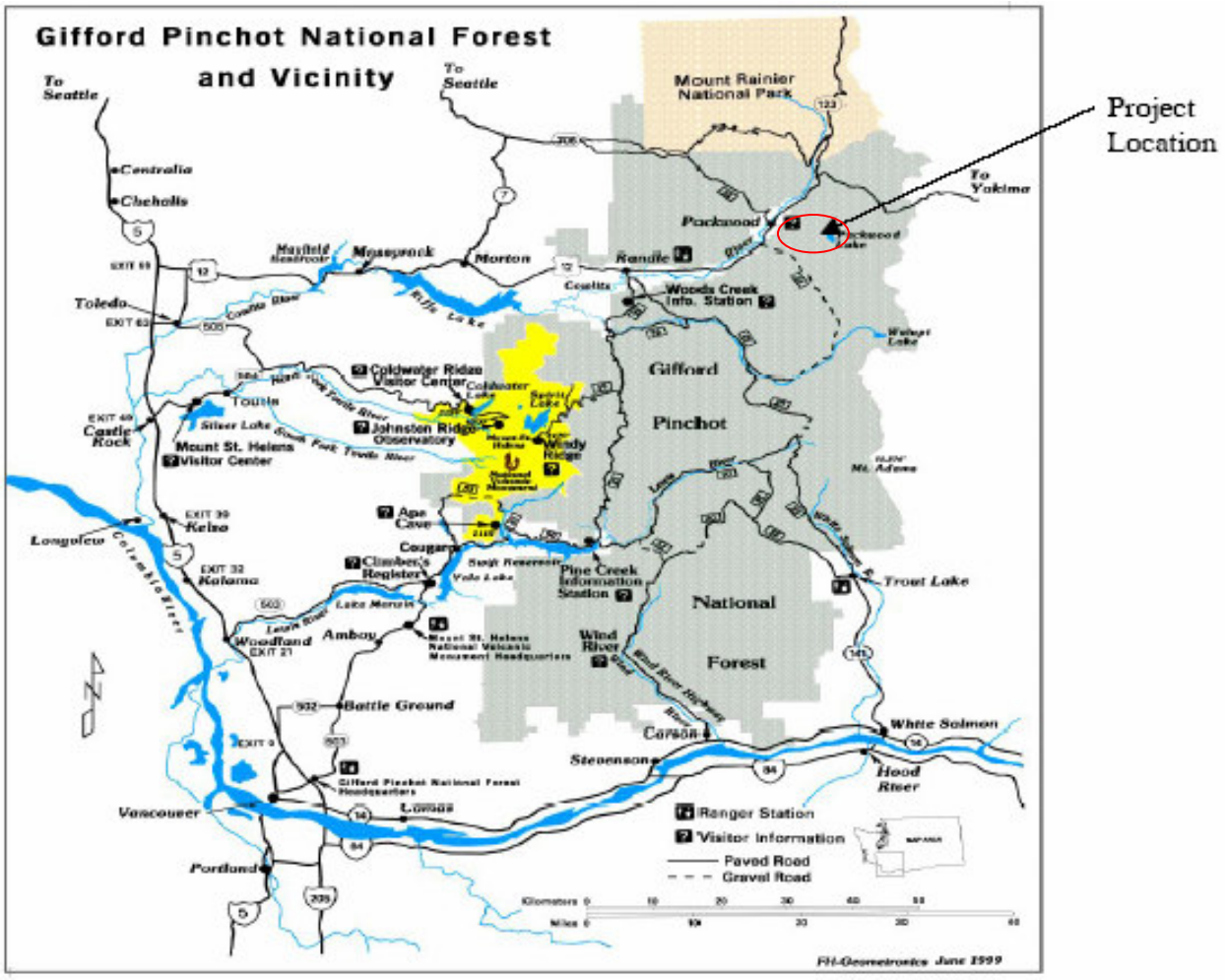

Figure 1.1 – Project Location.

1.1.2 Study Area

The study area, shown in Figure 1.2, encompasses the road right-of-way for Snyder Road (USFS Road 1260) from the Forest Service boundary at Milepost (MP) 0.83 to MP 5.8, where the road ends at the trailhead parking for Trail No. 78 and the Pipeline Trail (No. 74). The trailhead parking area and Pipeline Road right-of-way are in the study area as well as Trail No. 74 from its trailhead to Packwood Lake. The Latch Road (USFS Road 1262) right-of-way and the steep access trail leading to Trail No. 74 are in the study area. Sufficient area to either side of each of these right-of-ways is included in the study area as necessary to evaluate the hydrologic stability, resource impacts, and road/trail maintenance needs for these access routes.

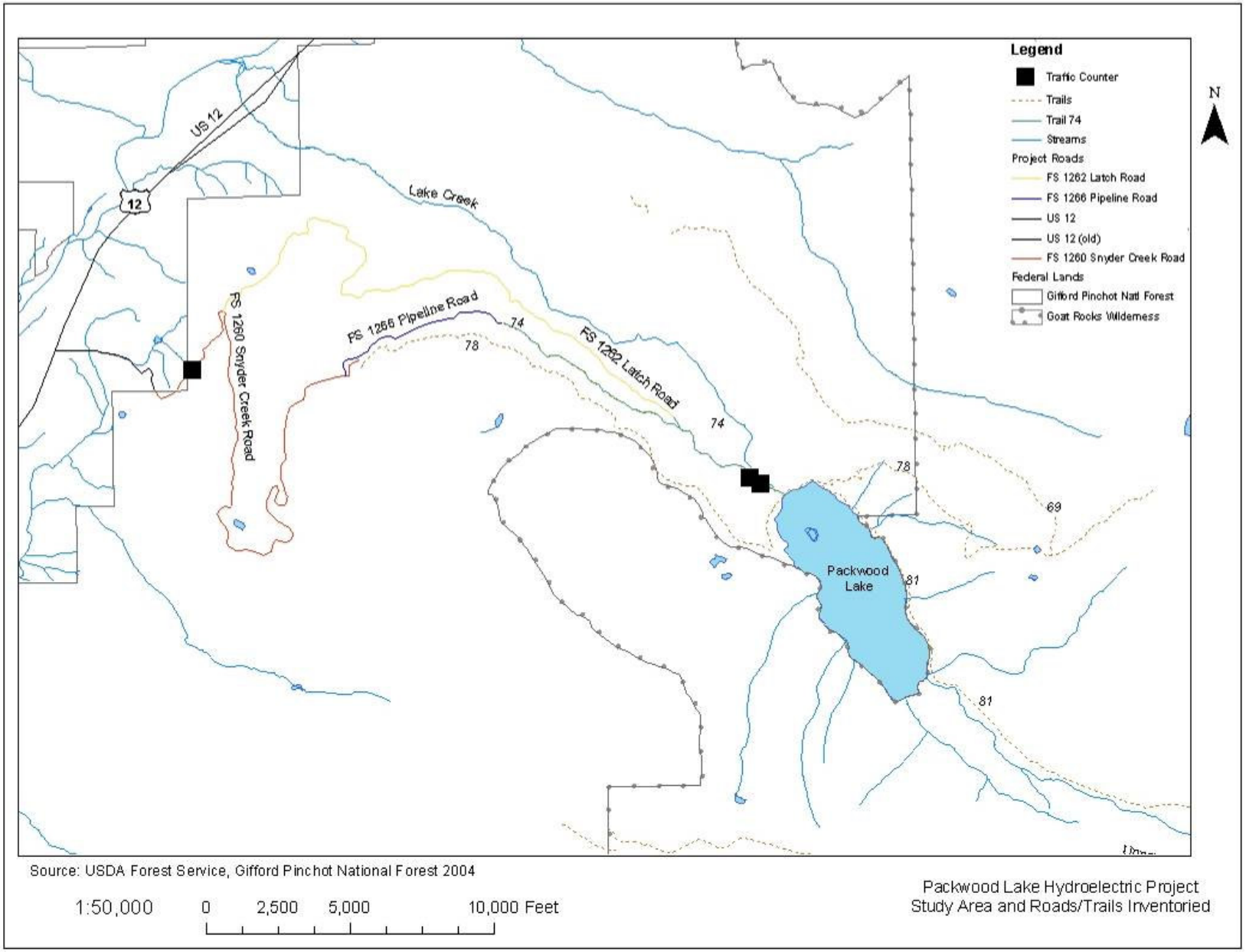

Figure 1.2 – Study Area

2.0 STUDY GOALS AND OBJECTIVES

The goal of this study is to develop sufficient information to support Energy Northwest's application to FERC for relicensing the Packwood Lake Hydroelectric Project regarding the condition, use, and maintenance of Project access roads so that appropriate actions can be identified for the protection of natural resources while providing safe access to the Project area. The goal of this study is to also develop sufficient information to provide a technical basis for developing a maintenance plan for managing access roads and trails that is consistent with applicable state and federal regulatory requirements and plans.

The objectives for this study include:

- Document current maintenance of access roads and trails; and
- Identify maintenance and reconstruction needs to make the access roads hydrologically stable and in compliance with maintenance levels and safety standards.

Use patterns for access roads were collected as part of the Recreation Resources Study Report; a summary of results is included below.

3.0 METHODS

3.1 Road and Trail Safety

Applicable safety and maintenance standards for the study roads and trails were obtained from the United States Forest Service (USFS) District Engineer (Danna Hadley, personal communication) to determine if any improvements are needed to bring each road or trail into compliance with the standards.

3.2 Maintenance and Reconstruction Needs Assessment

A road inventory was conducted on the roads and trail within the study area in consultation with the USFS District Engineer on October 17-19, 2006. The inventory included an assessment of road stability and hydrologic connectivity. Three field forms were used to inventory the roads and trails, and included separate forms to assess: (1) the condition and hydrologic connectivity of the road prism; (2) culverts; and (3) any mass wasting areas (Appendix A). The assessment of the roads, trails, and culverts generally followed the protocols developed for road inventories by the Washington Department of Natural Resources and Seattle Public Utilities (WPN 2006, SPU 2005).

The surveyor drove the roads and walked the trails to note the condition of the tread, fillslope, ditch, cutslope, and each drainage structure. Areas of past, present, and potential future erosion or instability were inventoried, and the factors contributing to the area of concern were recorded. The station of road features, in feet, was measured using a Jamar odometer installed on the field vehicle on Snyder Road, Latch Road, and the Pipeline Road. Stationing along trails was measured using a string box.

In locations where maintenance or improvement prescriptions were recommended, a relative rating of the urgency of the prescription was made based on a subjective call of the magnitude of the potential problem, the likelihood of the potential concern failing, and the likelihood of either sediment from an eroded area reaching a stream or water body or the failure endangering human life. The rating conveys the opinion of the surveyor as to the urgency of completing the prescription: a high rating suggests the site should be taken care of soon (within the next year); a medium rating suggests the site should be taken care of within the next 5 years; and a low rating suggests the site should be taken care of within the next 10 years.

Hydrologic connectivity and potential surface erosion issues were assessed using the methods described in the Washington Road Surface Erosion Model Manual (WDNR 2004).

3.3 Pipeline Leakage

The USFS expressed concerns regarding leakage from the Project pipeline in two locations identified as the French drain on Trail 74 and the wet area above Latch Road (USFS Road 1262) at approximately MP 3.9. These two areas, plus a third wet area found during the field visit, were investigated by USFS and Energy Northwest personnel before and after the pipeline was drained for maintenance in October 2005. Field visits were conducted by Energy Northwest and the USFS on April 27, May 4, September 29, and October 17/18. Water temperature and chemistry data in these three areas were also collected by EES personnel for comparison with groundwater and pipeline water.

3.4 Traffic Counters

Information on traffic counts on Trail No. 74 and Latch Road (USFS Road 1262) was collected as part of the Recreation Study (Howe Consulting 2007). The information is provided in this report to meet study objectives regarding Project use of USFS roads and trails.

Two pressure sensitive counters were placed on Trail No. 74 below the diversion structure to provide information regarding use on Trail No. 74. The counters were installed as soon as the snow melted enough to allow access (May 9, 2006). The counters were placed approximately 200 feet apart in the area between the junction of the upper and lower trails and the concrete sidewalk near the foot of the Packwood Lake diversion. The traffic counter data, along with use information obtained by other methods (user surveys, observations and Energy Northwest personnel Trail No. 74 use information), were used to estimate all terrain vehicle (ATV) use of Trail No. 74.

Another pressure sensitive counter was installed on USFS Road 1260 to document total vehicle use on this road. The counter was initially installed on April 26, 2006, then stolen on April 30, 2006. A new counter was installed on May 2, 2006. The traffic counts and average number of vehicle axles documented during on-sites surveys were used to estimate vehicle use of USFS Road 1260 based on counter data.

4.0 RESULTS

There are three access roads and three trail sections that are addressed in this study: Snyder Road (USFS Road 1260); Pipeline Road (USFS Road 1260-066); Latch Road (USFS Road 1262); Pipeline Trail (USFS Trail No. 74) with the split in the trail divided into the upper and lower trail sections; and the short trail leading from the end of Latch Road to Trail No. 74 (referred to as Latch Trail in this report). A detailed inventory of road/trail conditions, culverts, and mass wasting sites along each of the roads and trails was made for this study. A summary of the total length inventoried, number of culverts and mass wasting sites, and the length of each road or trail that was determined to be hydrologically connected to streams is included in Table 4.1. Culvert locations and mass wasting sites are shown on Figure 4.1. Detailed inventory data is included in Appendix B. The culvert and mass wasting site numbers shown on Figure 4.1 correlate with the numbering of sites in Appendix B.

Table 4.1 – Summary of Road and Trail Inventory

Road	Total Length Inventoried		Number of Culverts	Mass Wasting Sites Inventoried	Length of Road Hydrologically Connected (ft)	Percent of Road Hydrologically Connected
	Feet	Miles				
Snyder Road	27,048	5.12	53	0	4,201	16%
Pipeline Road	7,509	1.42	0	1	0 (plus 397 feet within 200 feet of a stream)	0%
Pipeline Trail (along upper route to Lake)	11,986	2.27	19	7	836	7%
Lower Pipeline Trail	4,232	0.80	2	2	0	0%
Latch Road	23,991	4.54	26	0	3,415 (plus 1,661 feet within 200 feet of a stream)	14%
Latch Trail	546	0.10	0	0	0	0%

Note that culverts on Figure 4.1 are numbered by sequentially along each road. For example, S1 is Snyder Road culvert #1; L15 is Latch Road culvert #15. Mass wasting sites are numbered sequentially with a MM prefix, e.g., MM1, MM2. Numbers refer to the numbers in Appendix B.

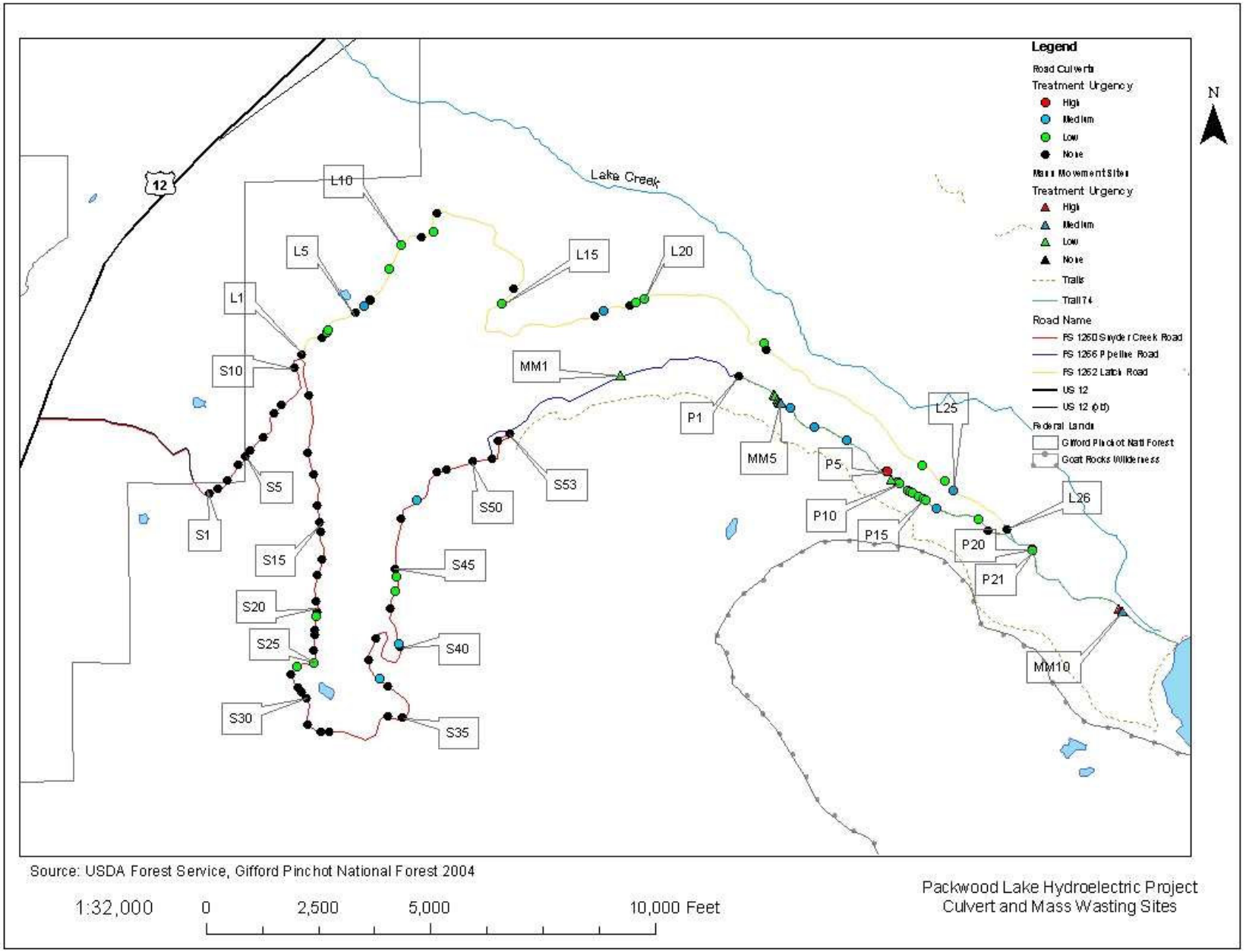

Figure 4.1 – Culverts and Mass Wasting Sites.

4.1 Snyder Road (USFS Road 1260)

Snyder Road (USFS Road 1260) is a double-lane paved road that extends 5.8 miles from Highway 12 to the parking lot at Trail No. 78. Lewis County has jurisdiction for the road segment leading to the Forest Service boundary (MP 0 to MP 0.83) and maintains the road to MP 1.2. The county maintains Snyder Road at Maintenance Level (ML) 5. The road inventory included the road from the USFS boundary marker (Mile 0.83) to the end of the parking lot at the Trail No. 78 trailhead. The parking area at the end of Snyder Road is utilized by hikers, horseback riders, and ATV's. Energy Northwest uses Snyder Road generally once per week for accessing either the Latch Road or the Pipeline Road and Trail No. 74. The purpose of these trips is to check on intake facilities and perform needed maintenance. More detailed traffic information is included in Section 4.6.

Snyder Road is a ML2 road from MP 1.2 to the trailhead at MP 5.8, as assigned by the Forest Service. ML2 means the road is passable by high-clearance vehicles, drainage structures are maintained, and the tread is maintained to accommodate speeds of 15 mph or less. Public use of Snyder Road is encouraged.

Snyder Road is paved, with the drivable tread averaging 20 feet wide and a total tread width (including shoulders) of 26 feet. The asphalt is cracked and patched at a few locations indicating some settling or movement of the fill, but the tread is generally in good condition and passable by passenger cars. The tread is either crowned or outsloped.

The majority of the cutslope and fillslope are stable with the exception of some minor over-steepened fillslopes and four areas totaling approximately 950 feet of raveling cutbank and fillslope between Milepost 4 and 5 (see details in Appendix B). This area should be checked periodically to determine if any signs of imminent instability are present such as widening of cracks in the road or additional settling of the road bed. The culvert and ditch line should be checked, cleaned, and maintained to ensure proper drainage in this area.

A total of 53 culverts were inventoried on Snyder Road within the USFS boundary; 10 stream crossings and 43 relief pipes (streams are identified as any channel with a defined bed and banks – including ephemeral channels). All culverts are corrugated metal pipes (CMP) except for one arched pipe at a larger stream crossing. Relief pipes are 18-24 inches in diameter. Stream crossing pipes range from 18-48 inches in diameter. The culverts are generally in good shape. Two have signs of rust. Fourteen have partially blocked inlets (11 of these were 0-25% blocked). Recommended maintenance is to clean the culverts; in one case installation of a flume (a downspout at the downslope end of the culvert to carry water past the fillslope) is recommended. The urgency of maintenance ranged from low (5 culverts) to medium (3 culverts) to none (45 culverts).

No mass wasting sites were inventoried along Snyder Road.

A total of 4,201 feet (16%) of the inventoried length of Snyder Road is hydrologically connected to a stream. Hydrological connectivity refers to portions of the road that drain directly into a stream via discharge of the ditch, usually locations where the ditch runoff is directed into a

stream at stream crossings. An average of 1.3 tons/year of sediment is estimated to be delivered to streams from surface erosion from the hydrologically connected portions of Snyder Road.

4.2 Pipeline Road (FSR 1260 – 066)

USFS Road 1260-066, better know as the Pipeline Road, is a single-lane native surface road with wide spots. This road is gated at MP 0.03 and is 1.33 miles in length between Snyder Road and the parking lot that marks the start of Trail No. 74 (Pipeline Trail). A short segment (0.09 miles) of Pipeline Road extends from the parking lot down to a pipeline access point.

The Forest Service has assigned Maintenance Level 2 (ML2) to Pipeline Road. ML2 means the road is passable by high-clearance vehicles, drainage structures are maintained, and the tread is maintained to accommodate speeds of 15 mph or less. Public vehicular use of Pipeline Road is prohibited, but it is open to public ATV and non-motorized use.

Pipeline Road and the connecting trail (Trail No. 74) provide motorized access to Packwood Lake. Pipeline Road and Trail No. 74 are maintained by Energy Northwest and are Energy Northwest's primary access for operation and maintenance of the Project's intake facilities. Energy Northwest use of the Pipeline Road and connecting trail is generally once per week, to check on intake facilities and perform needed maintenance. Access is sometimes restricted during winter and spring months due to snow conditions. There are several manhole sites, access for the pipeline, that are used by Energy Northwest staff during the annual maintenance shutdown.

Pipeline Road is native surfaced, with the drivable tread averaging 17 feet wide and a total tread width (including shoulders) of 25 feet. The tread is generally in fair condition, with potholes in several locations (see Appendix B). The road is passable by high clearance vehicles. The tread is graded flat and follows the pipeline route. Brushing would help maintain access.

Pipeline Road does not have a cutslope since it is located on the wide flat bench created during construction of the pipeline. The fillslope is stable with the exception of three locations where the road bed appears to be sagging (Stations 2,852, 3,114, and 3,937; see details in Appendix B). These locations should be checked periodically to determine if additional sagging is occurring that could indicate instability.

One past and potential future mass wasting sites was inventoried at Station 3,937-4,006. This site is an old shallow debris slide that is currently inactive, but has indicators of potential future movement (sagging and cracked road bed). This area should be checked to determine the potential for future movement and to determine if fixing the drainage and/or pulling back the steep fill will help maintain stability. This area was rated as a low treatment urgency due to the small size and location far from aquatic resources.

No culverts were inventoried on Pipeline Road. A total of 397 feet (5%) of Pipeline Road drains to within 100 feet of a stream. Ten to 35 percent of road drainage within 100 feet of a stream is assumed to reach a stream based on the protocol in the WDNR road assessment methodology (WDNR 2004). An average of 0.4 tons/year of sediment is estimated to be delivered to streams from surface erosion from the hydrologically connected portions of Pipeline Road.

4.3 Pipeline Trail (USFS Trail No. 74)

Pipeline Trail (Trail No. 74) provides primary ATV access to Packwood Lake for Energy Northwest. Trail No. 74 is maintained by Energy Northwest. The trail extends from the end of Pipeline Road to Packwood Lake. The trail splits into an upper steeper trail and a lower flat trail 1.42 miles from the end of Pipeline Road. The upper trail is 0.65 miles long and the lower trail is 0.80 miles long before they meet again just below the intake structure. The trail extends 0.13 miles from the second trail junction to the intake; 0.04 miles from the intake to the ATV parking lot (end of motorized use sign) and an additional 0.03 miles to the shore of Packwood Lake. Total mileage from the Pipeline Road parking lot to the ATV parking lot along the upper route is 2.24 miles.

Energy Northwest use of the Pipeline Trail is generally once per week to check on intake facilities and perform needed maintenance. Access to portions of the trail is sometimes restricted during winter and spring months due to snow conditions and safety concerns on the narrow trail. There are several manhole sites that are used to access the pipeline along the trail.

The Pipeline Trail is native surfaced, with the drivable tread averaging 6.5 feet wide and a total tread width (including shoulders) of 9 feet. The tread is generally in fair condition, with potholes in several spots and ruts on one steep section of the upper trail (see Appendix B). The tread varies between flat, outsloped, and crowned.

A total of 21 culverts were inventoried on Pipeline Trail; 6 stream crossings and 15 relief pipes (streams are identified as any channel with a defined bed and banks – including ephemeral channels). Eight culverts are corrugated metal pipes (CMP), 12 are half pipes, and one is concrete. Relief pipes were 12-36 inches in diameter. Stream crossing pipes ranged from 12-24 inches in diameter. Nineteen had partially blocked inlets (10 of these were over 50% blocked). Recommended maintenance was cleaning on most culverts. At one location it is recommended that the pipe eventually be replaced due to rust, intake damage, and crushing. The urgency of maintenance ranged from low (10 culverts) to medium (4 culverts) to high (5 culverts) to none (2 culverts).

The two sets of double culverts at Station 4481-4497 were identified as having a high plug potential, and were 25-75% plugged during the inventory. This is the site of a slide that occurred during the November 2006 rainfall event. This site is currently under investigation and will be resolved outside of the FERC relicensing process; it appears that the fillslope was saturated by the abnormally heavy rains that occurred during the November 2006 rainfall event (declared as a regional disaster by the State of Washington).

At the time of the road inventory, cutslope ravel was observed at twelve locations along the trail. (see details in Appendix B). Several areas of fillslope ravel/sliding were inventoried and are described below.

Nine mass wasting sites were inventoried on the Pipeline Trail; five inactive sites, and four active/potential sites (see details in Appendix B). Eight of the sites are shallow debris slides and one was a stream washout. Past failure volumes are estimated to be from 400-9,000 cubic feet (15-330 cubic yards). Only the stream washout and one potential site along the lower Pipeline

Trail delivered or could deliver sediment directly to a stream. Raveling was occurring at the currently active sites. Potential treatments for the sites include fixing the drainage, pulling back oversteepened fillslopes, fixing or installing crib walls, pulling back berms that have developed on the outside shoulder of the trails, and possibly cutting the large tree that is overhanging the trail with the roots being undercut at one location for safety reasons. Treatment urgency is high at one site, medium at three sites and low at 5 sites.

A total of 836 feet (7%) of the inventoried length of the upper Pipeline Trail is hydrologically connected to a stream. None of the lower Pipeline Trail is hydrologically connected. Hydrological connectivity refers to portions of the road that drain directly into a stream via discharge of the ditch, usually locations where the ditch runoff is directed into a stream at stream crossings. An average of 1.8 tons/year of sediment is estimated to be delivered to streams from surface erosion from the hydrologically connected portions of Pipeline Trail.

4.4 Latch Road (USFS Road 1262)

Latch Road (USFS Road 1262) is a single-lane gravel road with few turnouts. This road is located 1.2 miles up Snyder Road. Approximately 3 miles of the road is in the Lake Creek drainage. The Latch Road is gated and locked approximately 2.28 miles from the junction with Snyder Road. There is no public vehicular traffic behind the gate, a few hunters and recreationalists use the road up to the gate. From the gate, it is another 2.26 miles to the parking lot where the road ends and a short access trail connects to Trail No. 74.

Energy Northwest uses this road in the winter and spring months (approximately once per week), because access on Pipeline Road becomes difficult due to snow depths. In the summer, Energy Northwest most often uses the Pipeline Road to access the lake. During the summer field season, the Forest Service trail crews and volunteers use this road an estimated 10 times per season while working on trails in the Packwood Lake area.

The Forest Service has assigned Maintenance Level 2 (ML2) to Latch Road. ML2 means the road is passable by high-clearance vehicles, drainage structures are maintained, and the tread is maintained to accommodate speeds of 15 mph or less. Vehicular public use of Latch Road up to the gate is discouraged; use beyond the gate is prohibited.

Latch Road is gravel surfaced, with the drivable tread averaging 12 feet wide and a total tread width (including shoulders) of 20 feet. The tread is generally in fair condition, with potholes and ruts in several spots (see Appendix B). Two locations are in need of re-grading; an old slide near Station 17,110 and the recent November 2006 slide. After these areas are re-graded, the road will again be passable by high clearance vehicles. The tread is either outsloped or crowned.

At the time of the road inventory, the entire fillslope and the majority of the cutslope were stable with the exception of 50 feet of raveling/slumping cutbank at Station 17,110 (see details in Appendix B). An uphill slide in November 2006 occurred after the road inventory and is reported to have blocked Latch Road. This slide is being cleared and handled outside the FERC relicensing process. The road is in need of brushing if access is to be maintained.

A total of 26 culverts were inventoried on Latch Road; 11 stream crossings and 15 relief pipes (streams are identified as any channel with a defined bed and banks – including ephemeral channels). All culverts are corrugated metal pipes (CMP). Relief pipes are 18-36 inches in diameter. Stream crossing pipes range from 18-48 inches in diameter. The culverts are generally in good shape. Sixteen have partially blocked inlets (10 of these were 0-25% blocked). Recommended maintenance is to clean the culverts. The urgency of maintenance ranges from low (12 culverts) to medium (3 culverts) to none (11 culverts).

No mass wasting sites related to the Latch Road prism were inventoried (sites coming from the upslope Pipeline Road are described in the Pipeline Road/trail sections).

A total of 3,415 feet (14%) of the inventoried length of Latch Road is hydrologically connected to a stream. Hydrological connectivity refers to portions of the road that drain directly into a stream via discharge of the ditch, usually locations where the ditch runoff is directed into a stream at stream crossings. In addition, 1,661 feet of Latch Road drains to within 200 feet of a stream. Ten to 35 percent of road drainage within 200 feet of a stream is assumed to reach a stream based on the protocol in the WDNR road assessment methodology (WDNR 2004). An average of 3.5 tons/year of sediment is estimated to be delivered to streams from surface erosion from the hydrologically connected portions of Latch Road.

4.5 Latch Trail

The short section of trail that extends from the end of Latch Road (USFS Road 1262) to the Pipeline Trail (Trail No. 74) is referred to as Latch Trail in this report. This trail is used by Energy Northwest personnel to access the lake/intake by snowmobile when snow conditions prevent the use of Pipeline Road, and rarely by ATV during emergencies when the intake must be accessed in the quickest possible way. Latch trail is a short (546 feet long) steep trail (8-20% gradient) with an average width of 5 feet. The trail is in fair to poor condition with ruts, exposed roots, and large rocks in several places along the steeper sections. There are no culverts or mass wasting areas. A sign at the top end of the trail indicates it is closed to motorized public use.

This trail is in need of drainage and tread maintenance. The tread is eroding and rutted in the steeper sections; waterbars and/or surfacing improvements/hardening are needed, particularly if ATV use continues, to prevent further rutting and erosion.

4.6 Traffic Use Patterns

Table 4.2 shows the percentage of Energy Northwest use of USFS Road 1260 and Trail No. 74 by Energy Northwest personnel. The percentage of Energy Northwest use of USFS Road 1260 and Trail No. 74 was calculated based on comparisons of Energy Northwest trips and traffic counts on USFS Road 1260 and Trail No. 74. Generally Energy Northwest personnel visit the Packwood Lake intake once or twice a week. The percentage of Energy Northwest use compared to total use of USFS Road 1260 and Trail No. 74 varies depending on the season and associated number of visitors to the area.

As shown on Table 4.2, the percentage of Energy Northwest use was a small percent of the average use of USFS Road 1260. Energy Northwest averages between 0.28 and 1.08 percent of

USFS Road 1260 use in the peak-season, and between 0.69 and 6.1 percent of USFS Road 1260 use during the off-seasons. The highest percentage of Energy Northwest use of USFS Road 1260 was in the early spring when relatively fewer visitors use USFS Road 1260.

The percentage of Energy Northwest use of Trail No. 74 in the peak-season is higher than shown for USFS Road 1260, but is still relatively small during the peak-season. In the peak-season, Energy Northwest averages between 3.16 and 13.43 percent of Trail No. 74 use. The percentage of Energy Northwest use of Trail No. 74 is significantly higher during the off-season than during the peak-season due to fewer visitors to the area.

During late April/early May, Energy Northwest personnel used mostly Latch Road/Trail No. 74 due to access issues related to snow.

Table 4.2 – Percentage of Energy Northwest Use of FS Road 1260 and Trail 74.

Season/Month		**USFS Road 1260**	**Trail No. 74**
Off-Season Spring	Early Spring (4/26/2006 - 5/9/2006)	6.10%	71.43%
	Late Spring (5/9/2006 - 5/25/2006)	1.65%	18.10%
Peak-Season	May (5/25 - 5/30)	0.41%	7.62%
	June (5/30 - 6/28)	1.08%	13.43%
	July (6/28 - 7/29)	0.69%	6.15%
	August (7/29 - 8/29)	0.32%	3.16%
	September (8/29 - 9/7)	0.28%	4.68%
Off-Season Fall	September (9/7 - 9/28)	0.69%	9.80%
	October (9/28 - 11/10)	0.79%	25.60%
	November (11/10 - 11/29)	1.30%	83.33%

4.7 Pipeline Leakage

The USFS expressed concerns regarding leakage from the Project pipeline in two locations identified as the French drain on Trail No. 74 and the wet area above Latch Road (USFS Road 1262) at approximately MP 3.9. Three areas were investigated by USFS and Energy Northwest personnel before and after the pipeline was drained for maintenance in October 2005. Field visits were conducted by Energy Northwest and the USFS on April 27, May 4, September 29, and October 17/18.

The French drain system on Trail No. 74 was constructed to drain groundwater from Tunnel No. 1. Groundwater encountered during the construction of the tunnel required a re-design of the tunnel to accommodate the installation of a drainage system beneath the tunnel lining. The drain construction details can be found on Drawing 124-C-515.4. The system consists of three 10-inch perforated drain pipes that are bedded in gravel and located beneath the tunnel lining. Starting at the lower end of Tunnel No. 1, the three pipes run approximately 700 feet up the tunnel. The center pipe extends another 200 feet. The three drain lines join together at the lower end and exit as a single pipe along Trail No. 74 several hundred feet below the downstream portal of the tunnel. Water chemistry and temperature were used to determine that the water

flowing from the drain pipe was primarily groundwater and not lake water leaking from the pipeline (EES Consultants). This was confirmed by the observation of continued water flow coming from the drain over two weeks after the pipeline had been drained (October 17, 2005). Water temperature provides a strong contrast between groundwater and surface water during the summer months. The water temperature from the drain ranged from 4.4° to 4.8°C during May through September 2005 compared to 9.3° to 18.4°C for the pipeline (lake) water for the same period.

The second potential leak area is located along Latch Road at about MP 3.9 and was investigated in the field with USFS personnel on April 27, 2005. The swampy area along Latch Road (USFS Road 1262) was walked up slope to determine the source of the water. The water was traced to several culverts near pipeline station 71+00. The culverts had been installed to convey water flowing in a natural stream channel over the top of the pipeline in this area. A review of the USGS topographic map shows that this unnamed drainage continues up Snyder Mountain in the NE¼ of section 19 (T13N, R10E) and is the next drainage east of Art Lake Creek. It was concluded that this stream was the source of the water that formed the wet area along Latch Road.

During the course of these investigations, a third area of potential leakage was identified where a strong flow of water crosses Latch Road about 800 feet southeast (i.e., toward the lake) of the swampy area previously discussed. This stream was walked in the field to its source at the base of the fill material below the pipeline route (May 4, 2005). Temperature measurements were taken monthly from this steam where it crosses Latch Road during June through September 2005. The water from this stream was also identified as groundwater due to its cold and constant temperatures when compared to pipeline (lake) water. The stream temperatures ranged from 5.1° to 6.1°C through the summer when compared to 13.2° to 18.4°C for the lake water in the pipeline. The groundwater conclusion was confirmed by the observation that a strong flow of water was still present over two weeks after the pipeline had been drained (October 17, 2005).

5.0 DISCUSSION AND RECOMMENDATIONS

Critical Question/Objective 1: Document current maintenance of access roads and trails.

The current condition of roads and trails included in this study has been described in Sections 4.1-4.5 and documented in detail in Appendix B. Roads are generally in fair to good conditions with the exception of a few locations. Trails are generally in fair condition, with plugged culverts along Pipeline Trail and some rutting along steep sections of Latch Trail and the upper Pipeline Trail.

Critical Question/Objective 2: Identify maintenance and reconstruction needs to make access roads hydrologically stable and in compliance with USFS maintenance levels.

A final determination of maintenance and reconstruction needs and responsibility along different roads and trails will be made in consultation with the USFS. The USFS road goals and objectives are based on maintenance levels assigned to each road and applicable standards established in the Northwest Forest Plan Aquatic Conservation Strategy. A preliminary estimate of the needs along each of the roads follows.

- Snyder Road appears to meet ML2 requirements.
- Pipeline Road appears to meet ML2 requirements with the exception of periodic brushing.
- Pipeline Trail will likely require maintenance (cleaning) of culverts to maintain drainage, repair and/or installation of buttressing at several mass wasting locations, and maintenance of ruts in the steep section of the upper trail.
- Latch Road appears to meet ML2 requirements once the slide material is removed from the roadway. Periodic brushing is also recommended.
- Latch Trail will likely require treatment of the tread to reduce rutting if it will continue to be used by ATVs.

Critical Question/Objective 3: Are the wet areas observed along Latch Road and/or below the pipeline a result of pipeline leakage?

The three wet areas below the pipeline that were investigated as part of this report continued to flow when the pipeline was shut down. Water in these areas has temperature characteristics of groundwater rather than pipeline (lake) water. These areas do not appear to be the result of pipeline leakage.

6.0 LITERATURE CITED

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APPENDIX A. ROAD/TRAIL INVENTORY FIELD FORMS
ROAD PRISM FIELD FORM

Road Number	
Segment No.	
Surveyor	
Date	
Weather	☐ Sunny ☐ Cloudy ☐ Rainy ☐ Stormy
Segment Start Station	
Segment End Station	
Drainage Point Station (ft)	
Delivery (Stream, Lake or Wetland)	☐ None ☐ Direct ☐ Direct via gully ☐ 1-100 LF ☐ 101-200 LF
Drainage Point Type	☐ Culvert ☐ Arched Culvert ☐ Box Culvert ☐ Ditchout ☐ Bridge ☐ Natural Swale ☐ Sag Point ☐ Water Bar ☐ Dispersed
Ditch Width (sum of 2 ditchs)	LF
Ditch Veg. or Rocked	☐ Yes ☐ No
Ditch Eroding	☐ Yes ☐ No
2 ditches	☐ Yes
Ditch Depth	☐ No ditch ☐ < 1 LF ☐ 1–2 LF ☐ > 2 LF
Ditch Issues: ☐ Stream in ditch ☐ Ditch partially blocked ☐ Ditch fully blocked	
Tread Gradient	%
Full Tread Width	LF
Travel Width (tread wear)	LF
Road Configuration	❑ On Grade ☐ Thru fill ☐ Thru cut ☐ Partial bench ☐ Full bench
Tread Configuration	☐ None ☐ Half ☐ Full

Surfacing	
Road Shape	☐ Flat ☐ Insloped ☐ Outsloped ☐ Crowned
Drivability	☐ Overgrown ☐ Blocked ☐ Not drivable
Cut Slope Cover Density	☐ 90 – 100 % ☐ 70 – 90 % ☐ 50 – 70 % ☐ 30 – 50 % ☐ 10 – 30 % ☐ 0 – 10 %
Cut Slope Average Height	☐ No cutslope ☐ 2.5 VF ☐ 5.0 VF ☐ 10.0 VF ☐ 25.0 VF
Cut Slope Angle	☐ < 45º (<1:1) ☐ 45–50º (1:1) ☐ 50-70º (1/2:1) ☐ > 70º (1/4:1)
Cut Slope Structure Issues: ☐ Stable Cut Bank ☐ Overhanging' ☐ Solid Rock ☐ Seepage from bank ☐ Raveling, large ☐ Raveling, fines ☐ Slumping	
Road Issues: ☐ Sidecast berm ☐ Rutted >4" ☐ Potholes ☐ Holes/failed drng. structure ☐ Debris on road (rock, soil) ☐ Water running across road ☐ Saturated road bed ☐ Washboarding ❑ Washout	
Fill Slope Structure Issues: ☐ Potential to deliver ☐ Oversteepened fill ☐ Culvert fill failing ☐ Soft fill on shoulder ☐ Shoulder slope failure ☐ Perched landing ☐ Sidecast cracking ☐ Sidecast erosion	

Photo #'s:

Comments:

CULVERT INVENTORY FORM

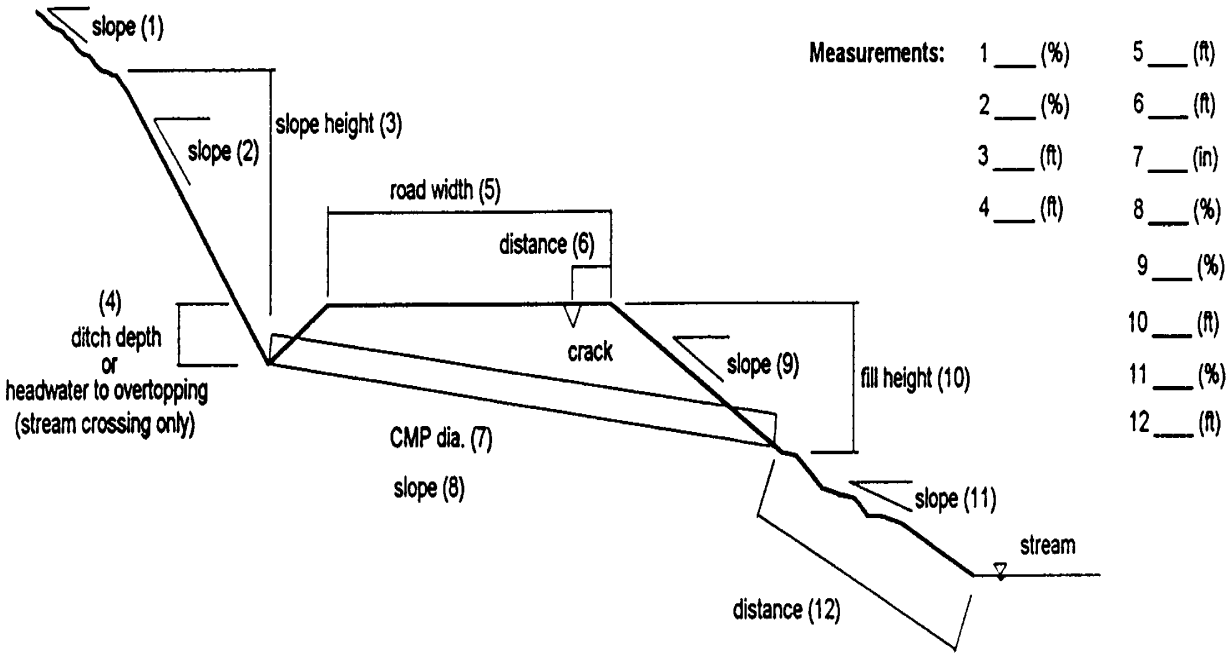
<table>
<tr><td>Road Number</td><td></td><td>Surveyor</td><td>Date</td></tr>
<tr><td>Culvert Number</td><td></td><td>Station (ft)</td><td></td></tr>
<tr><td>Culvert Length (ft)</td><td></td><td>Culvert Diameter (in)</td><td></td></tr>
<tr><td>Purpose
❑ Stream crossing
❑ Relief
❑ Other _____</td><td>Inlet
❑ OK
❑ Perched intake <1’
❑ Perched intake >1’</td><td>Outfall Drop
❑ Drop < 1’
❑ 1’ to 2
❑ 2’ to 5’
❑ > 5’</td><td>Photo
❑ Yes Number _____
❑ No</td></tr>
<tr><td rowspan="2">Type of Culvert
❑ CMP
❑ HDPE
❑ Puncheon
❑ Cast iron
❑ Concrete
❑ Tile
❑ Wood staves
❑ Arched Pipe
❑ Bottomless Arch
❑ Other _____</td><td>Inlet Features
❑ Trash rack
❑ Drop inlet
❑ Wingwall
❑ Other _____</td><td>Outlet Features
❑ Downspout
❑ Armored
❑ Other _____</td><td>Future Plug Potential
❑ None
❑ Low
❑ Medium
❑ High</td></tr>
<tr><td>Inlet Blockage
❑ None
❑ 0 to 25%
❑ 24% to 50%
❑ 50% to 75%
❑ 75% to 100%
Cause _____</td><td>Outlet Blockage
❑ None
❑ 0 to 25%
❑ 24% to 50%
❑ 50% to 75%
❑ 75% to 100%
Cause _____</td><td>Prescription Urgency
❑ None
❑ Low
❑ Medium
❑ High</td></tr>
<tr><td colspan="2">Culvert Condition Issues

❑ No Problems
❑ Belly
❑ Bent
❑ Broken
❑ Corrosive rust
❑ Corrosive Rust with holes
❑ Fill Failing
❑ Intake damaged
❑ Outfall damaged
❑ Partially Crushed
❑ Puncheon Failing
❑ Separated
❑ Undermined</td><td>Culvert Function Issues
❑ None
❑ Cutslope erosion
❑ Ditch Blocked
❑ Failed Headwall
❑ CB full of Sediment
❑ CB Full of Water
❑ CB too Deep/Sump
❑ Poor Alignment
❑ Intake Eroded
❑ Flow under/ around
❑ Too short
❑ Too Small
❑ Outfall eroded
❑ Shotgunned</td><td>Prescription
❑ None
❑ Clear Ditch
❑ Rebuild CB
❑ Headwall Install/Repair
❑ Backhoe
❑ Remove blockage
❑ Flush
❑ Raise
❑ Lower
❑ Lengthen
❑ Cut at outfall
❑ Repair
❑ Remove
❑ Add Flume
❑ Armor outfall
❑ Replace w./drivable dip</td></tr>
<tr><td colspan="4">Comments</td></tr>
</table>

MASS MOVEMENT INVENTORY FORM

Road Number		**Surveyor**	**Date**
Station (ft)		**Weather**	
Width (ft)		**Length (ft)**	
Scarp Height (ft)		**Estimated Past Failure volume (cu ft)**	
Delivery to Stream (%)		**Estimated Future Failure volume (cu ft)**	
Type ❑ Shallow debris slide ❑ Debris torrent ❑ Deep-seated rotational ❑ Other _____	**Activity** ❑ Active ❑ Potential ❑ Inactive	**Features** ❑ Cracks ❑ Scarps ❑ Sagging ❑ Holes ❑ Wet Vegetation ❑ Leaning Trees ❑ Ponded water	**Future Failure Potential** ❑ High ❑ Medium ❑ Low
Photos:	**Comments:**	**Potential Treatment** ❑ Fix drainage ❑ Dewater slope ❑ Pull back fill ❑ Retaining wall/buttress ❑ Revegetate ❑ Other_____	**Treatment Urgency** ❑ High ❑ Medium ❑ Low

Record dimensions as appropriate:



APPENDIX B. ROAD INVENTORY DATA

See File: Engineering Roads Appendix B.PDF; 7 pages